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CONTENTS

Laser Photoacoustic Spectroscopy and Imaging
S. N. Thakur

Modelling of High Speed Traction Using Linear Induction Motor
Manisha Agrawal, Girish Kumar Singh, Rahul Kr. Sharma and Harshit Tripathi

Short Term Power Load Forecasting based on Fuzzy Inference System with Grasshopper Optimization Algorithm
Arpit Varshney and Manisha Agarwal

Excitement of Higher Mode by Cutting Slot on the Patch to Increase the Bandwidth of Microstrip patch Antenna
Sonali Dubey and Manoj Kr Vishwakarma

Characterisation of Bituminous Concrete Mix and Warm Mix Asphalt Prepared Using Lime and Zycotherm as Additive
Deependra Kumar Varshney

The use of Novel Drug delivery system: Transdermal Patch
Niharika, Athira Nair, Swati Sabharwal and Navneet Verma

A Study of Government Schemes for Women Entrepreneurship Development in India
Dinesh Kumar Rana

Paris Agreement on Climate Change: A Multilateral Approach towards Achieving Sustainable Development
Hrishikesh Manu

Global Challenges to Higher Education of India and Its Strategies to Attain Global Standard
Dr. Shakti Prakash, Mr. Bipin Kumar Singh, Ms. Rachana Srivastava and Dr. Apurva Srivastava

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C O N T E N T S

Laser Photoacoustic Spectroscopy and Imaging **1-13**
S. N. Thakur

Modelling of High Speed Traction Using Linear Induction Motor **14-16**
Manisha Agrawal, Girish Kumar Singh, Rahul Kr. Sharma and Harshit Tripathi

Short Term Power Load Forecasting based on Fuzzy Inference System with Grasshopper Optimization Algorithm **17-22**
Arpit Varshney and Manisha Agarwal

Excitement of Higher Mode by Cutting Slot on the Patch to Increase the Bandwidth of Microstrip patch Antenna **23-27**
Sonali Dubey and Manoj Kr Vishwakarma

Characterisation of Bituminous Concrete Mix and Warm Mix Asphalt Prepared Using Lime and Zycotherm as Additive **28-33**
Deependra Kumar Varshney

The use of Novel Drug delivery system: Transdermal Patch **34-39**
Niharika, Athira Nair, Swati Sabharwal and Navneet Verma

A Study of Government Schemes for Women Entrepreneurship Development in India **40-45**
Dinesh Kumar Rana

Paris Agreement on Climate Change: A Multilateral Approach towards Achieving Sustainable Development **46-50**
Hrishikesh Manu

Global Challenges to Higher Education of India and Its Strategies to Attain Global Standard **51-60**
Dr. Shakti Prakash, Mr. Bipin Kumar Singh, Ms. Rachana Srivastava and Dr. Apurva Srivastava

Address for Correspondence

Director, IEC Group of Institution
4, Institutional Area, Surajpur Kasna Road, Knowledge Park, Greater Noida 201306, UP
Phones: 0120-2326665/232653
E-mail: editor_Journal@ieccollege.com Website: www.iec.edu.in

Laser Photoacoustic Spectroscopy and Imaging

S. N. Thakur
Banaras Hindu University
snthakur@gmail.com
www.laser-spectro.blogspot.com

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1. Introduction

Photoacoustic spectroscopy measures the effect of absorbed electromagnetic energy, particularly that of light, on matter by means of acoustic detection. It is based on the photoacoustic effect. When a periodically interrupted beam of light is incident on a material target, it generates a sound wave with the periodicity of interruption and its intensity depends on the optical absorption as well as the subsequent non-radiative decay in the material. This phenomenon, termed as the 'Photoacoustic Effect', was first discovered by Alexander Graham Bell in 1880 while attempting to transmit sound over a beam of sunlight. Bell converted a spectrometer into a 'Spectrophone' (Fig.1), by installing a thin film of lampblack in place of the cross-wires and replacing the telescope by a hearing tube to demonstrate that sound was generated at all wavelengths of the electromagnetic spectrum but its loudness was proportional to the spectral intensity [1].

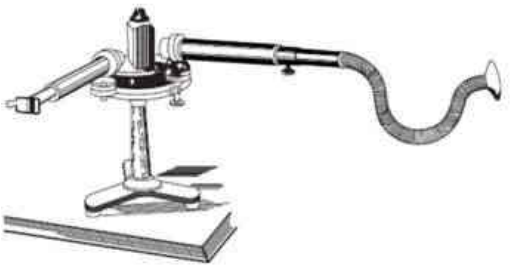


Fig.1: Bell's spectrophone for listening to the variation of sound intensity resulting from absorption of light by carbon black at different wavelengths

Photoacoustic spectroscopy remained dormant for more than nine decades, till the advent of tunable lasers in the 1970s [2], and since then it has been widely applied for investigations in the fields of material science, agriculture, defence, industry, biology and medicine. The main advantage of this technique is, that it does not require much sample preparation and the spectra of solids; liquids, gels and vapours can be recorded with equal ease. Two types of detectors, for light-generated sound waves, have been employed namely the electret-microphones and the piezoelectric transducers [3, 4]. In order to increase the sensitivity of spectral detection in gas-phase, photoacoustic cells operating on the principle of open-end or closed-end organ-pipes have been employed [5], and in the case of field investigations involving remote detection, tiny quartz tuning forks have been used [6].

Optical spectroscopy provides a channel for the atoms and molecules to communicate with the world outside them, and their various quantum states express themselves through the spectral lines. However, there are some excited quantum states of molecules that do not emit spectral lines following optical absorption. These are known as the 'Dark States'. Repulsive electronic states of molecules, that cause dissociation upon excitation, are an example of dark states. Photoacoustic spectroscopy has been found very effective in exploring dark states both in one-photon and two-photon absorption processes [7, 8].

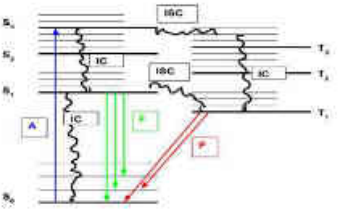


Fig.2: Radiative (A, F, P) and non-radiative processes in an organic molecule, where S and T stand for singlet and triplet electronic states respectively. Vibrational energy levels of the electronic states are shown by light horizontal lines. Rotational levels are not shown. A, F, and P stand for absorption, fluorescence and phosphorescence respectively. Non-radiative processes IC and ISC refer to internal conversion and inter-system crossing.

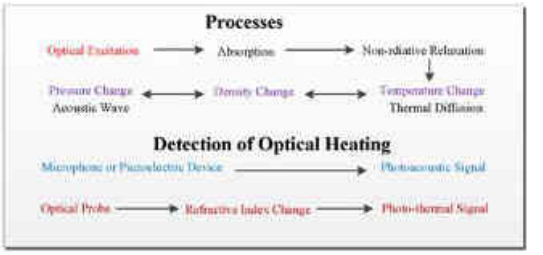
Laser photoacoustic technique has been used for trace detection of explosives and harmful chemicals in the laboratory as well as in the field [9]. During the past twenty years spectral imaging techniques have been increasingly used in medicine, following their success of remote Earth sensing, with the goal of enhancing objective assessments and diagnostic accuracy. A histopathologist looking into a biological sample and an earth scientist looking into a region of interest share similar objectives in classifying a complex field of view. In both cases the field of view is heterogeneous with abundant areas that may be of no direct interest, but it may be potentially surrounding or embedding target objects of great value to the researcher. In both cases the main goal of a spectral image is akin to locate a needle in a haystack – where the needle is the 'target' such as a melanoma, and the haystack is everything else. It has been possible to effectively resolve genetically expressed agents (fluorescent proteins) deep in intact living animals with high spatial resolution and high sensitivity using photoacoustic imaging [10].

2. Basic Processes in Photoacoustic Spectroscopy

When the excitation wavelength overlaps with an absorption band of the sample, the atoms or molecules of the sample get transferred into a higher electronic or vibrational energy state which relaxes to a lower energy state via radiative as well as non-radiative transitions. The non-radiative relaxation in the sample is accompanied by conversion of the absorbed optical energy into heat which results in a temperature change as well as changes in thermodynamic parameters of the sample that are related to temperature (see Table 1). The process of thermal diffusion in the sample shifts the heat from its initial region to other parts causing changes in its density and pressure, and also in the fluid that is in direct contact with the sample. When the incident beam intensity is modulated at a frequency in the acoustic range, it gives rise to heat induced thermal expansion in the sample and photoacoustic signal is produced.

The magnitude of PA signal is linearly dependent on the concentration of the optically absorbing constituent of the sample. The measurement of temperature, pressure, and changes in density occurring due to optical absorption result in photoheating of the sample. This proves that PA signals are directly dependent on light absorption. Scattering and reflection losses do not produce PA signals. Thus, the strength of PA signal is proportional to the absorption and to the subsequent non-radiative relaxation of atomic or molecular species.

Table 1. Basic processes and detection of optical heating



3. Photoacoustic Spectroscopy of Condensed Matter

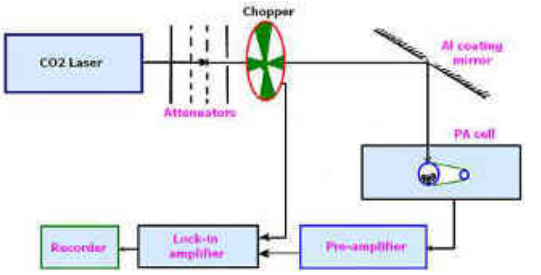


Fig.3: Experimental setup for recording photoacoustic spectra, of solid sample, in the infrared region with rotational-line tunable CO2 laser. [Adopted from Ref. 9]

A modern photoacoustic spectrometer with microphone detector is shown in Fig. 3. The air present in the photoacoustic cell transfers the periodic heating at the sample surface located below the optical window (larger circle), as an acoustic wave to the side microphone (small circle). The CO2 laser beam was attenuated to a few mW powers before meeting the chopper and its power was measured at each rotational-line emission from the laser with a power meter. The photoacoustic (PA) signal from the microphone is pre-amplified before its processing and the output of the lock-in amplifier was manually recorded at each wavelength of the line-tunable CO2 laser.

The PA signals are normalized at each wavelength using the corresponding power meter readings and is plotted against the wavelength to exhibit the spectrum in the

tunable range of the laser beam. The spectra of powder samples of RDX and TNT are shown in Fig. 4, where the solid circles represent the normalized PA signal at each rotational line of the CO2 laser which was tunable in 9.6 μm and 10.6 μm regions. Vibrational bands of pure RDX and TNT are shown in the upper part of Fig.4, while the bands in samples of the two explosives, by adding SiO2 powder, are exhibited at the bottom [9]. Four of the vibrational bands of RDX and five of TNT persist even at this low concentration and can be useful in trace detection of the explosives at concentrations of a few ppm.

One of the latest photoacoustic techniques uses a quartz tuning fork as the detector of sample-absorption [6]. A typical experimental set up for remote detection of trace impurities on surfaces is shown in Fig.5. The basic idea of quartz-enhanced photo acoustic spectroscopy is to accumulate the acoustic energy not in a gas-filled cell but in a sharply resonant acoustic quartz transducer. An easy material for such a transducer is crystal quartz, because of its low-loss piezoelectric property and quartz tuning forks (QTF) intended for use in electronic clocks as frequency standards have been used for PA detection. These QTF resonate at 32768 Hz in vacuum and the detection of PA signal is based on the piezoelectric effect. The two tines of the QTF shown in Fig.5 may be regarded as two identical beams of length 'L', width 'b' and thickness 'h'. We may approximate the QTF as a system of two weakly coupled beams, each of which is a cantilever with a fixed end. The tuning fork has two vibrational modes, each with a different natural frequency. One of the modes is symmetric in which the two tines move in opposite directions with respect to the central plane in the gap and the other mode is anti-symmetric with one tine approaching the central plane while the other is going away from it. The QTF is so designed that only the symmetric mode induces an electrical signal via the piezoelectric effect.

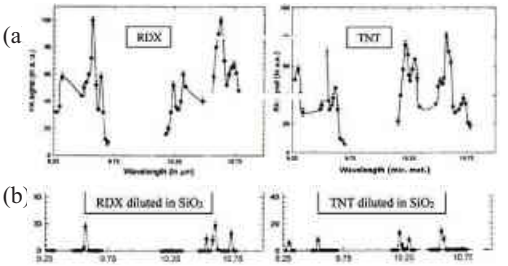


Fig.4: Photoacoustic spectra of vibrational bands of (a) RDX and TNT powders using CO2 laser, and (b) quantitative detection by uniform dilution of 10 mg explosive in 8g of SiO2 [Adopted from Ref. 9]

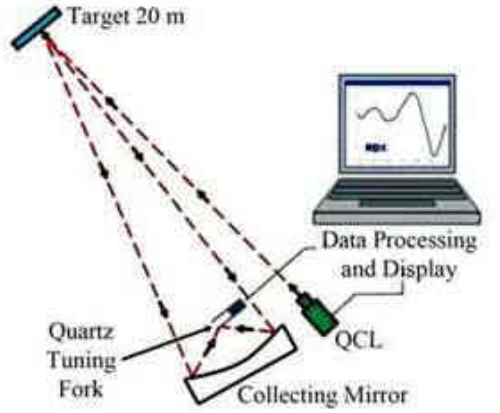
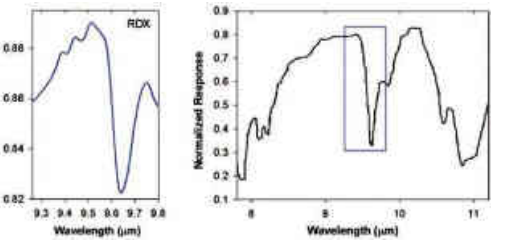


Fig.5: Remote photoacoustic detection of surface impurity with a quartz tuning fork (QTF) detector [Adopted from Ref. 6]



(a) (b)

Fig.6: (a) Remote recording of PA spectrum of RDX, at a distance of 20 meters from the QTF detector. (b) The IR spectrum of RDX in a wider wavelength region with the range of tunable QCL enclosed in a rectangle. [Adopted from Ref. 6]

The quantum cascade laser (QCL) is a compact narrow-linewidth mid-IR source that combines single-frequency operation with powers up to tens of mW. The large wavelength coverage available coupled with its room temperature operation makes it possible to monitor trace amounts of numerous molecular species. A pulsed QCL illuminates adsorbed RDX sample on the surface of a distant target and the repetition rate of the incident laser pulse is made equal to the mechanical resonant frequency of QTF. The scattered light from the target (its surface containing RDX residue) was collected using a mirror and focused on a Citizen QTF [6]. The periodic light beam focused on the tine surface of QTF generates periodic pressure changes due to optical heating and sets the resonant vibration. The amplitude of the tine vibrational motion is proportional to the intensity of

light focused on QTF surface. The scattered light from the target suffers a decrease in intensity at certain wavelengths due to selective absorption by the trace molecules and the amplitude of vibration of the QTF tine is decreased at those wavelengths. A computer captures the piezoelectric voltage generated from vibration of the QTF and records it as a function of the illumination wavelength. The photoacoustic signal appears as a dip at the wavelength of selective absorption by the trace material and constitutes the chemical signature of the molecules enabling the remote detection of the hazardous chemicals. The QCL light was varied in steps of 0.01 nm in its tunable range from 9.25 to 9.80 μm to record the spectrum shown in Fig. 6(a).

4. Hyperspectral Imaging

Fig.7: Hyperspectral image of the confluence of a river (black) and a polluting stream (Blue). Artificial colors adjusted on the basis of scattered of sunlight from different regions. Clean water of river reflects much less than the suspended particles in the polluted water, whereas reflection from white sand is the largest [Courtesy Prof. K N P Raju, Geography Dept., BHU]

Hyperspectral imaging (HSI) is a combination of spectroscopy and imaging, so it is often also called imaging spectroscopy. The spectral information identifies the materials in the scene, while the spatial information provides location. This technology has developed over a period of nearly five decades, but during the past two decades it has come into great prominence because of applications in many diverse fields such as, remote sensing of agriculture, medicine, biological science, crime detection, Earth resources, etc.[Fig.7]. Hyperspectral imaging can gather spectral and spatial information in wavelength ranges from the UV to long-wave IR. Targets of interest have spectral signatures in various wavelength ranges and the choice of wavelength range and imaging sensor is determined by its application. The acquired image of the target contains information on the characteristic spectral properties of materials present in different spatial locations in the scene and this image is stored in the form of numbers, by using appropriate optical sensor technology. This imaging concept produces a data cube (or a hypercube) comprising of 2-D spatial information and a third, spectral dimension providing a full spectrum for each pixel in the imaged scene [11]. The data obtained during these observations is so massive and complex in nature that its analysis requires the most modern methods of computer data processing. The end result of analyzing a hyperspectral image is akin to a superhuman eye that can see and distinguish materials, at different spatial locations, on the basis of information from those electromagnetic waves that are invisible to human eye. The importance of hyperspectral image analysis is that it can distinguish objects emitting or reflecting ultraviolet ($\lambda < 380$ nm) or infrared ($\lambda > 780$ nm) wavelengths in addition to the visible wavelengths. This versatile technology makes use of the knowledge of spectroscopy and digital imaging for acquiring the information and that of computer data processing for analyzing it. High resolution spectral imaging is a preferred means of remote Earth sensing and mapping the location of 'spectral objects' such as, pollution, vegetation, minerals and insect infection on agricultural farms. The same methodology has been adopted in medical field of histopathology with the goal of enhancing objective assessments and diagnostic accuracy.

The application of spectral imaging in medicine with a histopathologist looking into a biological sample, can be compared with that of an Earth scientist looking into a region with vegetation and dry soil. Although the imaging spectrometer for collecting the data may be the same for both earth sensing and histopathology, the algorithms needed for data processing are quite different. This difference can be illustrated by considering the examples of spectral imaging of a tree leaf and that of a histological section. The spectrum of a tree is dominated by its leaf when acquired from a distance, will be observed as a single spectrum (that of chlorophyll). But zooming into the leaf may reveal spatial differences in the color distribution due to localized areas of disease or insect attack. This composite spectral signature of the entire leaf can be

analyzed as a true linear mixture of the spectral components; because each area of different color (spectral curve) is independent of all the other colored areas. Thus the mixed spectral profile is a linear addition of the end members because they do not interact. However, in the case of a stained histological section, one cannot assume that any spectrum is a linear mixture of the individual components. When two or more stains are mixed, and interact with biological material; the individual stains will undergo spectral change as a result of chemical interactions. In such a situation, it is reasonable to assume that two or more co-localized color centers are the result of a nonlinear mixtures of the components. In order to employ the powerful algorithm necessary to handle nonlinear spectral data, a high spectral resolution is needed to ensure accurate digital reconstruction of the field of view.

Apoptosis and autophagy are two types of programmed cell death in normal physiology as well as in conditions such as cancer. Images, of tumor sections (colon cancer) from control mice and that treated with lexatumumab were immunostained with hematoxylin (H&E), are shown in Fig.8. These sections were imaged with a white light source and a Zeiss fluorescence measuring microscope [12]. Fluorescence excitation wavelength was 475 nm and a long-pass emission filter (500 - 750 nm) was used to record spectra for the distinct spectral profiles shown in Fig.8B. The green color-coded spectral profile corresponds to regions of dense non-cellular stromal tissue, the red profile represents cell-dense tumor tissue and the blue profile marks apoptotic regions. The amount of blue spectra in a 5mm-wide portion of tumor was quantified by scanning five 1mm sections. It is found that the average amount of blue spectra corresponding to apoptotic regions is significantly higher in the Lexa group compared to the control group. This is a validation of the HSI technique for assessment of apoptosis in broad tumor area with the advantage that subjectivity is minimized, which is introduced by manual methods that require counting of marker positive cells.

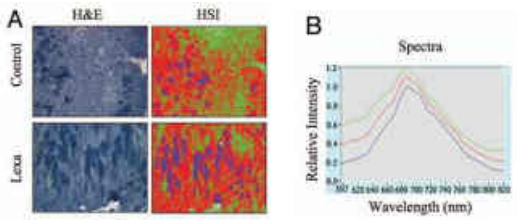


Fig.8: Low magnification (2.5X) images from H&E-stained HCT15 tumor (A) and the HSI pseudo-map derived from spectral library shown in (B) [Adopted from Ref. 12]

5. Photoacoustic Imaging in Medicine

Photoacoustic imaging is a non-invasive technique which produces structural, functional and molecular images of internal organs in small animals. When the sample is illuminated by a short pulse of laser light, its local absorption is followed by rapid heating, which subsequently leads to thermal expansion and generates ultrasonic waves. The outgoing ultrasonic waves are recorded with adequate transducers outside of the sample to form the image that reveals the initial absorbed energy distribution in the sample. Thus, photoacoustic imaging is a hybrid technique making use of optical absorption and ultrasonic wave propagation as shown in Fig. 9. It has the advantage of high contrast of optical imaging and high resolution of ultrasonic imaging.

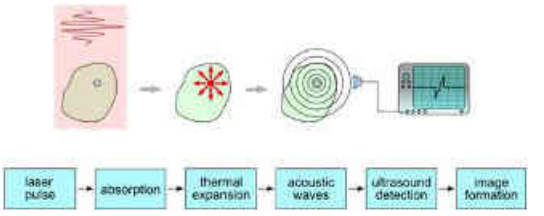
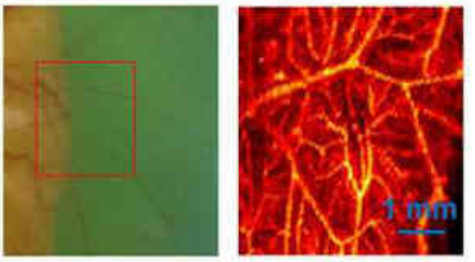


Fig.9: Principle of photoacoustic imaging of soft tissue

For efficient generation of a photoacoustic signal two conditions- 'thermal confinement' and 'stress confinement', in the sample must be satisfied. The condition of 'thermal confinement' requires that the laser pulse duration τp should be shorter than the temporal duration τth of thermal diffusion from the volume heated by the laser pulse. This condition implies that there is negligible heat diffusion during the excitation pulse. The thermal diffusion length during the laser pulse is given by $\delta T = 2(DT\tau p)1/2$ where DT is the thermal diffusivity of the sample. A typical value of DT =1.4x10-3 cm2/s for most soft tissue [13], so that $\delta T = 0.05\mu m$ for an optical pulse of $\tau p = 5ns$. The duration of thermal diffusion is given by $\tau th = L2/4DT$ where L is the radius of spherical region of heat propagation in the sample. Thus for $L = 15\mu m$ we get $\tau th = 0.4ms$. Similarly, the condition of 'stress confinement' requires that time τs for the stress to transit the heated volume should be larger than τp. If c is

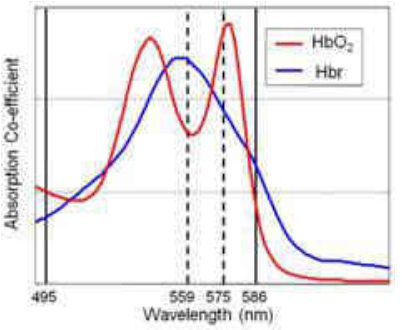
the speed of sound in the sample the time taken by the stress to transit a sample length L in the heated region is given by τs =L/c. Thus assuming c= 1.5mm/μs and DT =1.4x10-3 cm2/s, we would achieve a spatial resolution of 15μm in the PA image if τs =10 ns and τth =0.4 millisecond. In view of the above description of the process of heat generation, it is seen that a laser pulse of 5 ns duration would satisfy the two conditions for generating PA signals efficiently.

The difference between the optical image and the PA image of a biological sample is shown in Fig. 10. Optical absorption of biological tissues in the visible and near-IR regions depend on their molecular constituents. Hemoglobin is a very prominent molecular constituent of tissue and its absorption spectrum changes when it is bound to an oxygen molecule. Oxygenated hemoglobin (HbO2) has strong absorption up to 600 nm at which point it decreases by almost two orders of magnitude and remains low till it again increases in the near-IR region. The absorption in deoxygenated hemoglobin (Hb), however, does not drop as steeply with increasing wavelengths as in HbO2, but it goes on decreasing progressively in the near-IR region (see Fig.11).



(a) **(b)**

Fig.10: Images of a chick embryo chorioallantoic membrane (CAM): (a) using white light and (b) using PA microscopy. [Adopted from Ref. 14]



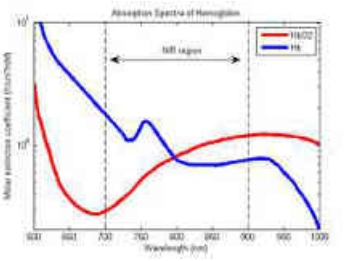


Fig.11: Absorption spectra of oxyhemoglobin (HbO2) and deoxyhemoglobin (Hb) in the visible and near-IR regions

There are two isosbestic wavelengths, 584 nm in the visible and around 800 nm in near-IR, where the molar absorption coefficients of the two forms of hemoglobin are identical. The PA signal is sensitive to the total concentration of hemoglobin at the isosbestic wavelengths but insensitive to the oxygenation of hemoglobin. Tuning the laser to another wavelength where the two forms of hemoglobin have different molar absorptions provides a second measurement and the two measures are combined to compute the oxygen saturation of hemoglobin. The oxygen saturation of hemoglobin is related closely to the metabolic state of the imaged organ. Rapidly growing cancer cells need additional blood and they develop a dense microvascular network around them to continue tumor growth. PA image can be used to deduce certain physiological parameters, to quantify the hallmark of cancer and thereby help early cancer detection.

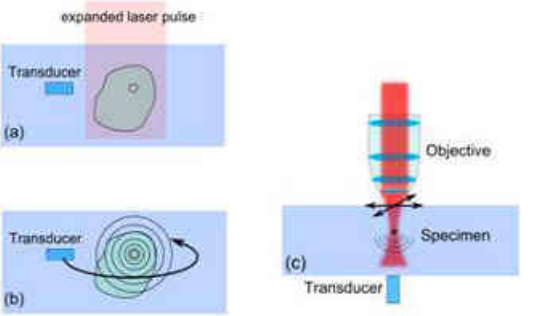


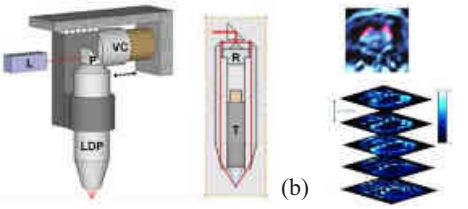
Fig.12: Schematic diagrams of photoacoustic tomography (a & b) and photoacoustic microscopy (c)

Like any other waves, photoacoustic waves are also subject to Doppler effect, which enables imaging of blood flow. PA technique is the only method that can measure all the endogenous physical parameters-including- concentrations of two forms of hemoglobin,

the diameters of blood vessels, the blood flow velocities and the volume of the region of interest. These parameters are needed to quantify the metabolic rate of oxygen in vivo in absolute units. There are two major implementations of photoacoustic imaging-photoacoustic tomography (PAT) and photoacoustic microscopy (PAM) as shown in Fig.12. In the case of PAT, the whole sample is illuminated by an expanded laser beam (Fig.12 a). Laser pulses absorbed at various points in the sample create pressure changes due to thermoelastic expansion leading to the generation of ultrasonic waves. An ultrasonic transducer placed outside the sample detects the PA signal, which can be measured either by moving a single transducer around the sample or by using an array of transducers. Photoacoustic image is obtained from the data set of PA signals by using suitable reconstruction algorithms. The resolution of PAT is determined by the duration of the excitation laser-pulse and the bandwidth of the transducers. The attenuation of ultrasound wave is caused by losses due to absorption and scattering. Ultrasound waves of a few MHz suffer very little attenuation, and can penetrate deep into the soft tissue. The attenuation, however, increases with increasing frequencies and 3 MHz might be the maximum frequency for a 15 cm penetration. The most commonly used ultrasound detectors for imaging, are piezoelectric based with low thermal noise, high sensitivity and a wide band up to 100 MHZ.

In photoacoustic microscopy the laser beam is focused into a small volume and ultrasound waves are launched only from this localized region. For a 3D image the sample is scanned in two dimensions and axial resolution of the image can be as good as the optical resolution i.e. below 1µm, where the depth information is determined by the run time of the acoustic waves. Theoretical studies deal with optimal detector geometries by taking stochastic processes into account and image reconstruction algorithms play a very important role in PA imaging. These algorithms handle the complex set of data gathered by the transducers and allow reconstruction for acoustic heterogeneous samples such as tissue including bone. Theoretical work also helps in characterization and compensation of ultrasonic attenuation and allows better imaging quality and higher resolution. In the following sections we will discuss a few examples of PA imaging in conjunction with 3-dimensional ultrasound and OCT imaging.

5.1 3-Dimensional Photoacoustic & micro-Ultrasound Imaging



(a) (b)

Fig.13: (a) Diagrammatic representation of the combined PA and micro-US imaging system (left and middle). (b) In vivo PA image of a section of Zebrafish brain that expresses the fluorescent protein mCherry. [Adopted from Ref.10]

Fluorescence microscopy is very effective tool in thin samples like single-celled organisms. However, with slightly thicker samples it becomes difficult to know from where exactly the fluorescence originates. Although the situation improves with the adoption of advanced techniques such as confocal fluorescence microscopy and multiphoton microscopy; it has been seldom possible to image deeper than 1 mm in transparent samples and matters are worse with diffuse samples. In more complex organisms, like Zebrafish, it is crucial to image deeper and deeper while keeping the samples alive and without slicing them. In the detection of light one loses information on its origin and propagation path, as a result of multiple scattering, giving rise to blurred images and destroying spatial resolution. The photoacoustic detection of light-matter interaction circumvents these limitations, because acoustic signals travel through the diffuse biological media with much less distortion than the fluorescence photons. With photoacoustic imaging it has been possible to effectively resolve genetically expressed agents (fluorescent proteins) deep in intact living animals with high spatial resolution (40 micron) and high sensitivity. Both intrinsic and dye based imaging can be done with higher dynamic contrast in intact tissues.

The technique of 3D photoacoustic imaging can be understood with reference to Fig.13a. A tunable laser beam L, is diverted towards the 45o reflective cone R, by the prism P, and a 45o polished face reflects the horizontal light downward along the longer sides of the ultrasound probe. Light is focused about 10.5 mm below the bottom of the probe. The ultrasound transducer (T) position is adjusted vertically to match its focus point

with laser focus by maximizing the photoacoustic signal from a carbon fiber sample [10]. The combined ultrasound and laser light probe is mounted on a voice-coil (VC) stage which is driven by a programmed motor controller to achieve up to 10 Hz oscillations over about 9 mm and providing up to 20 imaging frames per second. This imaging system can run in three different modes: ultrasound mode, photoacoustic mode, and interlaced ultrasound-photoacoustic mode. High frequency photoacoustic microscopy (PAM) can provide outstanding images of microvascular structures to depths of 2-3 mm in vivo. This hybrid imaging system can operate at 25 MHz and offers real time ultrasound imaging capabilities at a resolution and depth scale comparable with PAM parameters. The ultrasound and laser pulses are interlaced in this system, thus providing natural co-registration of the two complementary contrasts. This feature of the imaging system is illustrated in Fig.13b in the case of in vivo imaging of part of the brain of Zebrafish.

In an experimental investigation [15], tumor cells incorporated with tyrosinase (+TYR cells) and those without transfection of tyrosinase (-TYR cells) were injected subcutaneously in the back, right and left flanks of hairless SCID mice respectively as shown in Fig.14a. When tumors were at least 1mm in diameter, mice were given 1mg/mL DOX drinking water to induce TYR expression.

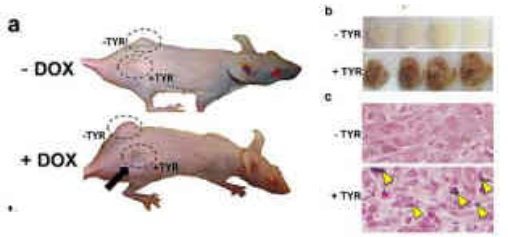


Fig.14: Visual examination TYR expression in xenograft tumors: (a) Photographs of mouse before and after DOX administration. (b) Photographs of excised tumors one week after DOX treatment. (c) Stained tumor sections with melanin granules shown by yellow arrows. [Adopted from Ref.15]

One week after TYR induction with DOX, the +TYR tumors were visually darker than –TYR tumors as determined by eye [Fig.14b] and in ½ mm tumor sections [see Fig.14c]. TYR is a key enzyme regulating melanin production in hair and skin in humans. Melanin has a broad spectral absorption in visible and near-IR wavelengths which have strong tissue penetration properties. Reporter genes are useful in the identification of specific cells within a population of cells and inducible systems represent an important class of reporter technology. TYR is an enzymatic reporter gene but its expression, in xenograft tumors, is not turned on (or off) until an inducer such as doxycycline (DOX) is added. The treatment of DOX can be administered in vivo by adding it to the drinking water of animals. After turning on melanin production, tissues with TYR-expressing cells may be detected with photoacoustic imaging.

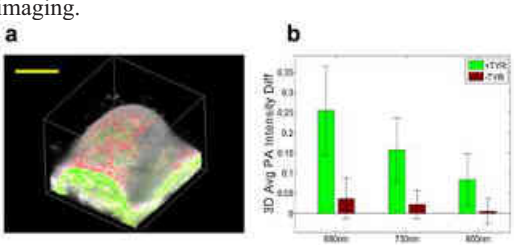


Fig.15: Single wavelength 3D photoacoustic and micro-ultrasound imaging: (a) Volumetric 3D visualization of +TYR tumor expressing melanin at 680 nm with PA signal at surface (in red) and inside (in green) with superposed ultrasound signal (in gray) and yellow bar represents 1mm. (b) Quantification of PA signal difference between pre and post DOX treatment at 680, 750, and 800, averaged over the tumor volume. [Adopted from Ref. 15]

For in-vivo experiments, mice were imaged one at a time with a hybrid imaging system similar to that shown in Fig.13 after one week of the DOX drinking water treatment. Single wavelength PA image and superposed ultrasound image are exhibited in Fig. 15. The +TYR and -TYR tumors on each of six mice were imaged separately using volumetric scans over wavelengths from 680 to 980 nm in 5 nm increments and significant changes were observed in PA images of tumors after melanin induction as shown in Fig.16. Single wavelength PA imaging cannot differentiate different sources of PA signal such as oxy-hemoglobin, deoxy-hemoglobin or melanin (see Fig 16a). Multi-component in-vivo PA images were generated with appropriate software by using a threshold for the total hemoglobin map (chosen as 1/3 of the maximum) and displaying saturated oxygen estimates in pixels above this threshold in a red-blue color map (see Fig. 16b). In pixels not occupied by threshold blood signals, the melanin image was displayed in a green color-map.

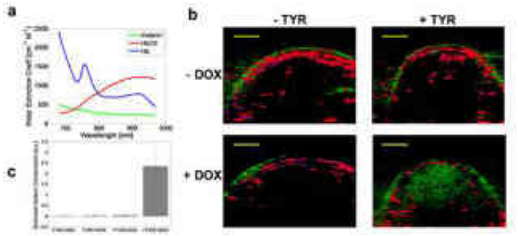


Fig.16: (a)Absorption spectra of melanin, oxy-hemoglobin and deoxy-hemoglobin. (b) Green color-map represents melanin concentration while red-blue color-map is hemoglobin oxygen saturation and yellow bars represent 2mm. (c) Relative melanin concentrations. [Adopted from Ref. 15]

5.2 Photoacoustic Tomography (PAT) of Palm

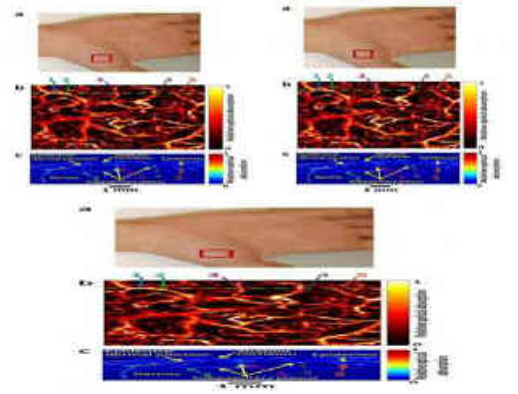


Fig.17: Photoacoustic tomography of a human palm: (a) Photograph of palm with the imaged area in red rectangle. (b) Transverse view of the interior skin vessels. (c) Axial view of the skin along the green dotted line as shown in (b). [Adopted from Ref. 16]

A laser system can generate optical pulses with a pulse energy of 100 mJ with pulse duration of 10 ns or shorter, which can sufficiently excite PA signals at high frequencies up to 100 MHz in a large area of soft tissues with good SNR. A focused ultrasound transducer scans along the tissue surface, and analogous to an ultrasonic A-scan, each detected time-resolved signal upon a pulsed-laser excitation can be converted into a 1D image along the acoustic axis of the transducer. Combining multiple A-scan images acquired sequentially from various positions on the same plane forms cross-sectional images. The axial resolution along the acoustic axis is dependent on both the width of the laser pulse and width of the impulse response of the transducer. The lateral resolution is determined by the focal diameter of the ultrasonic transducer and the center frequency of the received PA signal. In this imaging configuration, the imaging zone is limited by the focal zone of the transducer. An alternative configuration of PA scanning is analogous to the C-scan mode in ultrasonography, in which a cross-sectional image at a certain image depth is formed, and then slices imaged at different depths can be stacked together to form a 3D image.

The phototoacoustic image displaying the thick skin of the human palm has been recorded with a slightly modified version of experimental setup shown in Fig.13. The laser light is delivered by an optical fiber to a conical lens to form a donut-shaped beam with a hole around the center. This beam geometry reduces the photoacoustic signals from the palm surface. The laser beam is weakly focused into the skin tissue while the ultrasonic transducer focuses coaxially into the same region for photoacoustic detection. The time-of-flight PA signal is recorded at each lateral location of the ultrasonic transducer. The multiplication of time-of-flight with the speed of sound provides a 1D depth-resolved image (A-scan) while the focusing of the ultrasonic transducer gives the lateral resolution. Linear or raster scanning over the tissue yields 2D or 3D tomographic images. The broadband ultrasonic detector with a numerical aperture of 0.44 and a center frequency of 50 MHz produced lateral and axial resolutions of 45 μm and 15 μm respectively [16]. The laser wavelength was 584 nm for recording the image shown in Fig.17, where selected vessels are labeled in 17b and 17c for easy visualization of vasculature under the thick skin of the palm.

5.3 Combined PAT-OCT Imaging

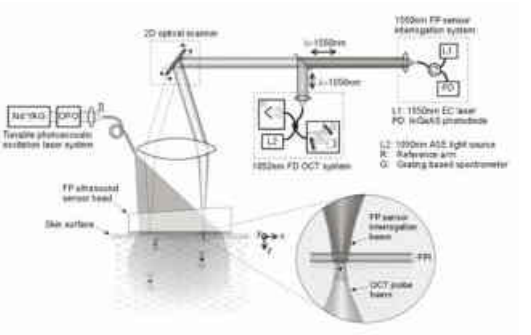
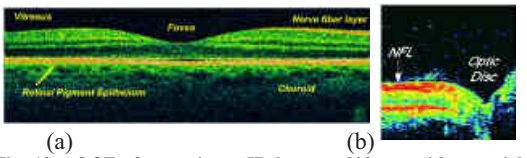


Fig.18: Combined photo acoustic and optical coherence tomography set up with a Fabry Perot Interferometer (FPI) sensor. The output of tunable OPO laser is transmitted through the FPI and produces PA signals which are detected by raster scanning a 1550 nm laser beam across FPI surface to form the PAT image. The OCT

image is obtained by combining a probe beam at 1050 nm coaxially with the 1550 nm FPI sensor interrogation beam. [Adopted from Ref.17]

In optical coherence tomography (OCT), low coherence or short pulse light is split into two arms – a sample arm containing the sample and a reference arm that contains a mirror. The combination of reflected light from the sample arm and the reference arm produces an interference pattern, but this happens only when the distance travelled by the light from both arms does not differ more than the length that is the coherence length of the source. Any light that is outside the short coherence length will not interfere. By scanning the mirror in the reference arm, a reflectivity profile of the sample is obtained. This reflectivity profile, called an A-scan, contains information about spatial dimensions and location of structures within the sample of interest. A cross-sectional tomograph (B-scan) is obtained by laterally combining a series of the axial depth scans (A-scan). OCT was first applied for imaging in the eye, and it has had the largest clinical impact in ophthalmology. The first in vivo tomograms of the human optic disc and macula were demonstrated in 1993 [18] (see Fig. 19). In conventional interferometry with long coherence length, interference fringes can be seen over a distance of metres, but in OCT this interference is shortened to a distance of micrometres by using broad bandwidth light such as lasers with extremely short pulses (femtosecond lasers) or white light.



(a) (b)

Fig. 19: OCT of eye using a IR laser at 800 nm with an axial resolution of 3µm (a) [Adopted from Ref.19] and using an Argon laser (b) [Adopted from Ref.18]

The technique of OCT imaging obtains its contrast optically from reflection at internal surfaces of tissues and depends on intrinsic refractive index gradients. Thus OCT signals are produced from all microscopic scatterers, independent of their spectroscopic properties. The interferometric detection scheme in OCT efficiently suppresses incoherently scattered, non-ballistic light. In a PAT imaging system, on the other hand, the image contrast is dominated by optical absorption making it very useful for imaging the vasculature due to the strong optical absorption of hemoglobin. Functional information in the form of blood oxygenation can be obtained by acquiring images at multiple wavelengths and exploiting the spectral differences between HbO2 and Hb. The information on blood flow can be obtained by extracting the acoustic Doppler shift encoded on to photoacoustic waves emitted by moving red blood cells. The dominance of hemoglobin as the primary source of endogenous PA contrast implies that PA images exhibit the vasculature with high contrast and spatial resolution but very little of the surrounding tissue morphology.

Both PAT and OCT acquire depth dependent information by time-of-flight measurements of the respective acoustic or optical waves. Combining PA imaging and OCT, the absorption-based spectroscopic contrast of PA imaging can be exploited to reveal the structure and oxygenation status of the microvasculature to depths of several millimeters while the scattering-based contrast of OCT can reveal surrounding tissue microstructure. Unlike PA imaging, spectroscopic OCT is not background-free and suffers from sensitivity to speckle, polarization changes and scattering losses that alter the signal components spectrally.

An experimental arrangement for dual mode PA-OCT imaging is shown in Fig.18. Fabry Perot (FP) sensor comprises a wedged PMMA substrate with a polymer film Fabry Perot interferometer (FPI) formed on the lower side, the wedge is required to avoid parasitic interference between the top surface of the substrate and the FPI. The FPI is fabricated by vacuum depositing a thin film structure comprising a 20 µm thick Parylene C polymer film spacer sandwiched between a pair of dichroic soft dielectric mirrors. These mirrors are highly reflective (>95%) between 1500 and 1650 nm but highly transmissive between 590 and 1200 nm. The FP ultrasound sensor is a key feature of this setup, that detects the PA waves. It allows transmission of the OCT probe and PA excitation laser beams through the sensor and thus provides a backward mode configuration.

The PA excitation laser is a fiber-coupled type I optical parameter oscillator pumped by the 355 nm third harmonic output of a Q-switched Nd:YAG laser. The excitation laser pulses are of 8 ns duration over the wavelength range 410- 2100 nm at a pulse repetition rate

of 50 Hz. The conical diverging excitation beam from the optical fiber is directed on to the FP sensor, which is acoustically coupled to the skin surface using a drop of water or gel. The PA excitation laser pulses in the 590-1200 nm wavelength range are transmitted through the sensor head and into the underlying tissue, where the beam diameter was 2 cm. Absorption of the laser energy in the tissue produces photoacoustic pulses which propagate back to the sensor head where they produce a modulation in the optical thickness of the FPI and hence its reflectivity. The incident PA wave from the back side is thus mapped by raster scanning a focused laser beam at 1550 nm over the surface of the sensor using a x-y scanner system. At each point of the scan, the acoustically induced time-varying power modulation of the reflected beam is detected with a fiber coupled InGaAs photodiode-trans-impedance amplifier unit connected to a digital storage oscilloscope. At the end of the scan the entire set of detected waveforms are downloaded from digital storage oscilloscope to a computer and used to form the image. Since the tomographic mode of PA imaging was used in this investigation, an acoustic back propagation algorithm was required to reconstruct the image from the detected PA signals.

A 1050 nm ASE light source with a spectral bandwidth of 70 nm is coupled via an 80:20 beam splitter to the reference arm that incorporates a length adjustable free-space pathway, as well as to the sample arm to the dual axis galvanometric scanner pair and the focusing lens. The return signal is optically processed by a fiber coupled grating based Czerny-Turner spectrometer fitted with a 1024 pixel InGaAs line array. With a 512 A-line per frame, this camera was capable of recording more than 90 frames per second. The spectral data is then inverse Fourier transformed and further processed to obtain the OCT image.

As shown in Fig.18, a dichroic mirror combines the fiber-coupled 1050 nm output of the ASE source with the 1550 nm FPI sensor interrogation beam after their independent collimation so that both beams are approximately co-axial with each other. The two beams are directed via the scanner through a convex lens and each was focused at a slightly different depth by controlling the divergence individually at their respective collimation units. The FPI sensor interrogation beam is focused on the plane of the FPI while the OCT probe focus is positioned at a slightly greater depth so that it is located just beneath the tissue surface. Although the FPI mirrors are 96% transparent in the 590-1200 nm spectral range, they still reflect a large fraction of 1050 nm OCT probe beam to exceed the dynamic range of the InGaAs array in the receiving spectrometer. To avoid this, a glass wedge was inserted between the scan lens and the FP sensor head during the OCT scan. This has the effect of tilting the OCT image plane with respect to the plane of the FPI so that the optical reflection from the latter is displaced and rejected by the receiving fiber in the sample arm.

The main advantages of this multimodal system are that it provides a simple means of integrating PAT and OCT, a convenient backward mode configuration, the potential speed benefits of optical scanning and inherent co-registration between the two modalities as a consequence of the OCT probe beam and PAT detection beams being co-axially aligned.

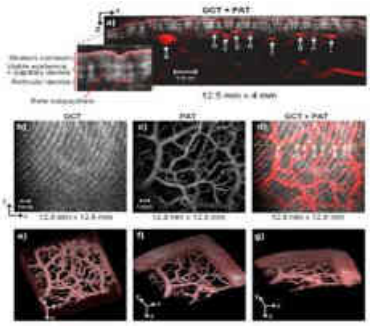


Fig.20: (a) 4 mm deep vertical image slice exhibiting OCT and PAT features in the palm tissue and (b), (c), (d), (e), (f), (g) reveal the cross-sectional images at different depths from the palm surface. [Adopted from Ref.17]

In vivo image of the subcutaneous vasculature in the palm of a volunteer was obtained by coupling the skin acoustically to the sensor head with a drop of water. Fig. 20a shows a single vertical slice of the fused PAT-OCT data set in which the stratum corneum, epidermis and dermis are seen in the gray-scale OCT image. The thickness of the three layers are approximately 300 μm, 186 μm and 233 μm measured at the center of the image. The PAT shows several blood vessels distributed throughout the dermis and the underlying subcutaneous tissue. It also exhibits image contrast at the level of the epidermis that is not associated with blood, but absorption by melanin. Over most of the field of view (FOV) in this region, the PAT image follows the surface

contours of the skin in the OCT image illustrating good image co-registration. On the left hand side of the image, a significant vertical offset between the two images is evident, most likely due to movement of palm between the two scans. The superficial topography of the skin is exhibited in the OCT image of Fig. 20b with the fine grooves on the skin and the PAT image of Fig. 20c reveals the vasculature at a depth of 0.8 mm, while Figs. 20c is a fusion of the two. The deepest detectable vessel was located 4.8 mm beneath the surface and 3D view of fused OCT-PAT at different orientations are shown in Figs 20e-g.

The diagnostic utility of combining PA imaging and OCT derives from the complementary contrast of each modality, that makes it possible to visualize vascular anatomy and tissue micromorphology. Dyshidrotic hand eczema is an obnoxious disease which exhibits the development of vesicles on the fingers and palm that are extremely itchy and painful. In PAT-OCT imaging of this disease, while OCT visualizes the scar tissue and its interface with healthy tissue in the epidermis and dermis, PAT shows changes in the vasculature at the edge of the scar tissue. This complementary information is clinically useful for assessing the scar tissue and providing more insight into the healing of such tissue.

6. Conclusion

Laser-generated photoacoustic image is a hybrid modality that combines the high contrast and absorption-based specificity of optical imaging with the high spatial resolution of ultrasound imaging. PA image offers greater specificity than conventional ultrasound image with its ability to detect hemoglobin, melanin and other light absorbing chromophores. In addition to visualizing the microvasculature, it can also provide functional information in the form of blood oxygenation and blood flow. It is important to note that all of this can be achieved over a wide range of tissue-depth from micrometers to centimeters. These attributes lend PA imaging to a wide variety of applications in clinical medicine and basic biology for studying cancer, cardiovascular disease and abnormalities of the microcirculation. PAT is basically a high-speed imaging technology where data acquisition is only limited by acoustic propagation across the biological tissue which is about 0.1 millisecond for a 15 cm range. Ultrasonic detection, however, requires direct contact between the ultrasonic transducers and the biological tissue. Ultrasound also undergoes significant attenuation in thick bones, such as the human skull, but unlike pulse-echo ultrasound imaging, PAT involves only one-way ultrasound attenuation through the skull and sufficiently strong PA signals have been observed through Rhesus monkey skull [16].

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W. Drexler, U. Morgner, R.K. Ghanta, F.X. Kartner, J.S. Schuman, J.G. Fujimoto, Nature Medicine 7, 502, 2001.

Professor Surya N. Thakur is an alumnus of the Banaras Hindu University. He passed MSc in 1964 and was recipient of the Chancellor's Gold Medal. He was an 1851 Exhibition scholar of the Royal Commission at the Reading University in England from 1970 to 1973. He has carried out research in the field of Molecular spectroscopy and Lasers with more than 130 publications in national and international journals. He was appointed Professor of Experimental spectroscopy in BHU in 1981 and retired from active service in 2005.

He has guided 18 research scholars. He worked on lasers at the National Institute of Optics in Florence, Italy, during the summer of 1977 and on photoacoustic spectroscopy at University of Manchester Institute of Science and Technology during the summer of 1981. He worked as a Fulbright scholar at Rutgers University, New Jersey in 1982 and as a visiting professor in 1991-92. He was the Sectional President of Physics at the 78th Indian Science Congress in Indore. Professor Thakur is a Fellow of Laser and Spectroscopy Society of India and co-author of two books: Atom, Laser and Spectroscopy with Prof. DK Rai and Laser Induced Breakdown Spectroscopy with Prof. JP Singh. He has been spending part of his time with his children in California during the past 5 years and has written popular science articles in English as well as in Hindi.

Modelling of High Speed Traction Using Linear Induction Motor

Manisha Agrawal[1], Girish Kumar Singh[2], Rahul Kr. Sharma[3] and Harshit Tripathi[4]
Department of Electrical Engineering
IEC College of Engineering and Technology, Greater Noida, U.P.
[1]hodee@ieccollege.com,[2] girishsinghrather @gmail.com,[3] rs786gka@gmail.com,
[4]harshittripathi07@gmail.com

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Abstract: Linear Induction motor abbreviated as LIM, is basically a special purpose motor that is in use to achieve linear motion rather than rotational motion as in the case of conventional motors. This is quite an engineering marvel, to convert a general motor for a special purpose with more or less similar working principle, thus enhancing its versatility of operation in the field of electric traction.

Keywords: LIM(Linear Induction Motor), traction, motor, three phase, linear motion

I. Introduction

A Linear Induction motor (LIM) is a special type of induction motor which gives linear motion instead of rotational motion, as in the case of conventional induction motor. It operates on the principle of which a conventional induction motor operates. In contrast with its rotary counterpart, a LIM may have a moving primary (with a fixed secondary) or a moving secondary (the primary being stationary). In our model, stator of LIM acts as primary and rotor as secondary. A LIM can be a short primary or short secondary, depending on whether the primary or secondary is shorter. In each case, either primary or the secondary can be the moving member. In our model, secondary is short and primary is a moving member. In addition, the LIM may have two primaries face to face to obtain a double-sided LIM (DLIM). In our work, we used LIM having only one primary, called as single sided LIM. The secondary of the LIM is conducting plate made of aluminum in which interaction currents are induced. In a single primary system a Ferromagnetic plate is placed on the other side of the conducting plate to provide a path of low reluctance to the main flux. However the ferromagnetic plate gets attracted towards the primary on energisation of the field and this causes unequal gap length on the two sides of the conducting plate.

Depending on the size and ratings of LIM they can produce thrust up to several thousand Newton's .The speed of the LIM is determined by winding design and supply frequency.

Conceptually all types of motors have possible linear configurations(dc, induction, synchronous and reluctance).The dc motor and synchronous motor requires double excitation (field and armature).This makes the hardware applications rather complex. The reluctance motor requires thrust since it has no excitation. This is the reason why most of the attention is given to LIM. As in a rotary motor, a LIM may have three phases two or one. The primaries of these all LIMs are essentially similar to stator winding of rotary machine .The starting mechanism in a single phase Lim is similar to that in the single phase conventional induction motor.

Linear induction motors can have various configurations: the air gap can be flat or cylindrical, and the flux can be longitudinal or transverse.

II. Construction

Our LIM consists of two main components:

Stator Assembly:

The coil assembly consists of a 3-phase winding that is wound into a steel lamination stack. These laminations are insulated from one another with very fine materials, such as paper or adhesive glue. The entire assembly is encapsulated with thermally conductive epoxy for insulation and stability. The coil assembly will require

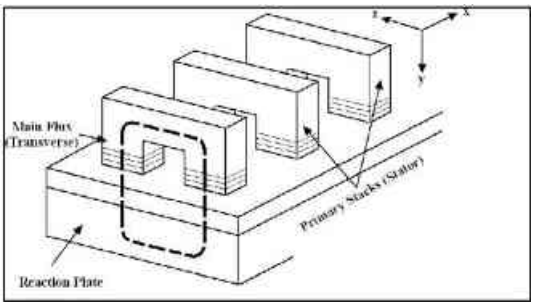
some form of mounting to ensure stability during operation. The single sided configuration consists of a single coil assembly that is used in conjunction with an Aluminium plate backed by a steel reaction plate. The coil assembly is directly connected to the AC line for single speed applications.

Reaction Plate:

A suitable reaction plate is required for proper operation of the LIM. The reaction plate is made from standard steel, Aluminum. For single sided operation, the required reaction plate consists of a .125" [3 mm] thick Aluminum plate that is backed by a .25" [6 mm] thick ferrous steel plate. The steel plate can be omitted but the force will be dramatically reduced.

The linear motor operates on the same principal as a rotary squirrel cage induction motor. The rotary induction motor becomes a linear induction motor when the coils are laid out flat. The reaction plate in the LIM becomes the equivalent rotor. This is made from a nonmagnetic highly conductive material. The induced field is maximized by backing up the reaction plate with an iron plate (conducting sheet). The iron plate serves to amplify the magnetic field produced in the coil. The air gap between the stator and the reaction plate must typically be very small, much smaller than the allowable gap for the synchronous motor, otherwise the amount of current required for the stator coils becomes unreasonable.

When supplying an AC current to the coils, a travelling magnetic wave is produced. Swapping the phases reverse the direction of travel. Currents induced in the reaction plate by the travelling magnetic wave create a secondary magnetic field. It is not necessary to kept the field of motion synchronized to the position of the reaction plate, since the second field is induced by the stator coil. A linear thrust is produced with the reaction between these two fields.



Linear Synchronous Speed

Consider a conventional rotary motor, it is possible to lay a section of the stator out flat without affecting the shape or speed of the magnetic field. Hence, the flat stator would produce a magnetic field that moves at constant speed . The linear synchronous speed is given by:

$Vs = 2pf$

where

v= linear synchronous speed [m/s]

p = width of one pole-pitch [m]

f = frequency [Hz]

It is important to note that the linear speed does not depend upon the number of poles but only depend on the pole-pitch width. By this logic, it is possible to for a 2-pole linear machine to have the same linear synchronous speed as that of a 6-pole linear machine, provided that they have the same pole-pitch width.

For case (a). For case (b),

$Vs = \omega 0R$ $Vs = 2\omega 0R$

$= 2\pi fR = 4\pi fR$

= 2f* pole pitch = 2f* pole pitch

For each one cycle of current the field travels two pole pitches. In Figure (4.1 b), the pole pitch is twice that of Figure (4.1 a). The results clearly indicate that linear synchronous speed does not depend on the number of poles, but depend on the pole pitch. To increase the linear synchronous speed of the LIM, the designer could either:

(a) Design a longer pole pitch.

(b) Increased the supply frequency.

SLIP

The slip formula of the LIM is identical to the conventional rotary machine. The slip is defined as, slip (s) of an induction motor is the difference between the synchronous speed and the rotor speed, expressed as a percentage (or per-unit) of synchronous speed." The per-unit of slip can be expressed by:

$Sl = (Vs - V)/Vs$

Where

S = Slip

Vs = Synchronous linear speed (m/s)

V = speed of rotor (m/s)

The principle of operation of a LIM is the same as that of a rotary induction motor. A linear Induction motor is basically obtained by opening the rotating squirrel cage induction motor and laying it flat. This flat structure produces a linear force instead of producing rotary torque from a cylindrical machine. LIMs can be designed to produce thrust up to several thousands of Newton's. The winding design and supply frequency determine the speed of a LIM.

The basic principle of LIM operation is similar to that of a conventional rotating squirrel-cage induction motor. Stator and rotor are the two main parts of the conventional three phase rotary induction motor. The stator consists of a balanced poly phase winding which is uniformly placed in the stator slots along its periphery. The stator produces a sinusoidal distributed magnetic field in the air-gap rotating at the uniform speed $2\omega/p$, with ω representing the network

pulsation (related to the frequency f by $\omega = 2\pi f$) and p the number of poles. The relative motion between the rotor conductors and the magnetic field induces a voltage in the rotor. This induced voltage will cause a current to flow in the rotor and will generate a magnetic field. The interaction of these two magnetic fields will produce a torque that drags the rotor in the direction of the field. This principle would not be modified if the squirrel cage were replaced by a continuous sheet of conducting material.

Design Calculations:

Q = Input Power
Zs = Total no. of conductor
m = no. of phase
Zss = no. of conductor per slot
Zph = no. oof conductor per phase
Eph = Per phase voltage
Ns = Synchronous Speed
Iph = Per phase current
q = No. of slot /pole/phase
f = Frequency
P = pole
Ø = Flux
Ŋ = Efficiency
Tph = Turns/Phase
cosØ = Power factor
Yss = Stator pitch
Kw = Winding Factor
ac = Specific Electrical Loading
Bav = Specific Magnetic Loading
Speed =120f/P
=120x50/2
= 3000 rpm(50 rps)
Maximum flux
Φm = 0.228*0.05*0.36/2
= 0.002052 Weber
Eph= 415/ 3
= 239.6 V
Kw = 0.88
Tph = *Eph*/4.44*f*Ø*Kw
= 239.6/4.44*50*0.002052*0.88
Tph= 597.6
Here we use 600 turns per phase.
We shall be using 6 coils of 300 turns each from which 2 coils will be used per phase in this ways turns per phase will be 600.

Applications Of Linear induction Motor

- Sliding doors
- Metallic belt conveyers
- Travelling cranes
- High speed Trains
- Electromagnetic pumps
- Catapults to accelerate warplanes
- Robotic systems

- Linear accelerators
- Stage/curtain movement

Advantages of linear induction Motor

- Low maintenance cost because of absence of rotating parts.
- Simplicity.
- No limitation of tractive effort due to adhesion between wheel and the rail.
- No limitation of maximum speed due to centrifugal forces.
- Cost is less as we use less lamination and less winding.

Conclusion

- Linear Induction Motor can be considering as a conventional rotary motor with both stator and rotor split and rolled out flat.'

- Speed of Linear Induction Motor is dependent on Frequency, Air gap between stator and reaction plate, Supply voltage and Pole pitch.

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Mrs. Manisha Agarwal working as HOD in Electrical Engineering Department, IEC College of Engineering and Technology, Greater Noida. She completed her B.Tech. from APS University, Rewa, MP and M. Tech from MDU, Rohtak, Haryana with honours. She has published four papers in different journals.

Short Term Power Load Forecasting based on Fuzzy Inference System with Grasshopper Optimization Algorithm

Arpit Varshnry and Manisha Agarwal
Electrical Engineering Department, IEC Engineering College, Greater Noida, India
E-mail: arpitvarshney.ee@ieccollege.com

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Abstract: Load forecasting is a vital activity for its importance in the power grid as it helps to assess the electrical load based on current/authentic information. It have capacity to handle and forecast energy usage trends, which in turn helps to track loads in future systems. However, the load forecasting is difficult as its accuracy get affected by various factors such as weather, population growth, economic factors etc. A number of methods were introduced by various researchers to predict the loads accurately but those methods were not efficient enough. Here, a new fuzzy based model is introduced in which ENN is combined with GOA optimization algorithm. The fuzzy logic takes average and standard deviation as two inputs which are then pre-processed by defined rules to produce an output which classifies the load into different clusters. The GOA-ENN algorithms are merged to perform the optimization task so that an optimum output is obtained which in turn enhances the accuracy of the system to predict loads. The output of the proposed technique is scrutinize and contrasted with traditional models in the MATLAB environment in terms of RMSE, max-error, min-error, MAPE. The simulation results revealed that the suggested GOA-ENN technique forecasts loads more efficiently and accurately.

1. Introduction

The electricity system essentially involves historical data. a generation, transmission, distribution and consumption systems. As electrical energy cannot be retained, the process must be generated whenever a demand arises. The power utilities aim to satisfy all the energy demands of customers. Utilities centers are seriously diverting from capacity expansion to the option of load management because of various financial constraints imposed due to high labor costs, high materials and interest rates, major environmental issues and the ever-growing fuel shortage [1]. The regulation of efficient load is dependent on an accurate load forecast. For electricity providers, it is also important to pre-estimate the demand on their networks. This load estimation is commonly called advance load forecasting. Planning the power framework is significant toreduce the costs of subcutaneous transmission systems, substations, feeder grids, laterals, and losses. Planning for the expansion of power networks begins with a forecast of future load requirements [2].

1.1. Types of load forecasting

Load forecast is classified into three basic classification depending on the time zone of the planning process:

- Short term load forecasting: Generally, itcovers a span of one hour and one week. It will result in an estimated charge flow and determine which overload can interfere with it. Short-term forecasts are used to provide mandatory data on the management of the regular operating structure and on unit interaction.
- Medium term load forecasting: The length of such a method of forecasting varies through one week to a year. The forecasts for various time horizons are important for different operations within a utility company. Medium-term forecasting is used for the purpose of planning fuel supply and unit power.
- Long term load forecasting: Thisforecast ranges for more than one year for the method of prediction. It is used by electricity utility management to provide a reliable forecast for future development, acquisition of assets or hiring needs [3].

1.2. Factors that influence load forecasting

The experimental forecasting method is impinge by a number of agents, each of which has effect on the process' accuracy. The experts must be able to choose the parameters carefully to anticipate the load precisely. The major factors that affect the precisions of forecasting are Time, weather, economic factors, population growth etc. besides this, there are some other major and minor parameters that affect its accuracy at each step [4].

Advantages of Load Forecasting

- Tends to help the utility provider to prepare precisely as they are familiar with future load use or demand.
- Attempting to identify critical resources including such fuels required for generating energy, as well as other assets necessary to ensure consistent and economical power generation and distribution for customers. This is important for short, medium and long-term planning.
- The load prediction can help with the plant size, position and type of future planning.
- Support for the dynamic and arranging of maintenance of power systems [4].
- Challenges in load forecasting
- The perspective is based on expected circumstances in the climate. Tragically, regularly the climate is unusual and the conjecture will change if the climate fluctuates. Besides, a few districts might have diverse natural patterns which definitely sway power interest. Specifically on the off chance that the utility creates more to fulfil the expected popularity, the use which can antagonistically influence incomes.
- Caused by changes in components, for example, costing and the subsequent interest dependent on such value fluctuations, it is hard to secure exact information on consumer conduct.
- The assignment of assessing the load is troublesome, since it is unpredictable and can differ contingent upon the season, and complete utilization might change between two seasons.
- Utilities may struggle if they do not know and evaluate a fair margin of error for the short-term load forecast [5].
- In request to conquer these difficulties, various models have been created lately so that loads can be predicted more accurately. The detailed description of the various techniques proposed are described in the next section.

2. Literature Survey

Researchers have conducted extensive research in this area in order to predict electrical load utilization. Some of them are mentioned here; KunXie, et al., [6], offered a framework for estimating short-term power loads in combination with Elman's neural network (ENN) and particle swarm optimization (PSO). R. Gao, et al., [7], proposed a system based on the LS-SVM and the fluid control for short-term load estimating. P. Mukhopadhyay, et al., [8], fostered a model that utilizes irate thinking to figure momentary conditions for the future burden and the temperature. Q. Zhang, et al., [9], provided good alternative with SVM and wavelet neural network optimization for the combined power load calculation to improve the accuracy. L. Yujie, et al., [10], In the summer, a vector auto-regression-based cold-electric with gas-load forecasting method for multi-energy flow systems was proposed (VAR).Y. Min, et al., [11], a load prediction model with variable weight was created to decrease the supreme mistake of combination model assessment. J. Cui, et al., [12], developed the load prediction model CEEMD-AE-LSTM to improve the precision of load forecasting findings. E. Akarslan and F. O. Hocaoglu., [13], set up a way to deal with charge projections for little locales with lower utilization utilizing the adaptive Neuro-Fuzzy Inference Method (ANFIS).V. Dehalwar et al. [14], proposed Artificial Neural Network (ANN) and Bagged Regression Trees using meteorological data to produce and forecast load forecasts in urban areas. For prediction precision, In comparison to Bagged Regression Trees, the ANN model is used. X. Liao et al. [15] presented a PSO-SVM-based transient interest anticipating and load early identification model for charging focuses.Moayedi, H. [16], the ability of two hybrid approaches, grasshopper optimization algorithm (GOA) and grey wolf optimization (GWO), in enhancing the cognitive evaluation of heating load (HL) of residential properties is determined in this experiment. For the dataset, eight HL essential components are taken into account to attain this purpose. The analysis indicates that using GOA and GWO methods improved accuracy is achieved. Liang Luo, et al. [17], a progressive energy the board framework for a microgrid with numerous sustainable wellsprings of energy was proposed in this examination. A modified bat algorithm (MBA) was used to deal with the microgrid's optimum power management. In comparison to GA and PSO, the suggested approach allows for faster calculation. Mehdi Pazhoohesh et al.

[18This investigation depended on a year's costing of charging/releasing data from a real 6MW/10MWh capacity battery that was introduced on the conveyance direct in Leighton Buzzard, United Kingdom.The findings of this study give up opportunities for debate and discussion in order to determine the right imputation methodology in perspective of storage management. Z. Tavassoli-Hojati [19],This examination offers a self-dividing neighbourhood neural fluffy derivation framework for transient estimating models that is both fast and successful.Razmjoo, A. [20], this article gives a techno-financial investigation of half breed power frameworks that can be introduced in two Iranian capital areas to meet SDG targets.

From the literature survey conducted, a number of meta-heuristic algorithms were used by many researchers that were focused on reducing the differences between the actual and predicted load values so that the accuracy of load forecasting can be enhanced. As the learning rate has a major impact of the network's weight adjustment, therefore, it is important to possess an optimum learning rate in the model. However, most of the models used techniques in which the learning rate was fixed and cannot be changed which lead to the slow convergence rate and can be trapped in local minima especially in complex problems. Furthermore, these models were complex, time consuming, less efficient and were easily getting affected by weather and environmental conditions. All these limitations degrade the performance of traditional systems inspired from these discoveries the proposed model in this paper will overcome the problems of the conventional models to improve the exactness of burden guaging. The nitty gritty portrayal of the proposed strategy is given in the following segment.

Proposed Model

In order to overcome the issue related to conventional approaches, this paper propose a novel model in which fuzzy logic is used along with the combination of GOA-ENN optimization algorithms. The main motive of using fuzzy logic is to classify the patterns of data. For instance, if two data patterns are present in the data base, then the two types will be created using fuzzy logic as per time interval. Fuzzy system will help in deciding the patterns in the data without any manual effort. The proposed fuzzy logic takes two inputs i.e. average and standard deviation to categorize the output load into two clusters based on their similarities. The square outline of the proposed fluffy rationale is displayed in figure 1.

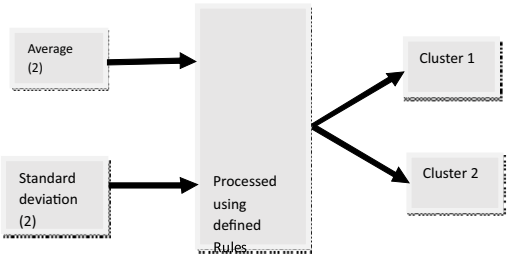

Figure 1 Proposed Fuzzy inference system

Figure 1, represents the block diagram of the proposed fuzzy logic in which average and standard deviation acts as two inputs. These two inputs are then pre-processed in fuzzy system by a defined set of rules to get an output determining whether the obtained pattern belongs to cluster 1 or cluster 2. Moreover, the introduced method enhanced the performance of the classical ENN network by using a meta-heuristic algorithm called as grasshopper optimization algorithm (GOA). The significant commitment of the proposed work is, to increased the performance of classification or forecasting rate by optimizing the network training process. The purpose of using the ENN and GOA together is to perform optimization so that an optimal output can be obtained and to increase the convergence rate. Therefore, this proposed approach can help to achieve more efficient results for load forecasting. The various constant parameters along with their specific values for grasshopper optimization algorithm (GOA) used in the proposed work are given in table 1.

Table 1: GOA parameters used for optimization

Sr.No.	Parameters	GOA
1	Population	5
2	Iteration	200
3	Cmax	1
4	Cmin	0.00004

The proposed GOA-ENN Model is evaluated and compared to that of other established models in terms of RMSE, max and min error and MAPE, which are discussed in the next chapter.

1. Result and Discussion

In the MATLAB simulation software, the suggested GOA-ENN model is tested and examined.The simulation results obtained are analyzed and compared with the conventional models in terms of RMSE, max-error, min-error, MAPE and power consumption and are discussed in this section.

1.1. Performance Evaluation

The proposed system's performance GOA-ENN model is equalled with the traditional PSO-ENN model where optimization was done by using PSO, in terms of their optimization process as shown in figure 2.

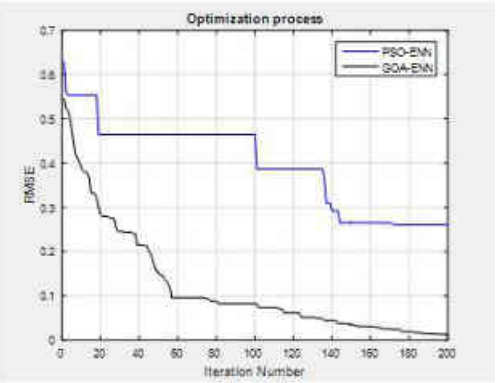

Figure 2 Comparison of traditional PSO-ENN and proposed GOA-ENN model

In terms of the RMSE, the proposed model's effectiveness is assessed and compared to that of traditional models, the value attained as shown in figure 3.

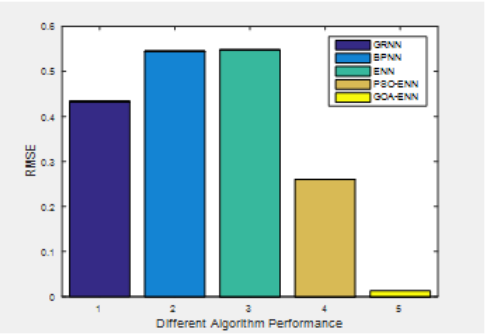

Figure 3 RMSE value in traditional and proposed models

Figure 3, depicts the effectiveness of the various traditional models such as GRNN, BPNN, ENN, PSO-ENN and proposed GOA-ENN model in terms of the RMSE value attained. From the graph, it is observed, that the RMSE value in the conventional GRNN, BPNN, ENN and PSO-ENN model comes out to be 0.5445, 0.4328, 0.54814 and 0.25992 respectively. Whereas, the RMSE value in the proposed system comes out to be almost zero i.e. 0.012563. This reduced error rate demonstrates that the proposed GOA-ENN model is more productive.Moreover, the effectiveness of the proposed GOA-ENN model is scrutinized and equalled with conventional models in terms of the Max error, min-error and MAPE. The exact values obtained for various parameters in traditional GRNN, BPNN, ENN and PSO-ENN and proposed GOA-ENN model are shown in table 2.

TABLE 2 SPECIFIC VALUES OF DIFFERENT PARAMETERS

Parameter	BPNN	GRNN	ENN	PSO-ENN	GOA-ENN
RMSE	0.4328	0.5445	0.54814	0.25992	0.0125
Max-Error	26.764	60.038	34.612	8.9174	0.0354
Min-Error	5.4496	1.0479	4.5465	0.040797	0.000912
MAPE	2.7157	2.7297	2.1086	0.4729	0.00111

From table 2, it is observed that the value obtained for the Max-error in proposed GOA-ENN model is almost negligible and is equal to 0.0354 while as in traditional GRNN, BPNN, ENN and PSO-ENN models the value for max-error comes out to be 60.038, 26.764,34.612 and 8.9174 respectively. Furthermore, the min-error value attained in the classical GRNN, BPNN, ENN and PSO-ENN methods comes out to be 1.0479, 5.4496, 4.5465 and 0.040797 respectively. While as in our proposed GOA-ENN system, the min-error rate is nearing to zero i.e. 0.00091237. Additionally, the value of MAPE in proposed GOA-ENN system comes out to be only 0.0011139. While as in traditional GRNN, BPNN, ENN and PSO-ENN systems, it came out to be 2.7297, 2.7157, 2.1086 and 0.4729 respectively. Hence, the proposed GOA-ENN model outperforms the traditional GRNN, BPNN, ENN and PSO-ENN methods in all parameters i.e. RMSE, Max-error, Min-error and MAPE which proves that our model is more efficient and reliable.

Finally, the effectiveness of the proposed GOA-ENN model has been analyzed and equalled with the traditional BP, ENN, PSO-ENN, GRNN models to see which method is closer to the desired output. The power consumption graph is shown in figure 4.

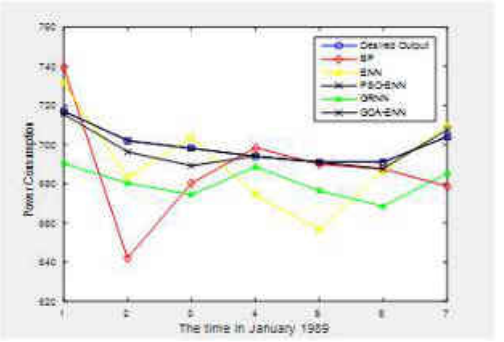

Figure 4 power consumption graph for traditional and proposed methods

From the graph, it is observed that traditional BP,ENN, PSO-ENN and GRNN models undergoes through huge fluctuations and thus are unable to predict loads accurately. While as the predictions made by the proposed GOA-ENN model are closer to the desired output with least fluctuations, thus improving accuracy. From the charts and table, it is investigated that the proposed GOA-ENN model beats the conventional models in all boundaries which makes our model more productive and exact to foresee loads.

1. Conclusion

This paper presented a new fuzzy based GOA-ENN model that deals with short-term power load forecasting to beat the impediments of conventional models. The proposed model is simulated and analysed in the MATLAB environment. The simulation results were obtained in terms of RMSE, Max-error, Min-error and MAPE. The value of RMSE in traditional GRNN, BPNN, ENN and PSO-ENN comes out to be 0.5445, 0.4328, 0.5481 and 0.2599 respectively. Whereas, the RMSE value in the proposed GOA-ENN system comes out to be 0.0125.Moreover, the effectiveness of the GOA-ENN model has beenanalysed by calculating the Max and min error, whose values comes out to be 0.035401 and 0.00091237 respectively. While as the min, max error in traditional BPNN and GRNN is 5.4496, 26.764 and 1.0479, 60.038 respectively. Also, the min, max errors in the traditional ENN and PSO-ENN model comes out to be 4.5465, 34.612 and 0.040797, 8.9174 respectively. In addition to this, the MAPE value of the proposed system also comes out to be very small i.e. 0.0011139 only while as in GRNN, BPNN, ENN and PSO-ENN models, it came out to be 2.7297, 2.7157, 2.1086 and 0.4729 respectively. All these results prove that the proposed GOA-ENN method is more accurate and efficient.

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Mr. Arpit have more than 9 years teaching experience in top Engineering college & University and currently working in IEC College of Engineering & Technology, Gr. Noida. He has expertise in Power Electronics, Renewable energy & Artificial Intelligence Engineering. More than 11 research papers published in National & International Journals. Share experience of imparting high quality education through frequent Faculty Development Workshop & programmers in number of top universities in northern India. Organized many Seminars & workshop in different Engineering colleges. Five students have been awarded M.Tech. degree under your supervision.

Mrs. Manisha Agarwal working as HOD in Electrical Engineering Department, IEC College of Engineering and Technology, Greater Noida. She completed her B.Tech. from APS University, Rewa, MP and M. Tech from MDU, Rohtak, Haryana with honours. She has published four papers in different journals.

Excitement of Higher Mode by Cutting Slot on the Patch to Increase the Bandwidth of Microstrip patch Antenna

Sonali Dubey[1]and Manoj Kr Vishwakarma[2]
Department of Electronics & Communication Engineering
IEC Group of Institutions, Greater Noida, Uttar Pradesh, India
[1]sonalirdubey@gmail.com,[2]manoj.rvsjsr@gmail.com

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Abstract: In this proposed work, microstrip patch antenna for X and Ku band applications with Excitement of higher mode with the help of cutting slot on the patch plane is designed using HFSS 12. The X and Ku bands primary used for satellite, radar, space Air-Craft, traffic light detectors, amateur satellite, motion detector etc. There are , Pedestrian slot array, on the patch so that we have found bandwidth from 9.3 GHz to14.1 GHz with resonant frequency at 8.1 GHz. Therefore, we can use this antenna for X and Ku band applications. We have excited the higher mode by cutting the slot on the patch thus the overall bandwidth is increased and due to the increment of edges the gain is also improved thus gain bandwidth product is improved. In the designing of microstrip patch antenna for feeding electrical energy we use microstrip line (50 Ω impedance) with coaxial cable. The substrate material used for designing of antenna is FR4 whose thickness is 1.6mm, relative permittivity is 4.4 and dielectric loss tangent is 0.02. The simulated bandwidth with return loss (S11)<-10 dB is from 10.61 GHz to 11.72 GHz and return loss -32 dB at frequency 8.1 GHz.

Keywords: Excitement of higher mode, Rectangular slot, Pedestrian slot array.

I. Introduction

Current research in the field of wireless communication systems emphasize on enhancing performance along with reduction in size of the antenna. Antenna is one of the important elements in the RF system for receiving or transmitting the radio wave signals from and into the air as the medium. Without proper design of the antenna, the signal generated by the RF system will not be transmitted and no signal can be detected at the receiver. Antenna engineering is a vibrant field which is bursting with activity and is likely to remain so in the foreseeable future. Many types of antenna have been designed to cater with variable application and suitable for their needs. One of the types of antenna is the microstrip antenna. The microstrip antenna has been said to be the most innovative area in the antenna engineering with its low material cost and easy to fabricate which the process can be made inside universities or research institutes. The augmented bandwidth of modern Microstrip antennas has enhanced the capacity of Wireless Communication [1]. Dual band microstrip antennas with single layer have been reported [2], but have a limited bandwidth. Another research [3][4]displays bent and wide slot antennas with a parasitic patch. Now a days the world depends upon the wireless communication. The development in the X and Ku band is the main topic in which interest is shown from few years for the communication. The printed slot can also operate in a wider bandwidth as the patch antenna.

The rest of the paper is structured as follows Section2 presents the work related to the slotted microstrip patch antenna. Section3 will describe the proposed antenna design methodology. Section4 presents the result and discussion and section 5 concludes the paper.

II. Literature Survey

Keith R. et.al.[5], have explained to describe analytical and experimental design approaches for microstrip antenna elements, and to provide a comprehensive survey of the state of microstrip antenna element technology. Mohammad. A. A. et.al.[6] , have proposed a single rectangular microstrip patch antenna operating at resonance frequency 2.15 GHz for TM01, TM02, and TM03 modes. The radiation pattern for these three modes has been calculated. The input impedance for TM03 modes at different feed position has been investigated theoretically by using cavity model and

Microwave Office Package MOP. The current distribution on the conductive patch for all modes has been evaluated using the package. P. Hammer et.al. [7], have proposed an aperture model is developed for calculating the radiation field of microstrip antennas. In this communication the model is applied to the rectangular microstrip resonator antenna. Antenna characteristics patterns and radiation resistance are computed and compared with experimental results.

A. F. Tinoco S. et.al.[8], have described a simple but accurate new approach for the design and analysis of thin rectangular microstrip antennas. After modifications are introduced in the classical transmission line model, the antenna electrical parameters agree very well with simulations performed using commercial software. This new approach is suitable for computer-aided-design procedures and is clearly adequate for undergraduate courses .K. George Thomas et.al.[9], have proposed a novel microstrip-fed dual-band printed antenna for wireless local area network (WLAN).The antenna comprises a rectangular and a circular radiating element, which generate two resonant modes to cover some GHz WLAN bands. The design was experimentally verified and measuring its impedance and radiation characteristics at both the bands. A rigorous experimental evaluation confirmed that the dual-band printed antenna maintained good radiation characteristics with minimum cross-polarization levels.

Aditi Sharma et.al.[10], have explained the effect of multilayer, 2-D photonic band gap substrate on the performance of rectangular microstrip patch antenna at THz frequency is simulated. The radiation efficiency, gain and directivity for the proposed antennas are 93.28%, 10.46 dB and 10.76 dBi, respectively at 875 GHz. The 10dB impedance bandwidth of the antenna is 36.67%, which is ultra-wide bandwidth. The simulation has been performed by commercially available CST Microwave Studio simulator, which is based on the finite difference time domain technique (FDTD).Yong-Xi Quian et.al.[11] have proposed a novel 2-D PBG lattice that is designed specifically to enhance the performance of microstrip patch antennas, then demonstrated that a substantial improvement in antenna performance can be achieved simply by surrounding a microstrip patch antenna with this 2-D PBG lattice, resulting in a significant increase in both antenna gain and frequency bandwidth. Mizan Rahman et.al.[12] have described a new equivalent circuit model. The model is based on the transmission line theory and periodic structures. The model is simple, but limited as it only allows for determination of the stop bands for the two principal directions of wave propagation. Nevertheless, it is a useful first step in design of PBG structures. If this model is coupled with a simple numerical modeling using the FDTD method it predicts complete characteristics of the structure. The proposed analytical and numerical modeling is applied to improve performance of a broadband circularly polarized patch antenna. Bin Lin et.al.[13] have proposed a antenna which used for 3G system, first analyze the characteristics of microstrip antenna and design methods of size structure, and then design the microstrip antenna with PBG by using MWO. The detailed analysis inquiries into the influence on the reflection coefficient S11 by key parameters, such as the length of PBG sides, the structural periodicity of PBG, the feeding point of antenna, the dielectric constant and thickness of circuit board have been studied. Vesna Radisic et.al.[14], have explained a new two-dimensional (2-D) photonic band gap (PBG) structure for microstrip lines, in which a periodic 2-D pattern consisting of circles is etched in the ground plane of microstrip line. No drilling through the substrate is required. Three PBG circuits were fabricated with different circle radii to determine the optimum dimensions, as well as a PBG circuit with the compensated right-angle microstrip bend. Measurements show that deep and wide stop bands can be achieved using this method. Y. J. Sung. et.al.[15], have proposed an active integrated antennas, moreover, the radiated power of microstrip antennas needs to be very low at harmonic frequencies.

The main goals of this study are impedance matching and harmonic suppression of microstrip antennas. The characteristic impedance of the microstrip line is controlled by the additional effective inductance of the PBG structure. Without any matching circuits, microstrip antennas can be easily fed by a simple 50 microstrip line with a PBG structure at the operating frequency. Additionally, the second harmonic of the proposed antennas is properly suppressed compared to a conventional antenna. Measured results indicate that the two PBG structures are quite effective for harmonic suppression.

III. Antenna Design Consideration

Instead TEM mode, the dominant mode of propagation would be the quasi-TEM mode. Hence; an effective dielectric constant (εeff) must be obtained in order to account for the fringing and the wave propagation in the line. The value of εreff is slightly less than εr because the fringing fields around the periphery of the patch cannot confined in the dielectric substrate but can also spread in

the air. The expression for width of patch (W), length of patch (L) and ɛre9ff is given by Balanis as:

$$W = \frac{C}{2f_0\sqrt{\frac{(\epsilon_r+1)}{2}}}$$

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}\left[1+12\frac{h}{W}\right]^{-1/2}, W/h > 1$$

$$\frac{\Delta L}{h} = 0.412\frac{(\varepsilon_{reff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{reff}-0.258)\left(\frac{W}{h}+0.8\right)}$$

$$L = \frac{C_0}{2f_r\sqrt{\varepsilon_{reff}}} - 2\Delta L$$

$L_0 = L + 6h$
$W_0 = W + 6h$

where:

f = Operating frequency
ϵ_r = Permittivity of the dielectric
ϵ_{eff} = Effective permittivity of the dielectric
W = Patch's width
L = Patch's length
h = Thickness of the dielectric
L_0 = Length of ground plate
W_0 = Width of ground plate

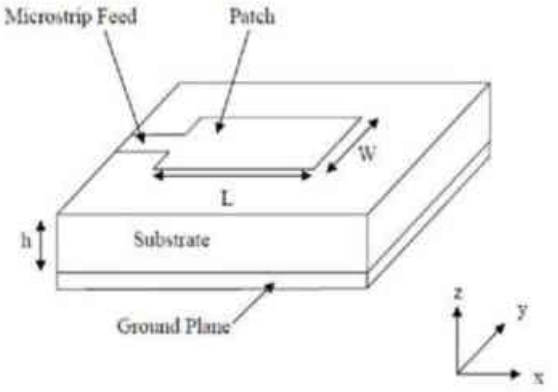

Fig. 1 Microstrip Patch Antenna

The top view of the proposed microstrip patch antenna is with slot is as shown in the fig 2. This antenna is fabricated and tested; the top view of fabricated antenna is as shown in fig 3.

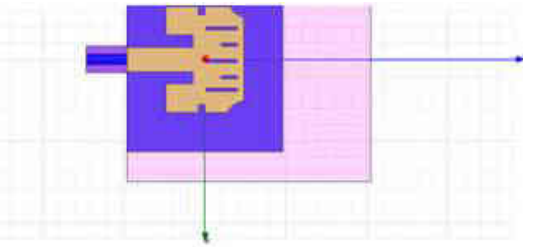

Fig 2: Top View of simulated Microstrip Antenna

Fig 3: Top View of fabricated Microstrip Antenna

I. Rresults And Discussion

In this section we have discussed about the result of microstrip patch antenna with pedestrian 'I' slot array cut on the patch.

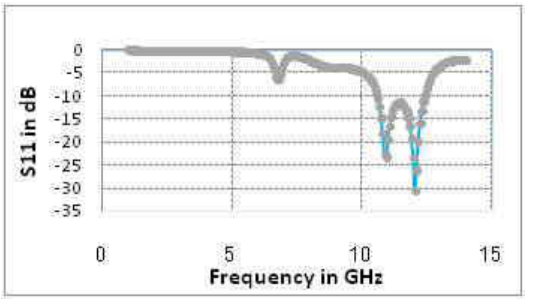

Fig 4: Return loss of the designed antenna in dB

As shown in Fig.4 the return loss of the proposed antenna is less than -10dB in the entire range of the interest .The minimum return loss is found to be -31dB. From this plot it can be observed that the return loss is less than -10 dB from 10.1 to 11.6 GHz, i.e. the

bandwidth is 1.5 Ghz.

This antenna was fabricated and tested. The of simulated and measured return loss of antenna is shown in the Fig.5.From Fig, 5 it is observed that the measured result is in good agreement with the simulated one.

The VSWR for the proposed antenna design is less than 2 everywhere in the desired range of frequency as shown in Fig.6 which supports the result found using return loss.

The 2D radiation pattern of the designed antenna is shown in Fig. 7.The gain of the antenna is between 2dB and 7dB in the desired direction of propagation.

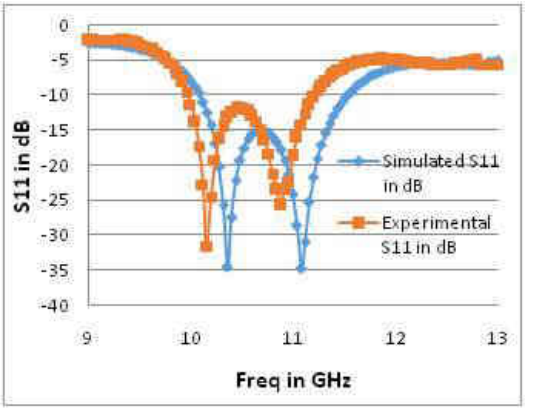

Fig 5: simulated and measured Return loss of the antenna in dB

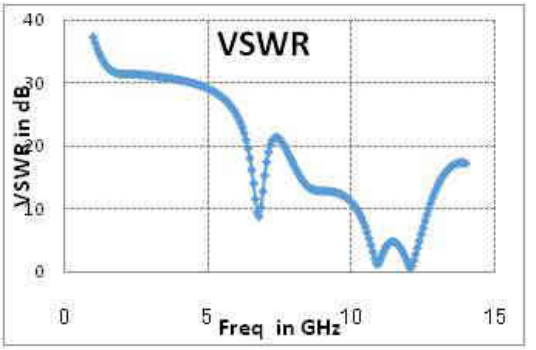

Fig 6: VSWR of the designed antenna

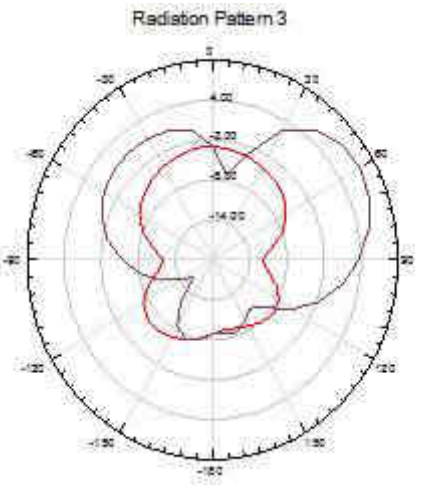

Fig 7: Radiation pattern of the designed antenna

I. Conclusion

In this paper we have made pedestrian slot array on the microstrip patch antenna and. analyzed the characteristic of the antenna designed. The measurement results for the rectangular microstrip patch antenna after fabrication process shows the operational frequency shifts to lower frequency and best result was found at 11.61 GHZ frequency. For this frequency the return loss was found to be -35dB .It shows that we can use this antenna efficiently for X and Ku band applications. The proposed antenna design show a good return loss more than -10dB in the entire operating range. This indicates that good impedance matching is achieved while designing the patches and Feeds. The properties such as return loss, resonant frequency and bandwidth are compared for all cases. The analysis of radiation patterns is summarized. There seem to be a significant difference in the simulation and fabrication values especially for return loss. The possible reasons that could have attributed to this fact is the poor design layout printing on transparency, some impurities in conducting patch, the non-uniformity of fed line width in the fabrication, the difference in length created when the ports are soldered and the possibility that there may be errors during the testing process. The difference between the simulated and measured result can be minimized by taking care of the above mentioned factors causing errors.

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Mrs. Sonali Dubey is working as assistant professor in Electronics & Communication Department, IEC College, Greater Noida. She has 17 years of teaching experience and has published papers in various journals.

Manoj Kumar Vishwakarma is working as Assistant Professor in Electronics Engineering Department, IEC College, Gr. Noida. He has completed his M.Tech in Microwave (ECE) from Birla Institute of Technology (BIT) Mesra, Ranchi and pursuing Ph.D from NIT, Patna. His area of interest is RF and Microwave and has more than 5 National & International research papers of reputed journals and conferences. He has guided 4 M. Tech Students. He has teaching experience of more than 8 years in different reputed engineering colleges.

Characterisation of Bituminous Concrete Mix and Warm Mix Asphalt Prepared Using Lime and Zycotherm as Additive

Deependra Kumar Varshney
Department of Civil Engineering
IEC Group of Institutions, Greater Noida, Uttar Pradesh, India
deependrakvarshney@gmail.com

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Abstract: The Warm Mix Asphalts (WMA) is customized bituminous mix which can be developed, laid and compact at lower temperature than conventional bituminous mix. The WMA is generally prepared by adding chemical additives to the conventional mix to get better the pavement performance. This study mainly emphasizes to compare the behavior of bituminous concrete mix and Warm Mix Asphalt (WMA). Bituminous concrete mix and WMA is prepared using lime (1% & 2%) as filler material. Zycotherm (0.1% by weight of binder) is adopted as chemical additive for the preparation of WMA. Optimum bitumen content (OBC) is determined by adopting Marshall method of bituminous mix design. Marshall Properties, Indirect tensile strength (ITS), Tensile strength ratio (TSR) of Bituminous concrete mix and WMA are determined and analyzed at OBC. The test results are satisfying the minimum requirements as defined by MoRT&H specifications. Based on the limited laboratory study carried out, it can be conclude that bituminous concrete mix is a better mix type then the WMA in terms of Marshall Properties, Indirect tensile strength and Tensile strength ratio. Since the WMA is also satisfying the minimum requirements, Therefore can also be accept as an alternative bituminous mix type as and when required.

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Keywords: ITS; TSR; Marshall Stability; Bituminous Concrete mix; WMA; Zycotherm.

1. Introduction

Warm Mix Asphalt (WMA) is a fast emerging new technology with potential of revolutionizing the production of asphalt mixtures. The asphalt paving industry is persistently exploring technical improvements that will improve the material's performance, increase construction efficiency, conserve resources, and advance environmental stewardship. Current and imminent regulations on emissions and energy conservation are making attractive the reductions in asphalt mix production temperature.The concept of warm mix asphalt (WMA) may be an end to this quest.Warm Mix Asphalt (WMA) is a quick rising innovative technology with potential of revolutionizing the making of bituminous mix. It is customized bituminous mix which permits the mixing, laying and compaction of mix at lower temperatures (20 to 40ºC) as compared to Hot Mix Asphalt (HMA). The WMA is generally prepared by adding chemical additives to the conventional mix to get better the pavement performance.

The world focus on the development of WMA technologies may be traced back to two distinctive events: the 1992 United Nations' discussions on the environment and the 1996 Germany's deliberation to review asphalt fumes exposure limits. The United Nations' discussions resulted in the 1997 Kyoto Accord, which finalized a commitment by the signatory states to trim down greenhouse gas emission to the 1990 levels, while the Germany's review of asphalt fumes exposure limits show the way to the formation of a partnership forum (The German BITUMEN Forum) to discuss these considerations. Reduction of mixing and placement temperatures became the obvious answer

and triggered the development of WMA concepts and technologies. The first trials were performed between 1995 and 1999 in Germany and Norway. The first application on a public road was carried out in Germany in 1999 using the Aspha-min® zeolite system. The introduction of the WMA concepts and the other systems in Canada are closely associated with the timeline of outreach activities and field trials performed in the United States. The first US trials were carried out in the fall of 2004, while the first Canadian trials were carried out in 2005 in Alberta, Ontario and Quebec. Five different systems were tested in Canada in 2005, Aspha-min® zeolite, Sasobit, Evotherm, WAM (Warm Asphalt Mix) and Colas 3E DB systems. The first Canadian papers on WMA were presented at Canadian Technical Asphalt Association (CTAA) in 2006. In 2007, trials were carried out in five provinces using different processes (Croteau and Tessier, 2008).

Warm mix asphalt technology is an alteration of traditional Hot mix Asphalt. Even at the low temperature, Marshall propertiesof Dense Bituminous Macadam can be enhanced with the use of chemical additive "ZycoThrem". WMA technology ended it possible to reduce mixing temperature with PMB-40 for conventional Hot Mix Asphalt (HMA) from a range of 150 ºC to 120 ºC and also reduce CO_2 emissions, extensive paving season and lower production cost (Rohith N and J.Ranjitha, 2013). Elie and Edward (2011) led lab test for the CECABASE warm mix additive utilizing a total of a size 19.0mm as indicated by Caltrans Standard particular and NDOT detail for Road and Bridge development. PG 64-28 polymer altered black-top fastener was utilized for the study. Temperature of 160ºC and 132°C were kept up for the arrangement of HMA and WMA blends individually.Graham and Brian (2005) studied about Aspha-Min use in Warm Mix Asphalt. Two aggregates, granite and limestone were used. The Superpave gyratory compactor was used to find out the mixture compactibility at different temperatures. Mixes were compacted at 149° C, 129° C, 110° C and 88° C, with mixing temperature about 19° C higher than the compaction temperature. The additive Aspha-min was mixed at rate of 0.3% by mass of the mix.Stacey Amy (2008) evaluated warm mix asphalt technology by using Sasobit. The mix is produced using penetration grade 64-22 binder, designated by VDOT SM-9.5A mixture and VDOT SM-12.5A mixture. The super pave gyratory compactor was used for the compaction. Bituminous mix was prepared out at different temperature viz. 149ºC, 162ºC and 121ºC. WMA additive Sasobit was added at a rate of 1.5% by weight of the binder. The results concluded using of the additive lowered the air voids and improved the compactibility.

Less binder aging has been reported as a benefit of lowering the mixing temperature. Areduced amountof hydrocarbon vapors clearly indicates that less light end portion of the binder is eliminated during themanufacturing process. Evotherm WMA process indicate that thepenetration of the recovered binder after production was significantly higher for the WMA compared tothe equivalent HMAmixture(Davidson et.al. 2007).Some binder characteristics may be affected by certain additives, particularly the organic additives.Certain organic additives may have a tendency to stiffen the binder at lower temperature, which mayconsequently increase the potential for thermal cracking. Warm mix asphalt systems concerningthe utilize of chemical additives or surfactants are not relying on the reduction of the binder viscosity, but rather the improvement of the coating capability of the binder at a lowermixing temperature. The WMA systems using this approach are relatively new and their development is promising (Croteau and Tessier, 2008). Various types of additives and chemicals can be add to the binder in manner similar to anti-stripping agents in a concentration as low as 0.3 % by mass of the bitumen for the preparation of WMA. Zycotherm is a product of Zydex Industries, Gujarat, India which can be used as an additive for making the WMA. ZycoTherm is accountable for chemical modification of bitumen so as to offer the ease and workability to handle the mix at lower temperature (Amit Kumar et.al. 2015).

XijuanXu, (2011) represents that WMA is a environmentally friendly low-carbon, asphalt mix. This sort of asphalt mix not only conserves the resources, but also trims down injurious gap emissions; meanwhile also preserve the asphalt mixture in a superior use of quality.

2. Objective Of Present Study

The objectives of the present study are -

- To study the effect of Lime 1% and 2% as filler materials on the Marshall properties, indirect tensile strength and tensile strength ratio of bituminous concrete mix and warm

mix asphalt.

- Comparative analysis of the behaviour of bituminous concrete mix and warm mix asphalt prepared using lime and zycotherm as additive.

3. Material Characterization

3.1 Aggregates

Aggregates make a vital role in the performance of a bituminous mix. Aggregates constitute roughly about 88% to 96% by weight and volume of the total mix, the effect of aggregate on the characteristics of bituminous mixes is of prime importance. One of the key aspects of aggregates affecting the stability and working properties of a mix is the gradation. Aggregates used are essentially classifies as coarse and fine aggregates based on their size. Aggregates which are smaller than 25 mm and larger than 2.36 mm in size are considered as coarse aggregate while the aggregates smaller than 2.36 mm and larger than 75μ in size are the fine aggregate. The test results of aggregates are presented in Table-1. Aggregate gradation for bituminous concrete mix (Grading-2) is adopted for the present study as per MORT&H (V^{th} Revision) and is presented in Table-2.

Table 1: Test results of aggregates

Aggregate Test	Test result	Requirement as per MORT&H (V revision) Specifications
Aggregate impact value (%)	20.47%	Max 24%
Los Angeles abrasion value (%)	21.32%	Max 30%
Flakiness and Elongation Index (Combined) (%)	26.17%	Max 30%
Water absorption (%)	0.91%	Max 2%
Aggregate specific Gravity		
Coarse aggregates	2.72	Min 2.5
Fine aggregates	2.68	Min 2.5

Table 2: Aggregate gradation of Bituminous mix (grading-2) as per MORT&H specification

Sieve Size in mm	% Passing (Specified)	Obtained Gradation
19	100	100
13.2	79-100	89.5
9.5	70-88	79
4.75	53-71	62
2.36	42-58	50
1.18	34-48	41
0.60	26-38	32
0.30	18-28	23
0.15	12-20	16
0.075	4-10	7

3.2 Binder

Bitumen is a non-crystalline viscous material black or dark brown in colour. Bitumen is considerably soluble in carbon disulphide (CS2), having glue and water-proofing qualities. In this investigation, viscosity grade (VG-30) bitumen treated withzycotherm as additive is used as binder. The test results satisfy the requirements as perIS 73-2013. The test results are presented in Table-3.

Table 3: Test results of Binder

Bitumen Test	Test Results		Requirements as perIS 73-2013
	VG-30	VG-30+Zycotherm Mix	
Penetration at 25℃	64	64	50-70
Softening point (Ring & Ball), ℃	51	48	47-57
Flash point, ℃	265	265	Min 220
Fire point, °C	291	290	Min 220
Ductility @27 °C ,cm	86	95	Min 75
Specific gravity	1.02	1.01	Min 0.99

3.3 Mineral Filler

Filler material fills air pockets between aggregates and improves the wearing capabilities of the mix type. It is stored and fed dry into the mix, during or after addition of binder. In the present study, hydrated Lime 1% and 2% is used as filler materials. Specific gravity of lime is 2.32. Gradation detail of lime is presented in Table 4.

Table 4: Gradation Details of Lime as Filler Material

IS Sieve size (mm)	Cumulative %passing by weight of total aggregates	
	Obtained Gradation	Requirement as Per MORT&H (V^{th} Revision)
0.6	100	100
0.3	100	95-100
0.075	97.78	85-100

3.4 Preperation of Mix

Zycotherm is added to the bitumen at pouring temperature and stirred thoroughly to get homogenous blend and left for 24 hours. This blend of bitumen and zycotherm is referred as binder for this present investigation. Sampling of coarse and fine aggregates is carried out and triplicate based on 4.5, 5%, 5.5% and 6% bitumen each were prepared. Aggregates, bitumen, additive and filler were mixed at temperature of 135ºC and compacted at 120ºC to make a homogeneous WMA mix.

4. Indirect Tensile Strength Test (ITS)

Load at failure is recorded and the indirect tensile strength is computed using the relation given below.

$$\sigma_x = \frac{2P}{\pi t D} \quad (1)$$

Where: σ_x = Indirect tensile strength, N/mm^2

P = Failure load, N

t = Height of the specimen, mm.

5. Tensile Strength Ratio (TSR)

Tensile strength ratio (TSR) can be determined using the following relation-

$$TSR = Sn / St \quad (2)$$

Where

TSR: Indirect Tensile Strength Ratio

St: Average Indirect tensile strength of Group-1 specimens

Sn: Average Indirect tensile strength of Group-2 specimens

6. Results And Discussion

Marshall Properties of bituminous concrete mix prepared using lime (1% & 2%) the warm asphalt concrete mix specimens prepared using Lime (1% & 2%) as mineral filler and Zycotherm (0.1%) as additive at 135oC mixing temperature and 120oC compaction temperature are presented in Table-5 to Table-9.

Table 5: Marshall Properties of Warm Mix Asphalt Prepared Using Zycotherm and Lime (1%) as Filler Material

Bitumen content, %	Marshall stability, kg	Flow, mm	Bulk density, gm/cc	Total air voids, %	Voids Filled with bitumen, %	Voids in Mineral Aggregate, %
4.5	932	2.8	2.326	7.697	17.957	55.767
5.0	1262	2.95	2.336	6.617	18.070	63.415
5.5	1176	3.10	2.36	5.438	18.109	69.976
6.0	1082	3.20	2.35	3.235	17.678	79.167

Table 6: Marshall Properties of Warm Mix Asphalt Prepared Using Zycotherm and Lime (2%) as Filler Material

Bitumen content, %	Marshall stability, kg	Flow, mm	Bulk density, gm/cc	Total air voids, %	Voids in Mineral Aggregates,%	Voids filled with bitumen,%
4.5	1012	3.10	2.34	6.7	17.049	60.71
5.0	1234	3.15	2.35	5.75	17.289	66.73
5.5	1366	3.20	2.37	4.22	17.029	75.22
6.0	1258	3.30	2.36	3.83	17.712	78.43

Table 7: Marshall Properties of Bituminous Concrete mix Prepared Using Lime (1%) as Filler Material

Bitumen content, %	Marshall stability, kg	Flow, mm	Bulk density, gm/cc	Total air voids, %	Voids Filled with Bitumen, %	Voids in Mineral Aggregates, %
4.5	1284	1.7	2.272	8.19	55.03	18.21
5.0	1448	2.15	2.306	6.23	64.47	17.53
5.5	1316	2.55	2.339	4.85	74.06	17.70
6.0	1239	2.75	2.324	3.62	79.14	17.63

Table 8: Marshall Properties of Bituminous Concrete mix Prepared Using Lime (2%) Filler as Filler Material

Bitumen content, %	Marshall stability, kg	Flow, mm	Bulk density, gm/cc	Total air voids, %	Voids Filled with Bitumen, %	Voids in Mineral Aggregates, %
4.5	1219.00	2.15	2.286	8.19	53.20	18.27
5	1280.47	2.30	2.307	6.71	62.74	18.01
5.5	1575.65	2.65	2.343	4.60	73.28	17.23
6	1435.32	3.20	2.324	3.36	80.26	17.03

Table 9: Marshall Properties of Bituminous Concrete Mix and Warm Mix Asphalt

SN	Marshall properties	Test results: Bituminous Concrete Mix		Warm Mix Asphalt		Requirements as per MORT&H (Vth Revision) Specifications
		Lime (1%)	Lime (2%)	Lime (1%)	Lime (2%)	
1	Optimum Bitumen Content (%)	5.50	5.64	5.43	5.57	5.4
2	Marshall Stability, kg	1471	1505	1314	1392	Min 900
3	Flow, mm	2.8	2.4	3.9	3.25	2.0 - 4.0
4	Air voids,(Vv) %	4.48	4.2	4.72	4.40	3.0 - 6.0
5	VMA, %	17.46	17.16	18.04	17.38	Min 14
6	VFB, %	74.30	74.42	73.83	74.30	65-75

Indirect Tensile Strength test is conducted on bituminous concrete mix prepared using lime (1% & 2%) and Warm mix asphalt prepared using lime 1% and 2% as filler materials and Zycotherm (0.10%) at optimum bitumen content. Specimens are conditioned at 25°C in water bath for duration of 2 hours. The test results are presented in Table-10 and Table-11.

Table 10: Indirect Tensile Strength of Bituminous Concrete Mix and Warm Mix Asphalt

Filler Type	Filler Content	Indirect Tensile Strength , N/mm^2	
		Bituminous Concrete Mix	Warm Mix Asphalt
Lime	1%	0.991	0.901
	2%	1.121	0.953

Table 11: Tensile Strength Ratio of Bituminous Concrete Mixes and Warm Mix Asphalt

Typeof mix	Filler	Indirect Tensile Strength, N/mm^2		TSR, %
		Unconditioned	Conditioned at 60°C	
Bituminous Concrete-II	Lime (1%)	0.991	0.903	91.11
	Lime (2%)	1.161	1.08	93.24
Warm Mix Asphalt	Lime (1%)	0.901	0.781	86.74
	Lime (2%)	0.953	0.865	90.78

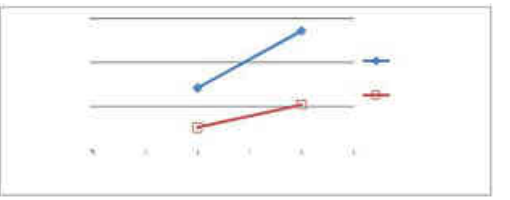
6.1 Marshall Properties

It can be observed from the table-9, that Marshall stability of the bituminous concrete mix and Warm Mix Asphalt (WMA) is sufficiently high against the minimum requirement of 900Kg. There is substantial increase in the Marshall stability of bituminous concrete mix of about 9.5% and 9.3% when compared with warm mix asphalt prepared using lime 1% & 2% respectively. It may be due to lower mixing and compaction temperature of WMA.

Optimum bitumen content (OBC) bituminous concrete mix and warm mix asphalt prepared using lime 2% is higher than the bituminous concrete mix and warm mix asphalt prepared using lime 1%. This pattern may be due to change in filler content causes the variation in specific surface area and accordingly binder requirement also vary. In the present study as the filler content vary from 1% to 2%, specific surface area increases, therefore the optimum bitumen content increases in either cases.

As the filler content increases, the percentage air void of the bituminous mix reduces. There is marginal increase in the air void content, VMA and VFB, This may be due to inter dependability of the above parameters. As well as the warm mix asphalt is prepared at lower mixing and compaction temperature. Both the mix type i.e. bituminous concrete mix and warm mix asphalt are satisfying the requirement as per the MoRT&H specifications.

6.2 ITS And TSR



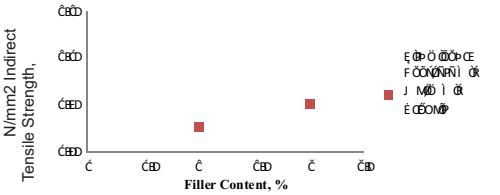


Fig.1. Indirect Tensile Strength of Bituminous Concrete Mixes Prepared Using Stone Dust and Cement as Filler Materials.

Table-10, Table -11 and Fig-1 shows the Indirect tensile strength and Tensile strength ratio of bituminous concrete mix and warm mix asphalt vary as filler content increases 1% to 2%. It may be due to reduction in percentage air voids. There is substantial increase in ITS value of about 9.1% and 15% when compared with warm mix asphalt prepared using lime 1% & 2% respectively. There is marginal increase in the Tensile strength ratio of 5% and 3% when compared with warm mix asphalt prepared using lime 1% & 2% respectively.
Introduction:

7. FTIR TEST

It was employed to determine the functional characteristics of base bitumen, Zycotherm and Zycotherm modified bitumen in wave numbers ranging from 4000 to 400CM-1. Asphalt binders are obtained from crude oil which is extracted from different wells and processed with various procedures. On the other hand, they are composed of carbonyl, hydroxyl, amine, amide, nitrile, ester, carboxylic, and aromatic which make them high complex construction materials.

This complexity is expected to get more critical after its modification with anti-striping additives. There is a need to investigate the effects of Zycotherm on the chemical compositions of base binder as such data do not exist in the public domain. Infrared (IR) spectroscopy is a powerful tool for analysis of asphalt binders in determining their chemical functional groups.

The wide-ranging peaks between 2850 and 3000cm-1 were supposed to signify the aliphatic C–H stretching (CH3, CH2 and CH) of alkane with strong intensity. The peak around 1450cm-1 Could indicate bending of CH2 and CH3, as well In case of Zycotherm, some peaks between 650 and 770cm-1, and around 720cm-1 , could indicate (CH2)n in-phase bending, representing the extended hydrocarbon chain in Zycotherm. Also, peaks within district from 750 to 680cm-1 are a signs of amorphous and/or crystalline arrangements. The wave numbers from 900 to 1300cm-1 are helpful to detect the type of compound, but the bands in this area begin in interacting vibrational modes resulting in a complex absorption arrangement, which is fairly complex and frequently problematic toconstrue.

In case of original binder, the wide-ranging peaks around 3000–3500cm-1 represents carboxylic acid where the O–H stretching absorption is tough and wide. During the mixing of binder with aggregate, carboxylic acid is rapidly absorbed by aggregates. At binder-aggregate interface, the bonds between carboxylic acids and Si-OH compounds on the aggregate surface are unstable against water. A weak peak in original binder at 1700cm-1 can be ascribed to the carbonyl functional group. Also, a peak at 1380 cm-1 may represent symmetric stretching, as well. In case of modified binder, the weak peaks at 1705 and 1030 cm-1 are signs of aging after modification as they show bitumen carbonyl compounds and sulfoxides demonstrating they are probably shaped at the time of blending the binder with Zycotherm resulted by the temperature and the time of mixing. Peaks at 1550, 1650 and 3300cm-1 are representations of amide groups.

The peaks at 2950 to 2854cm-1 are indications of stretching vibration band and bending vibration band of alkane C–H bonds. The peak near 2350cm-1 is CO2, and the peaks around 1650cm is water.

8. Conclusions

Based on the laboratory studies carried out in the present study, the following conclusions are drawn-

A. The WMA using Zycotherm is giving the satisfactory results.
B. Addition of Zycotherm additive in bituminous mix helps in reducing the mixing temperature for bituminous mix.
C. The Marshall stability has been increased with Zycotherm in plain and modified binders.
D. As an alternative of HMA, WMA in 120°C can be used for road construction.

Based on FTIR test results which clarifies the peaks related to the Si-O links in organosilane
components of the Zycotherm, upon exposure to moisture, this bonds turn into Si-OH silanoles.Based on FTIR test, Zycotherm creates a Si-O-Si hydrophobic

layer over the surface. Zycotherm significantly increased TSR, RMR, MSR and FER values of siliceous mixtures.

- Substantial increase in Marshall stability value of bituminous concrete mix as compared to WMA.
- Optimum bitumen content of the bituminous mix increases as the filler content increases irrespective of mix type i.e. bituminous concrete mix or the warm mix asphalt.
- As the filler content increases the percentage air voids reduces.
- Marginal increase in percentage air voids, VMA and VFB of bituminous concrete mix as compared to WMA.
- Bituminous concrete mixes possess better indirect tensile strength but marginally higher resistance against the moisture susceptibility as compared to WMA.
- Warm mix asphalt as a bituminous mix is exhibiting the lower ordinary results then the bituminous concrete mix. But on other side WMA is also fabulously satisfying the minimum requirements as defined by MoRT&H specifications. Hence can also be used as an alternative bituminous mix type.

Based on the limited laboratory study carried out, it can be conclude that bituminous concrete mix is a better mix type then the warm mix asphalt in terms of Marshall properties, Indirect tensile strength and Tensile strength ratio. Since the WMA is also fabulouslysatisfying the minimum requirements, Therefore can also be accept as an alternative bituminous mix type as and when required.

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Dependra Kumar Varshney is working as Assistant Professor in Civil Engineering Department, IEC College, Greater Noida. He has total 12 years of teaching experience and 10 years of Industrial experience. Has has completed his M.Tech in Transportation Engineering. He has published 7 papers in various journals.

The use of Novel Drug delivery system: Transdermal Patch

Niharika, Athira Nair, Swati Sabharwal and Navneet Verma
Department of Pharmacy , IEC Group of Institutions,
Greater Noida, Uttar Pradesh, India
Department of Pharmaceutics, IFTM University,
Moradabad, Uttar Pradesh, India

Corresponding author: niharikalal24@gmail.com

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Abstract: Transdermal drug delivery system is a systematic approach that delivers the medicaments topically in a predetermined and controlled rate at the site of action .The main objective of transdermal drug delivery system is to deliver drugs into systemic circulation through skin at predetermined rate with minimal inter and intra patient variations. This review emphasizes on Transdermal patch of drug delivery , which is a medicated adhesive patch that is placed on the skin to deliver a specific dose of medication through the skin and into the bloodstream.The factors affecting its absorption rate , the permeation rate and the role of vehicles are also explained. The strategies to enhance this approach is also discussed here which mentions the physical , chemical and biochemical enhancers. This approach gives an insight on compounds that interact with the lipid matrix of the stratum corneum to alter its nanostructure and thereby increase permeability , focuses on peptides that are believed to disrupt or penetrate stratum corneum lipids and describes about stripping which is a simple technique used in research protocols to remove the stratum corneum by sequential application of adhesive tape or cyanoacrylate glue.

Keywords: Transdermal drug delivery, Systemic circulation.

Transdermal drug delivery is an approachable substitute that could minimize as well as avoid limitations correlated with parental and oral drug delivery. The Transdermal drug delivery system provides an acceptable and prolonged drug delivery in steady state and minimizes the possibility of peak associated side effects. For controlled drug delivery, utilization of transdermal patches is immensely user friendly, comfortable and could be easily terminated if any kind of system toxicity arises. The transdermal route provides permeation of drug across the skin and into systemic circulation, avoiding the first pass hepatic metabolism of drugs which in turn increases bioavailability.

However, penetration of drug across the skin through percutaneous delivery is limited by the highly well-organized structure of the stratum corneum, which acts as a barrier function for permeation of drugs. The outermost layer, the stratum corneum is immensely compelled and useful for many dynamic drugs. The daily dose of particular drugs that have reached the market is consistently typically in terms of few milligrams. Moreover, the relationship between molecular properties and skin permeability, have developed Lipinski rules in 5, that a drug required potent pharmacological activity, to be an attainable candidate for TDD:

1. The molecular weight of the drug should lie in between 400 to 500 Daltons.
2. Balanced lipophilicity (log P, between 2 to 4) is

desired.

3. A consistent solubility both in the non aqueous and aqueous medium is required as the drug needs to breach the stratum corneum and its absorption is required in the systemic circulation
4. The number of Hydrogen bond donor should be less than 10.
5. The number of Hydrogen bond acceptor should be less than 5.

Despite mentioning drug properties, the penetration of drugs across stratum corneum is the major limiting factor. For an adult person, the skin covers around 15% of total body weight with a surface area of about 2 m2. It is a multilayered organ which is composed of various histological layers mainly described as epidermis and dermis.

The Epidermis is the outer layer of skin which consists of 95% of keratinocytes cell that has no blood supply, but is nourished by blood vessels in the dermis. The thickness of epidermis is usually 0.5mm-1mm but depends upon the site, for example, it is thick in the palms and soles to provide flexibility and to resist any mechanical injury. The epidermis is thin on the eyelids allow maximum movement.

The keratinocyte (major component) along with melanocytes, Langerhans cells and Merkel cells (minor components) forms a 'brick and mortar' structure. The lower portion of the epidermis is immature and they rapidly proliferate themselves to form daughter cells to mortal differentiation that resulted in the development of Stratum Corneum. The terminally differentiated keratinocytes called as corneocytes are responsible for the formation of tight junctions and named as 'bricks', with the nerve of skin. The space between these bricks is fulfilled by 'mortar' that consists of various lipid bilayers of fatty acids, ceramides, cholesterol esters, and cholesterol. Beneath the epidermal layer, lies the dermis, which is 25 to 30 times thicker than the epidermis. It's composed of a dense network containing specialized protein components called collagen and elastic fibers. In comparing to the epidermis fewer cells with much more fiber are found in the dermis.

The transdermal patch is used for controlling dose delivery of a drug through the skin over a period of time. The elements of transdermal patches are backing membrane, drug reservoirs, drug liners, release membrane, adherents, etc. that play a crucial role in the release of drug through the skin. It is considered that well-designed TDDS could supply drugs at a rate to sustain the required therapeutic plasma concentration without much fluctuation or therapeutic inefficacy. Due to the slow transport of drugs across the skin, the lag time required to reach steady state fluxes is in hours. The attainment of an effective level of the drug is therefore difficult without any enhancement of skin permeation. Thorough strategies were studied to enhance permeabilities of the drug of the stratum corneum in a controlled manner. A number of techniques have been amended to promote transport of a range of drugs across the skin. These methods involve physical and chemical methods in which the former provides driving force which act on a drug to promote its permeation and while later increases skin permeability by altering or disrupting nature of skin.

There have been many approaches that have been used to improve but are difficult to predict the exact degree of enhancement of drugs. These approaches range from the use of chemical enhancers of electroporation, iontophoresis and generated ultrasound waves or synergism of both mechanisms.

The limitation of these enhancement technologies is relevant with skin tolerability. The skin sensitization differs from one individual to another. It could be due to use of potent drug or chemical enhancer or polymer that will be in direct contact with skin. Skin irritation could be detected from reddening of the application site to merely occlusion of skin. Therefore an early testing for skin irritation studies is necessary for development and safe marketing of transdermal products.

Factors Affecting Skin Penetration

There are various factors that affect penetration of drug through the skin. This could be due to species variations, ageing of skin, site of application, condition of the skin (normal, hydrated or dehydrated), area of application, contact time, physical properties of the penetrant which could depend on lipophillicity of drug or penetration enhancers. However, the molecules could permeate across the SC by three pathways: intercellular, intracellular and by follicular.

There should be a deep understanding to study various factors that affect the permeability of drug via healthy

skin. The local effect could be achieved by dissolving the drug in suitable vehicle that could be applied topically. Most of semisolid formulations were used to achieve local cutaneous effects. The administration of a drug to the systemic circulation via skin could be accomplished by utilizing of transdermal patch that could sustain the drug release for the proposed period of time in a controlled manner. The drug is supplied at the skin surface from where it diffuses across stratum corneum and reaches in systemic circulation through dermal capillaries.

Factors Controlling Absorption

The conventional delivery of drug through the skin is a passive process and is ruled by Fick's law, which states that flux or the rate of absorption of a substance across a barrier is proportional to its concentration difference across that barrier. The maximum flux depends on the saturation of drug in the vehicle (Cv) and the permeability coefficient Kp. The permeability coefficient depends on properties of the drug on barrier as well as in between the interaction of drug and barrier.The various factors imparting in this interaction are partition coefficient (Km), diffusion coefficient (D) and length of the diffusion pathway (L).

Role of the Vehicle

The vehicle is an important link between drug potency and therapeutic effectiveness, since extensive pharmaceutical research has shown that the composition of the vehicle can profoundly influence the rate and extent of absorption (bioavailability). As illustrated by the potency ranking scale for glucocorticoids, the same drug appears in different potency classes when formulated in different vehicles. It was once axiomatic that ointments were more potent than creams. Though true for the early glucocorticoid products, it is no longer generally applicable. Greater understanding of the science underlying topical formulations has allowed creams, gels, solutions and foams to be specifically formulated equipotent to ointment. In the rational design of dermatologies vehicles that maximize bioavailability, two factors are of critical importance: (1) solubilizing the drug in the vehicle (CV); and (2) maximizing movement (partitioning) of drug from vehicle to stratum corneum (Km). The partition coefficient describes the ability of a drug to escape from the vehicle and move into the outermost layer of the stratum corneum. It is defined as the equilibrium solubility of the drug in the stratum corneum (SC) relative to its solubility in the vehicle (Km = Csc/Cv).

Drug Concentration

The driving force for percutaneous absorption is the concentration of soluble drug in the vehicle. Many older topical drug products were marketed with the expectation that higher concentrations were more potent. Although true for some products, e.g. tretinoin gels and creams (0.01–0.1%) in which the drug is completely solubilized at all concentrations, for others it is not. Hydrocortisone 1% and 2.5% in a cream formulation have been shown to be of equal potency, as triamcinolone acetonide 0.025%, 0.1% and 0.5% creams. One of the major advances in formulating glucocorticoids, as first shown with fluocinonide, came when it was discovered that the addition of propylene glycol to the vehicle could completely solubilize the drug. This led to corticosteroid products with greater potency, as demonstrated in the vasoconstrictor assay. Newer products are now tested during the development process to ensure that increased drug concentration results in increased bioavailability. However, excess non-dissolved drug can sometimes be advantageous; especially in transdermal patches worn for prolonged periods of time (e.g. up to a week). In this situation, as dissolved drug is absorbed into the body, non-dissolved drug can then become dissolved in order to maintain equilibrium, thereby maintaining a constant dissolved drug concentration over time and providing a constant rate of delivery.

Partition Coefficient

In general, topically applied drugs are poorly absorbed because only a small fraction partitions into the stratum corneum. Most of the drug remains on the skin surface, subject to the loss of a multitude of factors (exfoliation, sweating, wash-off, rub-off, adsorption onto clothing, and chemical or photochemical degradation). Even 10–12 hours following dosing, a drug that has not been lost by exfoliation or rub-off remains largely on the skin surface, and it is easily removed by a simple soap and water wash. In case the patches worn for several days, as much as half of the original amount of drugs may still be present in the patch when it is removed, and this can pose a safety hazard upon disposal, especially with

potentially dangerous drugs such as fentanyl. A number of physical and chemical factors can improve partitioning. Hydration of the skin due to occlusion, either from a topical formulation or a patch, expands the reservoir volume available to drugs within the stratum corneum; this can increase absorption as much as five to tenfold. Common excipients such as ethanol and propylene glycol can also alter the barrier structure so as to increase partitioning2-3.

Regional Variation

All body sites are not equally permeable. Variations in stratum corneum thickness, the number of sebaceous glands, and hydration status can all affect absorption. Current data and clinical experience suggest that one can broadly rank regional permeability as follows: nail< < palm/sole < trunk/extremities < face/scalp < < scrotum.

Strategies to Enhance Transdermal Drug Delivery

Despite the significant permeability barrier of the stratum corneum, drug delivery via the skin is a very attractive option and is widely employed for both local and systemic therapy. Topical treatment of cutaneous disorders obviously targets the site of disease, thereby minimizing adverse side effects elsewhere within the body. Delivery of systemic therapies via the skin avoids degradation of the medication within the gastrointestinal tract and first-pass metabolism by the liver, both of which are associated with oral administration of drugs, in addition to evading the pain and safety issues associated with injections. Transdermal delivery of drugs, especially via long acting patches, enables infrequent dosing of drugs and maintenance of steady state drug levels. Many dermatology medications can be applied topically to the skin because the required dosage is often exceedingly small and therefore they can be effective even in the setting of highly inefficient absorption. In addition, a number of skin disorders are associated with the compromised barrier function, which leads to enhanced drug uptake in sites of involvement. In contrast, systemic drug delivery via the skin typically requires administration of larger doses through normal skin. As a result, only ~20 drugs have been FDA-approved for transdermal administration. The drugs contained within these patches share several characteristics- they are low molecular weight (<400 DA), lipophilic (octanol–water partition coefficient up to 10000), and relatively low dose (typically <10 mg per day. Significant efforts have been expended on the development of new approaches to enhance transdermal drug delivery and thereby increase the number of drugs administered via this route. These strategies can be broadly subdivided into chemical, biochemical and physical approaches.

Chemical Enhancement

Chemical enhancers include compounds that interact with the lipid matrix of the stratum corneum to alter its nanostructure and thereby increase permeability. The major advantages of chemical enhancers are that they are typically low cost, can be incorporated into a conventional patch or topical formulation, and do not require the complexity of a battery- powered device. The primary disadvantage of chemical enhancers is that they are often associated with skin irritation or toxicity when present at high concentrations and with long exposure times. Thus, chemical enhancers have been employed principally to increase the permeability to compounds that already cross the skin reasonably well, but they have generally been unable to significantly impact delivery of new classes of molecules (e.g. Highly water-soluble drugs) or macromolecules such as proteins, gene-based medicines and vaccines.

Biochemical Enhancement

Biochemical methods have been developed to directly increase permeability of the stratum corneum lipid matrix as well as to indirectly affect skin permeability via alteration of lipid metabolism. Much of the work in this area has focused on peptides that are believed to disrupt or penetrate stratum corneum lipids. For example, polyarginine has been shown to ferry molecules attached to it across the stratum corneum and into the viable epidermis and dermis. Other peptides, identified by phage-display screening, appeared to target transfollicular pathways and did not require the drug to be attached. Magainin, a naturally occurring pore-forming peptide, has been shown to increase skin permeability by direct interaction with and disruption of stratum corneum lipids. In a related strategy, metabolically based approaches aim to enhance the efficacy of standard enhancers by biochemically inhibiting the repair (metabolic) response invivo and

thereby delaying barrier recovery. This can be accomplished by altering the critical molar ratio of the three key stratum corneum lipids or by inducing discontinuities in the lamellar bilayer system. Both lipid synthesis inhibitors and agents that interfere with the assembly, secretion or extracellular processing of lamellar bodies have been examined, including brefeldin A, monensin, chloroquine, high Ca2+/K+ levels and neutral pH buffers. Overall, biochemical enhancement methods are relatively new and to date they have not been used much in the clinical drug delivery.

Physical Enhancement

There are a number of physical methods to increase drug delivery via the skin, many of which require the use of devices and some of which hold the promise to significantly expand the spectrum of drugs that can be administered transdermally to include water-soluble molecules and macromolecules. Stripping is a simple technique used in research protocols to remove the stratum corneum by sequential application of adhesive tape or cyanoacrylate glue. With still different settings (in particular low frequencies such as <1 MHz), ultrasound can be used to generate bubble activity, referred to as "cavitation". Cavitation bubbles oscillating and imploding in the medium between the ultrasound transducer and the skin surface generate shock waves that mechanical impact the skin, creating submicroscopic defects in the stratum corneum structure. These defects increase skin permeability to water-soluble molecules and some macromolecules. In a related approach, pulsed laser beams have also been used to generate photomechanical shock waves at the skin surface, which also increase skin permeability. Cavitational ultrasound of the skin has been approved as a pretreatment prior to the application of lidocaine as a means of accelerating local anesthesia.

Basic Components of Transdermal Drug Delivery Systems

Polymer Matrix or Matrices

Polymers are employed in skin preparation and it strengthens the foundation of TDDS. Polymer selection and design are of prime importance in this system.

Considerations for Polymer Selection in Transdermal Delivery System

The polymer should be stable, non-reactive with the drug, easily manufactured and fabricated into desired product, and inexpensive. Properties of polymers (molecular weight and glass transition temperature and chemical functionality) should be such that the specific drug diffuses properly and get released through it and mechanical characteristics of the polymer should not deteriorate excessively when larger amount of active agents are incorporated into it, should have biocompatibility and chemical compatibility with the drug and other components of the system such as penetration enhancers and PSAs, should provide consistent and effective delivery of a drug throughout the product's life. Polymers are utilized in TDDS in a versatile manner, including as: rate-controlling membranes, adhesives (pressure-sensitive adhesives), backing layers, and release liner.

Rate Controlling Membrane

The elementary way to control the release of a drug is to disperse through an inert polymeric matrix. In this system, the drug is physically blended with polymeric powder (either hydrophilic or lipophilic), and the medicated polymer is then molded into a medicated disc with a defined surface area and controlled thickness. An inverse relationship is thus observed between the release rate and membrane thickness. Moreover, such relationship was confirmed when an occurrence of boundary layer effects on permeability measurements. The permeation rate (J) of the membranes, which was synthesized from three different monomers of A, B and C (2-hydroxy-3-phenoxypropylacrylate, 4-hydroxybutyl acrylates, Sec-butyl tiglate respectively) at different membrane thickness was determined (L), using Clonidine as a drug test by applying an expression of Fick's law of diffusion. Release rates of the drug are improved by the addition of a hydrophilic polymer, e.g. hydroxypropyl methylcellulose, to the rate-controlling membrane. Drug transfer from the hydrophilic matrix across the membrane is shown to be controlled by the drug partitioning from the matrix into the membrane. Thus, the diffusion properties of the membrane are used to ensure availability of the drug and/or excipients to the skin.

Adhesives

The adhesive, a vital component plays an intimate contact between the delivery system with the skin. The adhesion of TDDS is one of the critical factors to the safety, efficacy and quality of the product. It is related to drug delivery and therapeutic effect. It carries the drug which can either be dispersed or dissolved in the matrix or the compartment containing drug (solution or suspension) is separated from the adhesive layer by a diffusion controlling membrane, the drug permeates through this adhesive membrane to reach the skin. The quality of the bond between patch and skin holds importance as it directly reflects the consistency of drug delivered. The delivery of a drug from the patch diminishes as a result of patchy lift, or falling off, reduces the surface area of contact. In other words, poor adhesion results in improper dosing of patients. Secondly, patches that fail to adhere for their prescribed time phase must be replaced more frequently, thereby increasing the patient's cost. Thirdly, lack of adhesion is a safety issue. There are potential hazards when accidentally exposed (e.g. Transfer of a patch from an adult to a child while hugging, accidentally sitting or lying on a patch.

Conclusion

Fruitful transdermal medication application requires various considerations. Remembering that the essential elements of the skin are assurance and protection from external elements. It is necessary to study the structure and function of the skin and how to modify these properties, for drug permeation through transdermal route.. The properties of the medication, the qualities of the transdermal patches, determination of Invivo model and the status of patient's skin are exceptionally significant for effective and safe medications. The transdermal medication is a framework of the best novel drug delivery system.

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Dr. Niharika, currently she is working as Associate Professor in Metro college of Health sciences and Research, Greater Noida. She is Ph.D, M.Pharm in Pharmaceutics, has 7 years of teaching and research experience. She has 7 years of teaching experience of diploma, bachelors and postgraduate students. She is having total 18 publications in international journals, and many of her articles are indexed in Scopus and SCI journal. During her Ph.D she has worked on 'Design and characterization of Acrylic Pressure sensitive adhesive based Transdermal therapeutic system to which she has been appreciated by Departrment of Polymer Sciences, IIT Kharagpur. Her area of interest is Transdermal Drug delivery and Gastroretentive drug delivery. She has currently guided 6 M.Pharm students and encourages them to indulge in research areas.

A Study of Government Schemes for Women Entrepreneurship Development in India

Dinesh Kumar Rana
IEC Group of Institutions, Greater Noida.
ranadineshkumar@gmail.com

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Abstract: Entrepreneurship among Women is very essential for women empowerment and human resource Development in the country. As Compared to other countries the development of women entrepreneurship is very low in India, especially in the rural areas. However, women from middle class are not too eager to alter their role in fear of social backlash and don't dare to cross the boundaries of the old society. The progress is more visible among upper class families in urban cities and rarely in rural areas.

In Indian environment, men are always considered as economic supporter for his family as well as for the nation and women are considered as a care taker of the family rather than an economic supporter. But Social and economic development of women is necessary for overall economic development of any society or country. Due to changes in environment, now people are more comfortable to accept leading role of women in our society, though there are some exceptions. She has competed with man and successfully stood up with him in every walk of life and business. These women leaders are assertive, persuasive and willing to take risks. They managed to survive and succeed in this cut throat competition with their hard work, diligence and perseverance.

This paper focuses on the status of women entrepreneurs in India, and it talks about the problems, issues,& challenges faced by women entrepreneurs. It suggests them to overcome all these problems. The paper also analyses policies of Indian government for promoting Women Entrepreneurship in the country and the solutions for the problems faced by them while pursuing their business.

Introduction

The origin of the basic word "entrepreneurship" is from a French word "Entree" "To enter" and "Prendre" "to take" and in general sense applies to any person starting a new project or trying a new opportunity.

Entrepreneurship refers to the act of setting up a new business or reviving an existing business so as to take advantages from new opportunities. An entrepreneur is a person who starts an enterprise. He searches for change and responds to it. Entrepreneurs are innovators who come up with new ideas and creativity in terms of products, markets or techniques. An insight study reveals that it is not about making money, having the greatest ideas, knowing the best sales pitch, applying the best marketing strategy. It is in reality an attitude to create something new and an activity which creates value in the entire social and economic system.

Women represent approximately half of the total world population as well as in India also. In our societies Indian women are treated as show pieces to be kept at home. But now they are also enjoying the impact of growing industrialization, globalization, and social legislation not only on domestic but also on international sphere. Indian women are ready to take burden of work in house and as well as the work place.

The Definition given by Govt. of India about women entrepreneurship, "An enterprise owned and controlled by a Women and having a minimum financial interest of 51% of the capital & giving at least 51% of the employment generated in the enterprise to Women".

With the spread of education and awareness, women have shifted from kitchen to higher level of professional activities. Now-a-days women enter not only in selected professions but also in professions like trade, industry and engineering. Women are also willing to take up business and contribute to the Nation's growth. Their role is also being recognized and steps are being taken to

promote women entrepreneurship.

Women entrepreneurship must be molded properly with entrepreneurial traits and skills to meet the changes in trends, and challenges from global markets and also be competent enough to sustain and strive for excellence in the entrepreneurial arena.

Status of Women Entrepreneurs in India

Entrepreneurship is considered as one of the most important factors contributing to the development of society. India has been ranked among the worst performing countries in the area of women entrepreneurship in gender-focused global entrepreneurship survey, released in July 2013 by PC maker Dell and Washington based consulting firm Global Entrepreneurship and Development Institute (GEDI). Of the 17 countries surveyed India ranks 16th, just above Uganda. Countries like Turkey, Morocco and Egypt have outperformed India. Status of higher education in women in India came out to be lower than most countries in the world. At present, women's entrepreneurial role is limited in the large scale industries and technology based businesses. But even in small scale industries, the women's participation is very low. As per the third all-India census of Small Scale Industries, only 10.11% of the micro and small enterprises were owned by women, and only 9.46% of them were managed by women. While the number of women operating their own business is increasing globally, women continue to face huge obstacles that stunt the growth of their businesses, such as lack of capital, strict social constraints, and limited time and skill. Despite, there are few top most women entrepreneurs in different zones in our India.

Role of Government to Develop Women Entrepreneurs in India

The growth and development of women entrepreneurs required to be accelerated because entrepreneurial development is not possible without the participation of women. Therefore, a congenial environment is needed to be created to enable women to participate actively in the entrepreneurial activities. There is a need of Government, non-Government, promotional and regulatory agencies to come forward and play the supportive role in promoting the women entrepreneur in India.

The Government of India has also formulated various training and development cum employment generations programs for the women to start their ventures. These programs are as follows:

1. Steps taken in Seventh Five-Year Plan:

In the seventh five-year plan, a special chapter on the "Integration of women in development" was introduced by Government with following suggestion:

(i)Specific target group:

It was suggested to treat women as a specific target groups in all major development programs of the country.

(ii)Arranging training facilities:

It is also suggested in the chapter to devise and diversify vocational training facilities for women to suit their changing needs and skills.

(iii)Developing new equipments:

Efforts should be made to increase their efficiency and productivity through appropriate technologies, equipment and practices.

(iv)Marketing assistance:

It was suggested to provide the required assistance for marketing the products produced by women entrepreneurs.

(v)Decision-making process:

It was also suggested to involve the women in decision-making process.

2. Steps taken by Government during Eight Five-Year Plan:

The Government of India devised special programs to increases employment and income-generating activities for women in rural areas. The following plans are lunched during the Eight-Five Year Plan:

(i) Prime Minister Rojgar Yojana and EDPs were introduced to develop entrepreneurial qualities among rural women.

(ii) 'Women in agriculture' scheme was introduced to train women farmers having small and marginal holdings in agriculture and allied activities.

(iii) To generate more employment opportunities for women KVIC took special measures in remote areas.

(iv) Women co-operatives schemes were formed to help

women in agro-based industries like dairy farming, poultry, animal husbandry, horticulture etc. with full financial support from the Government.

(v) Several other schemes like integrated Rural Development Programs (IRDP), Training of Rural youth for Self employment (TRYSEM) etc. were started to alleviated poverty.30-40% reservation is provided to women under these schemes.

3. Steps taken by Government during Ninth Five-Year Plan:

Economic development and growth is not achieved fully without the development of women entrepreneurs. The Government of India has introduced the following schemes for promoting women entrepreneurship because the future of small scale industries depends upon the women-entrepreneurs:

(a) Trade Related Entrepreneurship Assistance and Development (TREAD) scheme was lunched by Ministry of Small Industries to develop women entrepreneurs in rural, semi-urban and urban areas by developing entrepreneurial qualities.

(b) Women Comkp0onent Plant, a special strategy adop0ted by Government to provide assistance to women entrepreneurs.

(c) Swarna Jayanti Gram Swarozgar Yojana and Swaran Jayanti Sekhari Rozgar Yojana were introduced by government to provide reservations for women and encouraging them to start their ventures.

(d) New schemes named Women Development Corporations were introduced by government to help women entrepreneurs in arranging credit and marketing facilities.

(e) State Industrial and Development Bank of India (SIDBI) has introduced following schemes to assist the women entrepreneurs. These schemes are:

(i) Mahila Udyam Nidhi
(ii) Micro Cordite Scheme for Women
(iii) Mahila Vikas Nidhi
(iv) Women Entrepreneurial Development Programs
(v) Marketing Development Fund for Women

4. **Consortium of Women entrepreneurs of India provides** a platform to assist the women entrepreneurs to develop new, creative and innovative techniques of production, finance and marketing.

There are different bodies such as NGOs, voluntary organizations, Self-help groups, institutions and individual enterprises from rural and urban areas which collectively help the women entrepreneurs in their activities.

5. Training programs:

The following training schemes especially for the self employment of women are introduced by government:

(i) Support for Training and Employment Program of Women (STEP).

(ii) Development of Women and Children in Rural Areas (DWCRA).

(iii) Small Industry Service Institutes (SISIs)

(iv) State Financial Corporations

(v) National Small Industries Corporations

(vi) District Industrial Centre (DICs)

6. Mahila Vikas Nidhi:

SIDBI has developed this fund for the entrepreneurial development of women especially in rural areas. Under Mahila Vikas Nidhi grants loan to women are given to start their venture in the field like spinning, weaving, knitting, embroidery products, block printing, handlooms handicrafts, bamboo products etc.

7. Rashtriya Mahila Kosh:

In 1993, Rashtriya Mahila Kosh was set up to grant micro credit to pore women at reasonable rates of interest with very low transaction costs and simple procedures.

Some other Schemes for the development and promotion of women entrepreneurs in India

According to the Third All India Census of Small Scale Industries conducted in 2001-02 and subsequent estimates made, only 10.11% of the Micro and Small Enterprises in India are owned by women while 9.46% of the MSE enterprises are managed by women. Currently (2006-07) their estimated number is 12.99 lakh women managed enterprise and 12.15 lakh women managed enterprise.

In order to encourage more and more women enterprises

in the MSE sector, several schemes have been formulated by this Ministry and some more are in the process of being finalized, targeted only at the development of women enterprises in India.

1.Trade Related Entrepreneurship Assistance and Development Scheme for Women (TREAD)

With a view to encourage women in setting up their own ventures, government implements a Scheme, namely, "Trade Related Entrepreneurship Assistance and Development (TREAD) during the 11th Plan. The scheme envisages economic empowerment of women through the development of their entrepreneurial skills in non-farm activities. There are three major components of the scheme;

(i) GoI grant upto 30% of the total project cost to the Non-Government Organisations (NGOs) for promoting entrepreneurship among women. The remaining 70% of the project cost is financed by the lending agency as loan for undertaking activities as envisaged in the project.

(ii) GoI grant upto Rs.1 lakh per programme to training institutions / NGOs for imparting training to the women entrepreneurs, subject to these institutions/NGOs bring their share to the extent of minimum 25% of GOI grant and 10% in case of NER.

(iii) Need-based GoI grants upto Rs.5 lakh to National Entrepreneurship Development Institutions and any other institutions of repute for undertaking field surveys, research studies, evaluation studies, designing of training modules etc.

Operationalisation of the Scheme

The scheme envisages that Women Associations /NGOs/SHGs should prepare composite bankable proposals for a group of women entrepreneurs, and submit to the office of the DC (MSME) for forwarding to the Banks for their appraisal. Bank examines the proposal and issues approval. 30% of the loan amount is sanctioned as grant and made available to the bank by office of DC (MSME) for further disbursement to NGOs.

2. Micro & Small Enterprises Cluster Development Programme (MSE-CDP)

a) Existing Clusters:

A cluster is defined as a group of enterprises, ideally having 100 members, producing same/similar products/services. While 100 members could be the minimum per cluster, depending on the density of population and other factors, even 200-300 could be agood target group for undertaking Diagnostic Study and the subsequent Soft Interventions in a cluster. However, in difficult and backward regions the target numbers could come down to 50 or less but it should not be too small as a lot of Government expenditure is made per cluster. The Cluster Development Programme (CDP) being implemented envisages diagnostic study of identified clusters of traditional skill-based MSEs to identify appropriate technologies and their providers and to facilitate adoption of available technology meeting the specific needs of the end users. The Cluster Development aims at enhanced competitiveness, technology improvement, adoption of best manufacturing practices, marketing of products, employment generation etc. The scheme provides assistance for capacity building, common facilities, marketing etc. the delivery, assimilation and diffusion of the identified technology from its producers to the recipient user/cluster of small enterprises.

Type of interventions

I) Soft Interventions: Capacity building activities in the cluster where nofixed assets is acquired or formed. Soft interventions, inter alia, include

i. Diagnostic study
ii. Forming association-Trust building & Developing Identity
iii. Capacity building,
iv. Organising workshops, seminars,
v. Training & Exposure visits,
vi. Market development,
vii. Launch of Website,
viii. Common procurement,
ix. Common/complementary sales and branding;

In the past depending upon the type of cluster, assistance available for soft interventions has varied in the range of Rs. 25 – 35 lakh per cluster. Currently we have an internal ceiling of Rs. 10 lakh for soft intervention under this Scheme.

II) Hard Interventions:– Hard interventions, inter alia, include

i. Setting up of Common Facility Centre

(CFCs),
ii. Mini Tool Room
iii. Design Centre,
iv. Testing Facilities
v. Training Centre,
vi. R&D Centre
vii. Common Raw Material Bank/Sales depot, etc.
viii. Display/Exhibition Centre

In case of the hard intervention the contribution from the M/o MSME varies between 30-80% of the total project cost, but in the case of clusters owned and managed by women entrepreneurs, contribution of the M/o MSME could be upto 90% of the project cost.

b) Creation of physical infrastructure:

This Ministry implemented the IID Scheme to provide developed sites with infrastructural facilities like power distribution network, water, telecommunications, drainage and pollution control facilities, roads, exhibition/display centres, raw materials, storage and marketing outlets, common service facilities and technological back-up services, etc. This scheme has been subsumed in the MSME-Cluster Development Programme. All the features of IID Scheme have been retained.

To create physical infrastructure exclusively for women enterprises central grant of 40% of the project cost subject to a maximum of Rs.2 crore is available. The Ministry of MSME is making efforts to enhance the quantum of grant to 80% in a project of Rs.10 crore.

Operationalisation of the Scheme

i) A Cluster Development Executive (CDE) is required for executing and monitoring all soft interventions in a cluster. Normally, a CDE can be a DIC Officer/MSME-DI officer/retired expert or even hired person from Non-Government Sector.

ii) The hard interventions in a cluster and creation of physical infrastructure require to set up a users body/special purpose vehicle which could be society/trust/company to be formed by the cluster beneficiaries.

3. Credit Guarantee Fund Scheme for Micro and Small Enterprises

The Scheme was launched in August 2000 to ensure better flow of credit to micro and small enterprises by minimizing the risk perception of financial institutions and banks in lending without collateral security. Under the scheme, guarantee cover is provided to collateral free credit facility extended by member lending institutions (MLIs) to the new as well as existing micro and small enterprises on loans up to Rs.50 lakh. The guarantee cover available is up to 75% of the loans extended. The extent of guarantee cover is 80% for (i) micro enterprises for loans up to Rs.5 lakh; (ii) MSEs operated and/or owned by women; and (iii) all loans in the North-East Region. The lending institutions availing guarantee from the Trust have to pay one time guarantee fee of 1.5% and service charges of 0.75% per annum of the credit facility sanctioned. For loans up to Rs.5 lakh, the one time guarantee fee is 1% and service charges are 0.5% per annum of the credit facility sanctioned.

4. Support for Entrepreneurial and Managerial Development

MSME DIs regularly conduct EDPs/MDPs for existing and prospective entrepreneurs and charge nominal fee for such courses. To encourage more entrepreneurs from among the SC/ST, women and physically challenged groups, it is proposed that such beneficiaries will not be charged any fees but, instead paid a stipend of Rs.500/- per capita per month, under Promotional Package Programmes. 50,000 entrepreneurs will be trained in IT, Fashion Technology, Catering, Agro & Food Processing, Pharmaceutical, biotechnology etc. through specialized courses run by MSME DIs. 20% of courses conducted by these Institutions shall be exclusively for women.

5. Exhibitions for Women Under Promotional Package for Micro & Small Enterprises Approved by CCEA Under Marketing Support

DC (MSME) has formulated a scheme for women entrepreneurs to encourage Small & Micro manufacturing units owned by women and register in DI/DIC in their efforts at tapping and developing overseas markets, to increase participation of representatives of small/micro manufacturing enterprises under MSME stall at International Trade Fairs/Exhibitions, to enhance export from such units. Under this scheme, participation of women entrepreneurs in 25 international exhibitions is envisaged during the 11th Plan (2007-2012).

With a view to encourage women entrepreneurs to

participate in the International Exhibitions under MDA scheme it has been decided to:

i) provide rent free space (6/9 Sq Mts) in the exhibitions

ii) reimburse 100% economy class air fare for one representative The overall ceiling shall however be Rs. 1.25 lac.

Conclusion

Entrepreneurship is presently the most discussed and encouraged concept all over the world to overcome economic challenges. Women being the vital gender of the overall population have great capacity and potential to be the contributor in the overall economic development of any nation. Therefore, programs and policies need to be customized to not just encourage entrepreneurship as well as implement strategies which can support entrepreneurial culture among youth. Developing countries are definitely in dire need to encourage women entrepreneurship as women workforce is promptly available to exploit the unexplored dimensions of business ventures.

But unfortunately, the government sponsored development activities have benefited only a small section of women. The large majority of them are still unaffected. Women are willing to take up business and contribute to the nation's growth. Their role is being recognized and steps are taken to promote women entrepreneurship. Resurgence of entrepreneurship is the need of the hour. Women entrepreneurs must be moulded properly with entrepreneurial traits and skills to meet changing trends and challenging global markets, and also be competent enough to sustain and strive in the local economic arena.

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Dinesh Kumar Rana is working as Assistant Professor in MBA Department, IEC College, Greater Noida. He is NSE Certified Stock Market Professional with total experience of 13 years in Teaching Finance, Financial Market Trainings (NISM Courses), Financial Advising and Portfolio Management.

Paris Agreement on Climate Change: A Multilateral Approach towards Achieving Sustainable Development

Hrishikesh Manu
Assistant Professor of Law, Chanakya National Law University, Patna
hrishikeshmanu@cnlu.ac.in

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Introduction

The year 2015 will be remembered for two landmark international events: the historic climate change agreement under the UN Framework Convention on Climate Change (UNFCCC) in Paris in December 2015 and the adoption of the Sustainable Development Goals in September 2015. The Paris Agreement on Climate Change is considered to be a 'monumental triumph' in international climate change law and policy. After nearly seventeen years of stalemate, 197 Parties to the UN Framework Convention on Climate Change concluded a new international agreement at the 21st Conference of the Parties to the UNFCCC (COP21) in Paris on 12 December 2015. The Treaty aims to strengthen the global response to the threat of climate change in the context of sustainable development. It represents a confirmation that the international community will continue to approach climate change multilaterally. One of the main focus of the agreement is to hold the increase in the global average temperature to well below 2°C above pre- industrial level and on driving efforts to limit it even further to 1.5°C. The Paris Agreement sets a roadmap for all nations in the world to take actions against climate change in the post-2020 period.

One of the important principles of international environmental law is sustainable development. Like the notion of common but differentiated responsibilities and respective capabilities (CBDRRC), the concept of sustainable development is concerned with the relationship between environmental and developmental considerations. The Brundtland Commission has defined the term sustainable development as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. The Rio Declaration uses the term 'sustainable development' in twelve of its twenty seven principles. But the precise content and contours of this basic concept remains elusive. Rather offer a definition, the declaration outlines various elements of sustainable development. One important element is that development, while essential, must remain within the carrying capacity of the environment and, therefore, that environmental protection must be part of development process.

On 25th September 2015, countries adopted a set of goals to end poverty, protect the planet and ensure prosperity for all as part of a new sustainable development agenda. Each goal has specific targets to be achieved over the next 15 years. The Millennium Development Goals (MDG) that were in place from 2000 to 2015 were replaced by the Sustainable Development Goals (SDG) with the aim of guiding the international community and national governments on a pathway towards sustainable development for the next fifteen years. A new set of 17 SDGs and 169 targets were adopted by the world governments in 2015. Goal 13 specifically provides that world community should take urgent action to combat climate change and its impacts.

Climate Change: Greatest threat to Sustainable Development

Climate change is the most important challenge to achieving sustainable development, and it threatens to drag millions of people into poverty. The Intergovernmental Panel on Climate Change (IPCC) has noted, from 1880 to 2012, average global temperatures increased by 0.85°C. Global emissions of carbon dioxide (CO2) have increased by almost 50 per cent since 1990, and emissions grew more quickly between 2000 and 2010 than in each of the three previous decades. Developing countries will suffer most from the effects of climate change. Their economies are more

dependent on natural resources, such as agriculture, forestry and fisheries, and they often lack the infrastructure, the financing and capacity to adapt to a changing climate.

Climate change has been rising on the political agenda. Climate change involves all three dimensions of sustainable development: the economic, the environmental and the social dimension. Addressing this challenge demands a long term perspective on how our actions today will affect the lives of our children, and it also demands a dialogue with all stakeholders involved in order to reach viable solutions. The prevention of dangerous global warming requires the reduction and limitation of emissions of greenhouse gases. The international response to climate change began at the Rio Earth Summit in 1992, where the UN Framework on Climate Change (UNFCCC) was adopted. This convention set out a framework for action aimed at stabilizing atmospheric concentrations of greenhouse gases to avoid "dangerous anthropogenic interference with the climate system." In 1997 Kyoto Protocol supplemented the framework laid out in UNFCCC, by establishing internationally negotiated, legally binding emission targets for Annex I parties.

Paris Agreement on Climate Change

The Paris Agreement marks a historic moment in the international climate change negotiation. It signifies that the international community will continue to approach climate change multilaterally. This universal agreement will succeed the Kyoto Protocol. Unlike the Kyoto Protocol, it provides a framework for all countries to take action against climate change. Placing emphasis on concepts like climate justice and sustainable lifestyles, the Paris Agreement for the first time brings together all nations for a common concern under the UNFCCC. The Paris Agreement sets an ambitious direction for the climate regime and it also establishes a common transparency and accountability framework. The Paris Agreement comprises of 29 Articles and it covers all the crucial areas recognized as essential for a comprehensive and balanced agreement, including mitigation, adaptation, loss and damage, finance, technology development and transfer, capacity building and transparency of action and support. The Paris Agreement provides a remarkably strong basis for future global action on climate change.

The Paris Agreement prescribes a multilateral framework for taking action on climate change in the post-2020 period. It recognizes that developed countries are responsible for the cumulative historic stock of greenhouse gases (GHGs) in the atmosphere and therefore must take the lead in climate actions and also provide financial, technological and capacity building support to developing countries with respect to both mitigation and adaptation. The imperative would be to ensure that UNFCCC and Paris Agreement continue to take cognizance of the fact that developing countries have unique vulnerabilities, special circumstances, and development priorities like eradication of poverty, food security, energy access etc.

There is no question about the Paris Agreement's legal force under international law. After entry into force by 2020, the agreement will be a legally binding multilateral treaty within the meaning of the Vienna Convention on the Law of Treaties. The agreement's provisions on signature, ratification and entry into force, remove any doubt about the intent of the parties to the agreement to be bound under, and hence governed by, international law.

The focus of the Paris Agreement is on a process for achieving the well below 2°C target. Key to that process is the bottom up submission by parties of "Nationally Determined Contributions" (NDCs). NDCs are high level policy plans setting out what approach each country will take to reduce emissions and contribute to the global well below 2°C goal. The Paris Agreement requires that when countries submit their longer term NDCs, they ensure that the revised commitments reflect the "highest possible ambition". Each NDC is also to be revised every five years "with a view to enhancing the level of ambition".

Scope of Sustainable Development in the Paris Agreement

A promise to sustainable development is clearly reflected in the various provisions of the Paris Agreement. The Preambular recital 11 reads:

Climate change is a common concern of humankind, Parties should, when taking action to address climate change, respect, promote and consider their respective obligations on human rights, the right to health, the rights of indigenous peoples, local communities, migrants, children, persons with disabilities and people in vulnerable situations and the right to development, as

well as gender equality, empowerment of women and intergenerational equity.

The Sustainable Development Goals (SDGs) as detailed in the UN Resolution, "Transforming our World: the 2030 Agenda for Sustainable Development" and the Paris Agreement are both universal visions and are both based on being implemented from the "bottom-up", meaning that countries identify their own priorities, needs and ambitions. The 17 SDGs have 169 related targets to be achieved by 2030 and are expected to help organise and streamline development action for achievement of greater human well-being.

The principle of common but differentiated responsibilities and respective capacities is an important component of the Paris Agreement. This Agreement will be implemented to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances. Each Party's successive nationally determined contribution will represent a progression beyond the Party's then current nationally determined contribution and reflect its highest possible ambition, reflecting its common but differentiated responsibilities and respective capabilities, in the light of different national circumstances. All Parties should strive to formulate and communicate long-term low greenhouse gas emission development strategies, mindful of Article 2 taking into account their common but differentiated responsibilities and respective capabilities, in the light of different national circumstances.

In the Paris Agreement, the principle of common but differentiated responsibilities and respective capacities can also be found in the provisions related to mobilisation of financial assistance, assistance in adaptation efforts, facilitation of technology transfer, and capacity-building. For developing countries to effectively implement their NDCs, industrialized countries will have to offer assistance in various forms. The basis for this obligation is traceable to Article 4 of the UNFCCC. Support to developing countries in general should come in the form of finance, technology development and transfer, as well as capacity building.

One important component of sustainable development is precautionary principle which can also be found in the Paris Agreement. The Treaty recognises an urgent 'threat' of climate change and the need to strengthen global response to the threat of climate change and to significantly reduce the risks of climate change. In essence, while references could be more explicit, the Paris Agreement and the UNFCCC are founded on the precautionary principle. In order to stabilise GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system and in order to allow ecosystems to adapt naturally to climate change, so as to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner, mitigation and adaptation actions must be taken even in the event of scientific uncertainty as to the exact contours of the challenge.

The principle of public participation and access to information and justice is emphasised throughout the Paris Agreement, including in provisions on mitigation, adaptation and on the Sustainable Development Mechanism and non-market approaches which aim to enhance public and private sector participation in the implementation of NDCs. Further, Parties shall enhance education, training, public awareness, public participation and public access to information, recognising their importance in enhancing actions under the Agreement. In essence, the treaty depends on public engagement, informed by the information that is made available through the national communications that are submitted to international registries, the global stock take, the peer review, and other measures, to assist parties progressively to intensify their contributions to mitigation, adaptation, finance and other aspects of the global response to climate change.

Paris Agreement and Sustainable Development Goals

The Paris Agreement is a complimentary mechanism to the SDG's goals that addresses climate change. The SDGs were arrived at through a unique global process, centring on an open working group of member states and consultation with a broad range of stakeholders. The text was subsequently agreed on by all UN member states in the General Assembly in September 2015. While the 2030 Agenda is global in its ambition and universally applicable, it is up to countries to decide how to implement it, and how to prioritize goals and targets, depending on national needs and ambitions. They are free to set up their own national and sub national implementation structures and plans. Countries

are also encouraged to work in partnership to learn and assist each other.

The SDGs aim at tackling key systemic barriers to sustainable development, such as poverty, inequality, unsustainable consumption and production patterns, inadequate infrastructure, climate change and lack of decent jobs. The SDGs provide useful guidance for shaping law, policy and practice for implementation of effective and ambitious climate change action. Tackling climate change and fostering sustainable development are two mutually reinforcing sides of the same coin. Sustainable Development cannot be achieved without climate action, as many of the SDGs are actually addressing the core drivers of climate.

The 17 SDG's are global agenda intended to guide action that balances human needs with environment protection. The problem of climate change can be addressed by SDG's and, if unaddressed, will cause new ones. The coordination between the Paris Agreement and SDG's can achieve the targets necessary to keep the global temperature low enough that society can correct the inequalities that burden our world. The Paris Agreement is an ambitious climate agreement that is critical to achieve the SDGs by 2030. It apparently provides a clear policy framework and legal basis for action on climate change.

Conclusion

The world is facing the challenge of sustaining its economic growth while dealing with the global threat of climate change. Climate change impacts are part of the larger question of how complex social, economic, and environmental sub-systems interact and shape prospects for sustainable development. The solution to this problem lies in a multilateral action which is positive, constructive and forward looking under the United Nations Framework Convention on Climate Change. The Paris Agreement is an important step in the right direction.

The world has realized and is completely convinced that climate change is affecting global health, poverty, food security, and national and global security. The Paris agreement is a clear indication that our global policy makers and stakeholders of global sustainable development are determined to mitigate the inevitable climate disaster and accelerate sustainable development for the benefit of the people and the planet. The Paris agreement contains ambitious goals, extensive obligations and comparatively rigorous oversight. Taking into account SDG commitments can help countries to ensure that climate actions promote wider social, economic and environmental ambitions. It is now up to the individual countries to adopt concrete mitigation and adaptation measures. If all the stakeholders of global sustainable development proceed with their respective tasks for the achievement of SDGs, then we will certainly accomplish them in time which will help to improve the lives of people and to build a better and safer future with no one left behind.

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Mr. Hrishikesh Manu is an Assistant Professor of Law at the Chanakya National Law University, Patna. He holds an LL.B. degree from the Banaras Hindu University and an LL.M. from the University of Delhi. He has qualified for the UGC NET examination and holds a Junior Research Fellowship. He teaches Environmental Law, Alternative Dispute Resolution and Criminal Justice at the undergraduate and post-graduate levels and has presented papers at National and International Conferences.

Global Challenges to Higher Education of India and Its Strategies to Attain Global Standard

Dr. Shakti Prakash (Corresponding Author)[1], Mr. Bipin Kumar Singh,[2] Ms. Rachana Srivastava[3], Dr. Apurva Srivastava[4]

[1]Professor & Head, Management Department, IEC College of Engineering and Technology, Greater Noida.
[2]Assistant Professor, Management Department, IEC College of Engineering and Technology, Greater Noida.
[3]Assistant Professor, Management Department, IEC College of Engineering and Technology, Greater Noida.
Visiting Faculty IMS Devi Ahilya University, Indore (M.P.)
hodmba@ieccollege.com,

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Abstract

Indian higher education system is the third largest higher education system in the world with 993 universities, 37,643 institutions and with 37.6 million students, which receives criticism for its low quality in international scenario. Not only does the quality vary from type of institutions, between regions, but also, there is a wide range of variations between various institutions. It needs to be ensured that every student who is a part of the higher education system shall have a minimum acceptable standard of education. This calls for the adopting all the measures which can enhance quality of higher education.

As per the largest and most diverse university rankings report of "Times Higher Education (THE) World University Rankings 2022" out of 1,662 universities, across 99 countries and territories. Only one of Indian institute IISC Bengaluru (Karnatka) placed in the slab of 301 to 350. Otherwise rest of Indian Universities/Institutes are placed below 351 rank. This University Rankings is topped by the United Kingdom's (UK) University of Oxford for the 6 successive year. It was followed by the United States' (US) California Institute of Technology (Caltech) and Harvard University at rank 2nd, and Stanford University at rank 4th. A total of 71 Indian university made it to World University Rankings 2022 compared to 63 1ast year. However only three Indian universities made it to the top 400 global rankings. IIT Indore (Madhya Pradesh) is placed in the group of 401-500 while Alagappa University (Tamil Nadu) and Thapar University (Punjab) were in the 501-600 cohort. 10 Indian Universities, including Jawaharlal Nehru University (JNU), Delhi Technology University (DTU), JamiaMilliaIslamia (New Delhi) and Panjab University (Chandigarh) were listed in the 601-800 band. Delhi University slipped from last year's ranking of 601-800 to the 801-1,000 band.

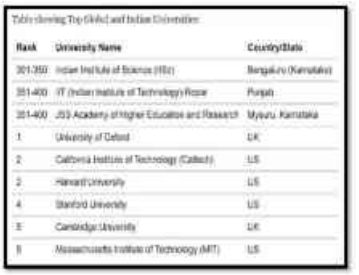
This paper is critically examined to higher education of India against global challenges on the basis of major three issues, The Gross Enrolment Ratio (GER), Equity and Education quality up-gradation and inclusion, and Strategies of India to attain itspast glory ofJagatGuru.

Keyword: Higher Education, The Gross Enrolment Ratio (GER), Equity, Education quality up-gradation and inclusion.

Introduction

As per the largest and most diverse university rankings report of "Times Higher Education (THE) World University Rankings 2022" out of 1,662 universities, across 99 countries and territories. Only one of Indian institute IISC Bengaluru (Karnatka) placed in the slab of 301 to 350. However other Indian universities and institutions falls below 400 ranking. On the other hand China's Peking University and Tsinghua University achieved the list with a global joint ranking of 16th .The rankings premised upon the 13 indicators that measure an institution's performance across four areas: teaching,research,knowledgetransfer and international

outlook.US is the most-represented country overall with 183 institutions, This University Rankings is topped by the United Kingdom's (UK) University of Oxford for the 6 successive year. It was followed by the United States' (US) California Institute of Technology (Caltech) and Harvard University at rank 2nd, and Stanford University at rank 4th. UK's Cambridge University is placed at 5 position alongside US' Massachusetts Institute of Technology (MIT). In the top 200 list the maximum universities are from the US (57) followed by the UK (28), and Germany (22) From Asia.



Rank	University Name	Country/State
301-350	Indian Institute of Science (IISc)	Bengaluru (Karnataka)
351-400	IIT (Indian Institute of Technology) Ropar	Punjab
351-400	JSS Academy of Higher Education and Research	Mysuru, Karnataka
1	University of Oxford	UK
2	California Institute of Technology (Caltech)	US
2	Harvard University	US
4	Stanford University	US
5	Cambridge University	UK
6	Massachusetts Institute of Technology (MIT)	US

Figure 1: Top Global and Indian Universities

A total of 71 Indian university made it to World University Rankings 2022compared to 63 1ast year. However only three Indian universities made it to the top 400 global rankings. Among them, Indian Institute of Science (IISc), Bengaluru (Karnataka) is on the top and continues to be between 301-350 cohort. It was followed by IIT (Indian Institute of Technology)-Ropar (Punjab) which also retained its position in the 351-400 group. Mysore (Karnataka) based private university JSS Academy of Higher Education and Research made its debut in the global rankings while grabbing a place in the 351-400 group.

India is home to 35 universities in the global top 1,000 list. IIT Indore (Madhya Pradesh) is placed in the group of 401-500 while Alagappa University (Tamil Nadu) and Thapar University (Punjab) were in the 501-600 cohort. 10 Indian Universities, including Jawaharlal Nehru University (JNU), Delhi Technology University (DTU), Jamia Millia Islamia (New Delhi) and Panjab University (Chandigarh) were listed in the 601-800 band. Delhi University slipped from last year's ranking of 601-800 to the 801-1,000 band.

India is one of the largest higher education system in the world with 993 universities, 37,643 institutions and with 37.6 million students,over the years, significant progress has been made in higher education in the country. There is a significance shift in moving from an elite centric higher education system to more that recognizes issues of massification to enhance access and equity, but due to unbalanced increase access and equity impacted on quality and excellence in higher education of the country.Indian higher Education system is facing three major global challenges.

1. The Gross Enrolment Ratio (GER),
2. Equity,
3. Education quality up-gradation and inclusion.

Methodology

There are many viewpoints to do research in the field of Global Challenges of Higher Education to India and Its Strategies. But due to some limitations, only secondary data has been used in this descriptive paper.

Objectives

1. A critical analysis of GER in higher education of India and strategies to meet out global standard.
2. To evaluate the equity of higher education of India and strategies to balance equity as per global standard.
3. An analysis and Indian strategies to achieve excellence in higher education as per global standard.

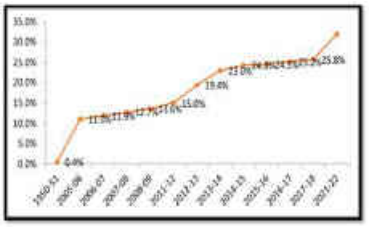


Figure 2: India's GER over time

As per the report of Department of Higher Education MHRD Government of India on Education Quality Upgradation And Inclusion Programme (Equip) Five Year Vision Plan 2019-2024. The continues efforts over the last few decade reflected significant progress in the GER, which is currently at 25.8% as against the world average GER of 27% as of 2018. This increase in GER due to increase in the number of higher education institutions serving the population, from 26 universities and 695 colleges at the time of independence, Indiahas tremendously risen to 993 universities and 37643 institutions today. However, as the low GER very aptly

indicates, increase in the number of institutions has remained inadequate to meet the increased demand for higher education.

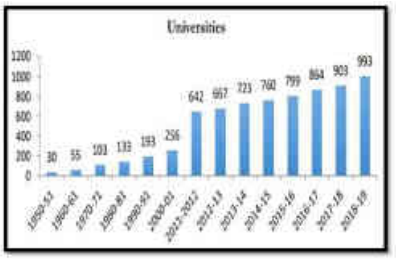


Figure 3: Growth of universities and colleges in India

According to the International Labor Organization (ILO) estimates, by 2020, India can take advantage of its demographic dividend as per the report, India will have 116 million workers in the age group of 20-24 years as against 94 million in China.

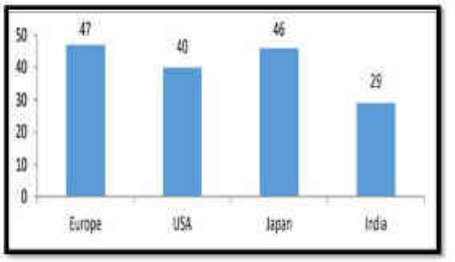


Figure 4: Average age in 2020

In addition to this, the average age of Indian population by 2020 will be 29 while many developed countries will be in the early or late 40s. Provided that India should prevent socio-economic complications arising out of a large unemployable young population this massive workforce would need to be gainfully employed.

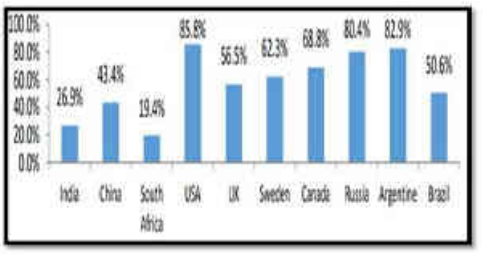


Figure 5: GER of selected countries

This indicates that India must foresee to create infrastructure and competence to educate and provide skills to the great numbers of people. Importance will also have to be laid on giving an education that promotes employability, entrepreneurial spirit, and innovation as these are the factors that will help in creating enough sustainable job opportunities within India.

The Global Competitiveness Report 2017-18 reflected Access Illustrated in Figure 4, India's GER is far below those of most developed countries and even below that of the other BRIC nations (Brazil, Russia, and China).

As per the report In Bihar, Jharkhand, Odisha, and Rajasthan, both the institutional density and GER are very low. It is important to note that a high GER does not depend solely on the attributes of the higher education system in the country but also on the quality and output of the school system. Higher education institutions receive only a limited pool of students from the school education system. Economic considerations, cultural factors, low performance, etc. often force many students to drop out of schools after the primary and secondary levels in our country.

Equity

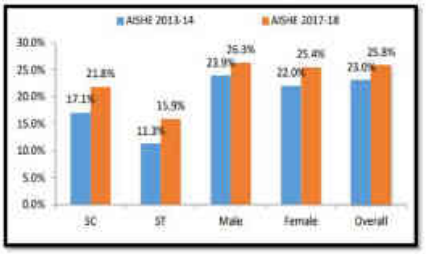


Figure 6: GER across categories

Disparity in Equal access to opportunities is another important challenge to our country. As per Education Quality Upgradation And Inclusion Programme (Equip) Available data indicates the improvement in access to higher education by socio-economic and gender categories over the last five years. Note: In the All India Survey of Higher Education (AISHE 2017-18)

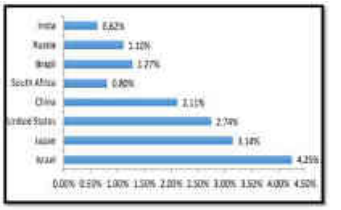


Figure 7: Gross Domestic Expenditure on research and Development (GERD)

Figure 6 Indicates the significant improvement by socioeconomic categories (SC, STs) and gender groups in improved educational attainment, but they still fall behind the national averages. However, much more needs to be done to reduce inter-state disparities amongst social groups and improve their GER. For female students as well as students from disadvantaged backgrounds, the lack of financial resources and challenging social conditions are the primary concerns in accessing higher education.

Excellence

Investment in R&D

As per the report of Times Higher Education (THE) World University Rankings 2022. Research, Internationalization, better Perception are areas where universities in the developed countries have the edge over their Indian counterparts. Investment in R&D in developed countries is not limited to public funding; funding from the private sector (especially industry) is equally essential.

This has helped universities and industries in such countries maintain their competitive edge. An analysis (Figure 7) of Gross Domestic Expenditure on research and Development (GERD) as a percentage of GDP shows that countries like the USA (2.74%),Japan (3.14%) and China (2.11%) have invested far more than India (0.62%), and the universities in these countries naturally far better in the global rankings.

Research Publications

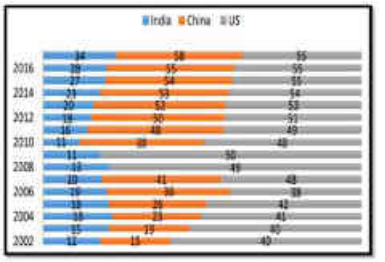


Figure:8 Research Publications

India ranks 5th in global research publication on the basis of quantitative output as per Scimago Journal Rankings, where countries such as USA, China, Germany, and the UK dominate both in terms of quantitative and qualitative research. The US emerges in the top (683,000), with China (599,000) and UK (211,710) respectively in 2nd and 3rd place. The R&D spending, research output in recent years has grown more rapidly in China, and its publication output nearly doubled since 2007, and as a result, China's output is now almost comparable to that of the United States.

The number of doctoral degrees produced is an indication of the emphasis of an educational system on research and in the creation of new knowledge. As per available figures (Figure 8), China now produces the maximum number of PhD's globally, having steadily increased the numbers yearly over the United States. As per the report of AISHE year 2017-18, in India, according to figures available with 34,400 students were awarded PhD level degree during 2017. However, the ever increasing numbers of PhD Candidates across the world also raise questions on whether the intention to increase the number of PhD graduates will be at the expense of their quality. One consequence of increasing numbers of PhD graduates is that job opportunity available and the remuneration these opportunities provide do not always appear commensurate with the increasing numbers. Additionally, the number of qualified faculty needed to supervise doctoral programs also needs to increase.

India is short of Faculties

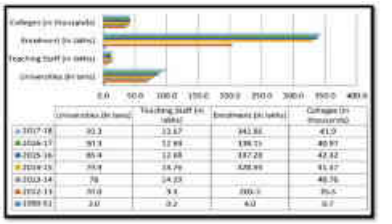


Figure 9: Growth of Teaching Staff in Universities and College

As per Education Quality Upgradation and Inclusion Programme (Equip) Five Year Vision Plan 2019-2024 India is short of professors, with 6,600 posts vacant in central universities, a shortfall of 33%. In IITs and State Universities, 35% and 38% vacancies need to be filled respectively. Vacancies have negatively impacted the quality of teaching and research. Available data shows that this shortfall in faculty is being somehowbridged by using large numbers of ad hoc or part-time faculty. Faculty shortages have worsened over time, with growth in the number of colleges and universities, and

role that it wants to assume.

Country Name	Public expenditure on education as % of GDP
Brazil	6.24
South Africa	6.13
Australia	5.32
World	4.81
India	4.38
China	4.26

Figure 13: Public expenditure on education

Strategies of India to Attain Global Standard

According to concept note of the 95th Annual Meet and National Seminar of Vice Chancellors of the Association of Indian Universities on the theme 'Implementing NEP-2020 to Transform Higher Education in India' was held at Baba Saheb Ambedkar University, Ahmedabad from 14th and 16th April 2021. Some of the key recommendations of the Policy on higher education were:

- Increase GER to 50 % by 2035
- Moving towards a more multi-disciplinary undergraduate education;
- Moving towards a higher educational system consisting of large, multidisciplinary universities and colleges, with at least one in or near every district, and with more HEIs across India that offer medium of instruction or programmes in local/Indian languages;
- Establishment of a National Research Foundation to fund outstanding peer reviewed research and to actively seed research in universities and colleges;
- 'Light but tight' regulation by a single regulator for higher education.
- Creating Academic Bank of Credits
- Setting up Multidisciplinary Education and Research Universities (MERUs)
- Setting up the National Research Foundation.

Access and Equity

Access and equity are key challenges for creating an inclusive and high quality higher education in India. The idea of pluralism is deeply embedded in India's rich cultural heritage. It is the responsibility of the Government as well as Higher Education Institutions to provide the eligible with good quality higher education at reasonable cost. Higher Education Institutions have even greater obligation to ensure access and equity. The Policy envisions ensuring equitable access to quality education to all students, with a special emphasis on Socio-Economically Disadvantaged Groups (SEDGs). For this purpose, the NEP has explained the additional actions that are specific to higher education shall be adopted by all Governments and HEIs: steps to be taken by Governments and Higher Education Institutions.

However, this situation is improving rapidly. The success of Sarva Shiksha Abhiyan (SSA) and Rashtriya Madhyamik Shiksha Abhiyan (RMSA) and the consequent improvement in transition rates is going to increase the number of students that will opt for higher education and thus, it makes a strong case for enhancement of financial support for expansion, upgradation and quality improvement of higher education system. Such enhancement can bring about balanced growth of new institutions, based on spatial and need based planning. This, in turn, can help absorb the ever-increasing number of students completing the higher secondary level.

Holistic and Multidisciplinary Education

The National Education Policy (NEP) 2020 emphasizes holistic and multidisciplinary education with an aim to provide 21st century skills to learners. NEP 2020 states that such education would be aimed at developing all capacities of human beings – intellectual, aesthetic, social, physical, emotional, and moral in an integrated manner. The Policy emphasizes the importance of multidisciplinary education through both disciplinary and professional programmes for developing competencies of critical thinking, adaptability and self-management amongst learners. A holistic and multidisciplinary education would aim develop all-rounded individuals that possess critical capacities in fields across the arts, humanities, languages, sciences, social sciences, and professional, technical, and vocational fields; an ethic of social engagement; soft skills, such as communication, discussion and debate; and rigorous specialization in a chosen field or fields. Such a holistic education shall be, in the long term, the approach of all undergraduate programmes, including those in professional, technical, and vocational disciplines.

The Policy recognizes that the knowledge of the rich diversity of India should be imbibed first hand by learners. Towards this direction under 'Ek Bharat

increasing enrolment rate of students.

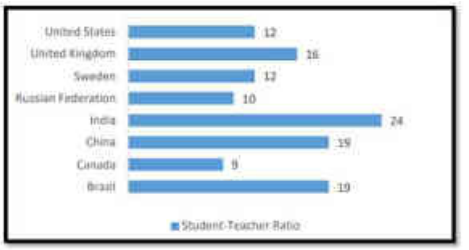


Figure 10: Student-teacher ratio is selected countries1

The student-teacher ratios

Figure 10 highlights the student-teacher ratios in selected countries. The student-teacher ratio in India (24:1) is meagre as compared to other countries 19:1 in China; and 12:1 in the United States. A low student-teacher ratio indicates the burden on a single teacher of teaching multiple students as well as the lack of time that each student gets. Apart from this simplistic effect, in an institution of higher learning, a smaller number of and overburdened teachers are also unable to pursue any research or encourage their students to do so. There are multiple reasons for low student-teacher ratios. Even though the student intake of colleges and universities has increased over time, due to the fear of taking up an almost life-long financial burden of paying the faculty, most institutions hesitate in creating new faculty positions and getting benefits of such situation Universities/institutions are paying low or very low remuneration to faculties. In addition to the low number of sanctioned faculty positions, faculty vacancy even in sanctioned strength is an extremely serious problem. Due to various reasons such as a ban on recruitment, lack of funds, and the reluctance of states to bear the long-term salary burden, a large number of faculty positions are not filled. On other hand, attracting faculty is a big challenge for rural and backward areas because of the lack of infrastructural support and reluctance of teachers in moving to non-urban areas.

Accreditation

One of the best ways of ensuring quality in higher education is the system of accreditation, unfortunately, in India, the accreditation of higher education institutions and programs is optional and has not yet caught up as a trend. While institutional accreditation through the National Assessment and Accreditation Council (NAAC) and program accreditation through the National Board of Accreditation (NBA) has gained momentum, only 39% of all universities and 20% (Figure 11) of eligible colleges have been accredited so far.

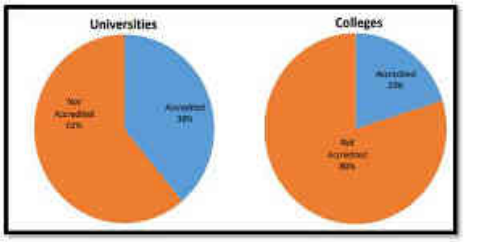


Figure 11: Proportion of Universities and Colleges accredited by NAAC

A rigorous effort is needed to ensure that quality reforms in most of the processes in higher education. New strategies need to made by the government must ensure that accreditation becomes mandatory and sufficient incentives and disincentives are built into the system to ensure that every higher education institution obtains accreditation. Stress must be at each level in the system, about the quality of higher education.

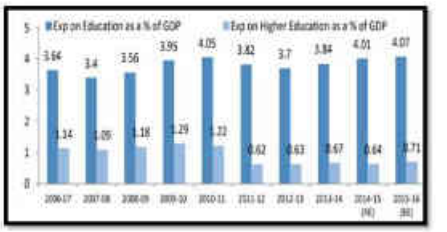


Figure 12: Expenditure on Education in India (As % of GDP)

Expenditure on Education in India

The public investment in education as a percentage of GDP has remained almost stagnant in the last ten years. The more worrying aspect is that public investment in Higher education has declined as a percentage of GDP from 1.14% in 2006-07 to 0.71% in 2016-17 (Figure 12). Higher education was a 'non-priorityarea' till 2016, and this is the reason higher education institutions are treated as if they are a part of the non-essential sector.

As per Figure13, international comparisons table shows that India would need to increase its expenditure on education appreciably if it wants to play the geo-political

Shrestha Bharat', 100 tourist destinations in the country will be identified where educational institutions will send students to study history, scientific contributions, traditions, indigenous literature and knowledge, etc. India will also urgently expand its translation and interpretation efforts in order to make high quality learning materials and other important written and spoken material available to the public in various Indian and foreign languages. For this, an Indian Institute of Translation and Interpretation (IITI) will be established. The IITI could naturally grow with time, and be housed in multiple locations including in HEIs to facilitate collaborations with other research departments as demand and the number of qualified candidates grows.

Skill Development

The most crucial component that is missing in our education system so far is the culture of skill development. Due to this the youth has been grappling with the challenges of employability or self-employment for a long time. Out of 8 million students that graduate every year, nearly 6 million students do not find employment, even when there are jobs available in the market. This gap exists due to lack of employable and entrepreneurial skills amongst the youth. Thus, there is a need to inculcate the skills in students that will be responsive to the changing demands of the market. The NEP recommends skill component in higher education to make more useful for students as well as country's economy.

The policy aims to overcome the social status hierarchy associated with vocational education and requires integration of vocational education programmes into mainstream education in all education institutions in a phased manner. Policy recommended the detailing of National Skills Qualifications Framework for each discipline vocation and profession and aligning with the International Standard Classification of Occupations maintained by the International Labour Organization. The credit-based Framework will also facilitate mobility across 'general' and vocational education.

Quality and Excellence

Indian higher education system which is the third largest higher education system in the world receives criticism for its low quality in international scenario. It needs to be ensured that every student who is a part of the higher education system shall have a minimum acceptable standard of education. This calls for the adopting all the measures which can standardize quality of higher education.

The Policy recognizes that at the societal level, higher education must enable the development of a progressive, socially conscious, knowledgeable, and skilled nation that can find and implement robust solutions to its own problems. The purpose of quality higher education is, therefore, more than the creation of greater opportunities for individual employment. It represents the key to more vibrant, socially engaged, cooperative communities and a happier, cohesive, cultured, productive, innovative, progressive, and prosperous nation. This policy envisions a complete overhaul and re-energising of the higher education system to overcome these challenges and thereby deliver high-quality higher education, with equity and inclusion.

Research

NEP—2020 acknowledges that knowledge creation and research are critical in growing and sustaining a large and vibrant economy, uplifting society, and continuously inspiring a nation to achieve even greater heights. Research is one of the inevitable dimensions of higher education. But the universities in India have lagged behind in carrying forward the research culture and consequently, the country is facing repercussions both socially as well as economically. None of India's Institution is amongst the top 100 research and innovation institutions in the world. The universities are held responsible for low research output, a smaller number of patents and publications, citation impact. Government is also responsible for research and innovation investment in India which is at present only 0.69% of GDP as compared to 2.8% in the United States of America, 4.3% in Israel and 4.2% in South Korea.

The NEP therefore, envisions a comprehensive approach to transforming the quality and quantity of research in India. Most importantly, to build on the elements in a synergistic manner, and to thereby truly grow and catalyse quality research in the nation, the policy envisions the establishment of a National Research Foundation (NRF). The NRF will competitively fund research in all disciplines. Successful research will be recognized, and where relevant, implemented through close linkages with

governmental agencies as well as with industry and private/philanthropic organizations

Internationalization

The NEP—2020 envisions to promote India as a global study destination providing premium education at affordable costs thereby restoring its role as a Vishwa Guru. For this the Policy has recommended setting up International Students Office at each HEI hosting foreign students to coordinate all matters relating to welcoming and supporting students arriving from abroad. Research/teaching collaborations and faculty/student exchanges with high-quality foreign institutions will be facilitated, and relevant mutually beneficial MOUs with foreign countries will be signed. High performing Indian universities will be encouraged to set up campuses in other countries, and similarly, selected universities e.g., those from among the top 100 universities in the world will be facilitated to operate in India. A legislative framework facilitating such entry will be put in place, and such universities will be given special dispensation regarding regulatory, governance, and content norms on par with other autonomous institutions of India. Furthermore, research collaboration and student exchanges between Indian institutions and global institutions will be also promoted.

Governance

Governance is a central issue in higher education because it determines the way universities function or dysfunction and defines the relationship with the government. Governance at the higher education system is a complex interplay of the internal and external environment. Regulation of higher education has been too heavy-handed for decades; too much has been attempted to be regulated with too little effect. To address these issues, the NEP-2020 recommends a gradual but effective shift from input-centric approach to outcome-based approach aligned to the 'light but tight' approach. The Policy envisions Setting-up the Higher Education Commission of India (HECI), carrying out distinct functions of Regulation, Accreditation, Funding, and Academic through with following autonomous verticals:

- National Higher Education Regulatory Council (NHERC) - A single point regulatory agency (Excluding Medical and Law).
- National Accreditation Council (NAC) - Meta Accreditation agency
- Higher Education Grants Council (HEGC) - To ensure mechanisms and models for financing including fellowships and scholarships.
- General Education Council (GEC) - To formulate National Higher Education Qualification Framework and expected learning outcomes for higher education programmes.

Technology Integration

India proved its mettle as a global leader in information and communication technology and in other cutting-edge domains. But the use of technology for the purpose of education has not been exploited fully. However, the COVID-19 Lockdown had given a thrust to this factor. The Digital initiatives of the Government of India facilitating the transformation of the entire nation into a digitally empowered society and knowledge economy. Strong advocacy of the policy for use and integration of technology to improve multiple aspects of education has come as opportunity to the country. The Policy recommended setting up of an autonomous body, the National Educational Technology Forum (NETF), to provide a platform for the free exchange of ideas on the use of technology to enhance learning, assessment, planning, administration, and so on, both for school and higher education. The aim of the NETF will be to facilitate decision making on the induction, deployment, and use of technology, by providing to the leadership of education institutions, State and Central governments, and other stakeholders, the latest knowledge and research as well as the opportunity to consult and share best practices.

Financing

The Policy commits to significantly raising educational investment, as there is no better investment towards a society's future than the high-quality education of our young people. Unfortunately, public expenditure on education in India has not come close to the recommended level of 6% of GDP, as envisaged by the 1968 Policy, reiterated in the Policy of 1986, and which was further reaffirmed in the 1992 review of the Policy. The current public (Government - Centre and States) expenditure on education in India has been around 4.43% of GDP (Analysis of Budgeted Expenditure 2017-18) and only around 10% of the total Government

spending towards education (Economic Survey 2017-18). These numbers are far smaller than most developed and developing countries. In order to attain the goal of education with excellence and the corresponding multitude of benefits to this Nation and its economy, this Policy unequivocally endorses and envisions a substantial increase in public investment in education by both the Central government and all State Governments. The Centre and the States will work together to increase the public investment in Education sector to reach 6% of GDP at the earliest.

Conclusion

India was known as vishwa guru and Indian Government is doing sincere efforts to get back its glory. In this sequence Indian Government has taken a drastic step and introduced New Education Policy 2020 to attain global standard in higher education.

As per the data of last few decade reflected significant progress in the GER, which is currently at 25.8% as against the world average GER of 27% as of 2018 and as per government policy it has strategically targeted to Increase GER to 50 % by 2035.

As India is a country known for Unity in Diversity. Therefore, all HEIs inherently need to be as representative as possible of the communities they are located within, in order to thrive. The Policy envisions ensuring equitable access to quality education to all students, with a special emphasis on Socio-Economically Disadvantaged Groups (SEDGs). For this purpose, the NEP has delineated the additional actions that are specific to higher education shall be adopted by all Governments and HEIs: steps to be taken by Governments and Higher Education Institutions. However, this situation is improving rapidly by the Sarva Shiksha Abhiyan (SSA) and Rashtriya Madhyamik Shiksha Abhiyan (RMSA) and the consequent improvement in transition rates is going to increase the number of students that will opt for higher education and thus, it makes a strong case for enhancement of financial support for expansion, upgradation and quality improvement of higher education system. Such enhancement can bring about balanced growth of new institutions, based on spatial and need based planning. This, in turn, can help absorb the ever-increasing number of students completing the higher secondary level.

As per the data reveals that India should reduce the student-teacher ratios which is at present is (24:1) in India, however 19:1 in China & 12:1 in the United States. A low student-teacher ratio indicates the burden on a single teacher of teaching multiple students & multiple subjects as well as the lack of time to get for each student & most of universities/institutions are getting benefits of such situation & hesitate in creating new faculty positions they are paying low or very low remuneration to faculties.

As per the available data apex Indian universities/institutions are short of professors, with 6,600 posts vacant in central universities, a shortfall of 33%. In IITs and State Universities, 35% and 38% vacancies need to be filled respectively. Data shows that this shortfall in faculty is being bridged by using large numbers of ad hoc or part-time faculty. However, institutions with a high number of ad hoc or part-time faculty perform poorly in terms of teaching quality. Faculty shortages have worsened over time, with growth in the number of colleges and universities, and increasing enrolment rate of students.

India have lagged behind in carrying forward the research culture and consequently, the country is facing repercussions both socially as well as economically. None of India's Institution is amongst the top 100 research and innovation institutions in the world. Whereas the universities are responsible for low research output, a smaller number of patents and publications, citation impact, the Government is responsible for research and innovation investment in India which is at present only 0.69% of GDP as compared to 2.8% in the United States of America, 4.3% in Israel and 4.2% in South Korea.

As per Scimago Journal Rankings, where countries such as USA, China, Germany, and the UK dominate both in terms of quantitative and qualitative research. The US emerges in the top (683,000), with China (599,000) and UK (211,710) respectively in 2nd and 3rd place. Whereas India ranked 5th on the basis of only quantitative, qualitative research is major issues in India.

System of accreditation is one of the best ways to ensure quality in higher education but India has not yet caught up as a trend, as per data National Assessment and Accreditation Council (NAAC) and program

accreditation through the National Board of Accreditation (NBA) has gained momentum, only 39% of all universities and 20% of eligible colleges have been accredited so far.

As per analysis Indian Government is doing sincere efforts to attain global standard in higher education. In this regards Indian Government has taken a drastic step and introduced New Education Policy 2020. This Policy have all the provisions to improve, reform and upgrade the quality of higher education as per global standard, provided that its implementation process should be strategic, honest and without influence of Money, Muscles and Political powers.

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Dr Shakti Prakash did his MBA & PhD in Management from IMS, Devi Ahilya University, Indore. He has started his career from S Kumar (Textile) Ltd. As Management trainee, and worked with Goodyear India Ltd. in a responsible position in marketing. He acquired total industry experience about 05 years. Last 23 years he has contributed as an academician in academic planning, administration; teaching, research and as a research guide. He has vast academic experience and worked in various reputed B-Schools of National Capital Regions (NCR) as director/Head of Management department. He has published and presented more than 50 research papers in national and international journals of repute & conferences. His major areas of research are Retail, Advertising, Consumer Behavior, E-Commerce and Digital Marketing. He has also organized various national conferences, workshops and seminars. He has delivered guest lecturers in various reputed institutes like IMT Ghaziabad (Executive Course), International Maritime Institute (IMI) and Army Business School. He is member of editorial board of various reputed journals.

Ms. Rachana Srivastava is Assistant professor in MBA Department. She has over 14 years teaching experience. She has done her MBA with HR and marketing specializations from Dr. RML Avadh University. She is NET qualified in HRM. Her interest area is Talent management and Work life balancing.

Mr. Bipin Kumar Singh is Assistant Professor in MBA Department .He has completed MBA from VBS Poorvanchal University, Jaunpur (UP), and UGC NET in Management. He has published four National & International papers. He has total 23 Years of teaching & corporate experience.

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