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Current Issue: Green Technologies in Pollution Control and Management

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From Director's Desk

Currently, world is facing increasing environmental threats which are posing severe scientific, social and economic challenges to the human being. Today's challenge for sustainable environment management is to develop environmentally friendly, economically viable, and energy-efficient processes for treating wastes generated through different processes and preserving the world's limited natural resources. In the present scenario, green technologies are playing significant role in changing the course of nation's economic growth towards sustainability and providing an alternative socio-economic model that will enable present and future generations to live in a clean and healthy environment, in harmony with nature. Several innovative technologies have been developed in last decade that provide a high removal-efficiency of pollutants and nutrient recovery while also reducing the carbon footprint, minimizing waste, and protecting human health and the environment.

The emerging green technologies in the areas of green energy, organic agriculture, eco-friendly textiles, green building constructions, and manufacturing of related products and materials to support green business are being implemented at wider scale. Reuse and recycling in industrial processes have significantly reduced the greenhouse gas emissions and its harmful impact. Artificial intelligence techniques and energy efficient devices have proven their worth in efficient utilization of power in different sectors.

We are releasing current issue of newsletter on the theme 'Green Technologies in Environmental Pollution Control' with focus on green chemistry, nanotechnology, utilization of bio molecules as an energy source, surfactants and plastic, waste management, green IT in providing solutions for the management of natural resources and control of pollution

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Biosurfactants for Oil Pollution Control and Management

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Oil pollution has become a persistent problem in the oceans world over. Offshore oil wells, under-water leakage of oil pipelines, accidents of ships, ballast water release, discharge of industrial and municipal wastewaters, diesel pump and ship cleaning activities, loading and unloading activities at port and natural seeps are the various causes of marine oil pollution. India has recently faced massive oil pollution due to oil spill at Chennai, MSC Chitra and Khalijia accident and ONGC pipeline leakage. The oil forms a thin film or slick on the water surface and affects the marine flora, fauna and human beings. It also damages boats, fishing gears, port installations and greatly diminishes the value of shores and heritage sites as recreational resources. If not treated, crude oil spills would require a very long period of time to naturally biodegrade; it nearly takes about 22 years for complete biodegradation of 1 kg of crude oil by natural processes.

Many methods are being used to remove oil from water including physical removal by booms, skimmers and sorbents; chemical methods like use of gelling agents and dispersants and biological methods like fertilization, seeding inoculation of different bacteria and applications of biosurfactants. All these methods have their own advantages and disadvantages.

Synthetic dispersants contain surfactants which are highly toxic to aquatic flora and fauna. On the contrary, microbially produced surfactants or biosurfactants are less toxic. As a result, there is a growing interest in biosurfactants. Moreover, biosurfactants can bring about surface tension reduction, emulsification/de-emulsification, dispersion, foaming, wetting and increase bioavailability of hydrocarbons which makes them useful in physico-chemical and biological remediation technologies. They are structurally diverse. The most common types are rhamnolipids, lipoproteins, phospholipids, polymeric and particulate surfactants. They could be ionic or nonionic. They are known to beat chemical surfactants in specificity, low toxicity, high biodegradability, effectiveness at extremes of temperature, pH, and salinity. They are produced by a variety of bacteria such as *Pseudomonas, Rhodococcus, Corynebacter, Acinetobacter, Bacillus licheniformis, B. subtilis, Arthrobacter, Myroide, Halomonas, Alcanivorax, Rhodococcus, Halomonas* and yeasts like *Torulopsis, Candida* and *Saccharomyces.*

Biosurfactants assist in emulsification and degradation of oily waste and can be used in control of oil pollution in many different ways. (Fig.1)

Fig. 1: Applications of biosurfactants

The most common application of biosurfactants is in oil spill control and oil biodegradation where they replace toxic synthetic surfactants. Biosurfactants are also used to remediate oil contaminated soils as Soil Washing Technology.

TERI, India has developed microbial consortia in the form of Oilzapper and Oilivorous-S which are effective in remediation of oil contaminated sites. Besides, biosurfactants are also used in oil tank and container cleaning, oil sludge treatment, oily ballast water treatment and cleanup of contaminated beaches and mangroves, etc. Biosurfactants have also been successfully used on commercial scale in India as well as abroad to enhance recovery of crude oil from depleted oil wells.

Some biosurfactants exhibit antimicrobial activities against bacteria, fungi and viruses. They can be used as biocides for control of microbial growth particularly in the form of biofilms which develop in ballast water.

The focus on sustainability and new environmental legislation has led to the search for natural surfactants as alternatives to existing chemical surfactants and therefore biosurfactants witness high demand.

At SIES IIEM, we have successfully demonstrated biosurfactant production from shrimp shell waste using bacteria in a Department of Science and Technology sponsored Project. Worldwide scientists are working on reducing the cost of biosurfactant production and making its application ecologically and economically successful.

Commercial production of biosurfactants reached 3.5 million tons and approx. 2000 million USD in 2012. The estimated global market by 2023 is 2.6 billion USD.

In conclusion, biosurfactants hold great promise for control of oil pollution and related problems.

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Green Nanotechnology and its Role in Sustainable Environment

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Technology is combination of Science & Engineering that helps us to build applications and tools that make our lives easier. Technology can be of many types and forms. Here we discuss the most latest and sought after forms of technology,

Green technology

What is Green technology?

Such technology is not literally 'green', but it refers to any type of technology that is eco-friendly and helps us save our earth and conserve our environment. It includes all the innovations and methods that involve nontoxic inputs as well as products.

Figure 1: Source: http://www.moneycrashers.com/green-energy-technologies/

Why Green Technology?

Pollution management and control of pollutants has been the issue of utmost concern since last decade. Green technology is the most soothing solution for this burning topic. Our resources are continuously depleting at a staggering rate. We, therefore need a technology that gives a much more sustainable and consistent solution to the problem of pollution and depleting resources.

Types of Green Technology

Mentioned below are some very efficient and practical forms of Green Technology:

- Green chemistry
- Green energy
- Green buildings
- Green nanotechnology

Green Nanotechnology

Nanotechnology refers to fabrication of materials to nanometre scale and their application along with principles of science and technology. The quantum size of nano materials attribute to its unique and altered properties like physical, chemical, magnetic, mechanical, magnetic, catalytic etc. **Green technology** refers to technology that helps us to evolve green and clean expertise that minimizes the potential hazards to mankind as well as to the environment. The task is done in two major ways; converting pollutants to cleaner products using nano-materials or vice versa, i.e. converting pollutants into useful nano- materials using Green Chemistry.

Applications of Green Nanotechnology

Several forms of nanotechnology have already been exploited for the application of green and clean environment. A few of them are discussed below:

1. Remediation of heavy metals: Bulk gold is catalytically inert. But gold nanoparticles when bonded to Al_2O_3 become catalytically active and are used for environmental testing of mercury.
2. Nano TiO_2 is used in air purifying lamps to kill microbes like molds, bacteria, dust mites etc.
3. Use of Carbon Nano Tubes (CNT) as biosensors: Instead of depositing the enzyme directly on the transducer element, metal is coated with an array of CNT which makes better contact between enzyme and transducer. There is 3-D contact between analyte and sensing enzyme, thus making it more sensitive and stable.
4. Nano scale Iron (Fe_2O_3) for waste water treatment: Non-toxic amount is used in very less concentration for clean-up of toxins like trichloroethane,

Acid Orange	Dichlorobenzenes	Orange II
Acid Red	Dichloromethane	Pentachlorobenzene
Arsenic	Cis-Dichloroethene	Pentachlorophenol
Bromoform	Trans- Dichloroethene	Perchlorate
Cadmium	1,1- Dichloroethene	PCBs
Carbon tetrachloride	Dichromate	Silver
Chloroform	DDT	Tetrachlorobenzenes
Chloromethane	Hexachlorobenzene	Tetrachloroethene
Chlorobenzene	Lindane	Trichloroethene
Chrysoidine	Mercury	Trichlorobenzenes
Dioxine	Nickel	TNT
Dibromochloromethane	Nitrate	Tropaeolin
Dichlorobromomethane	NDMA	Vinyl Chloride

Figure 2: Pollutants remediated by Nano iron technology
Source:http://www.jmaterenvironsci.com/Document/vol8/vol8_N2/78-JMES-2831-Yadav.pdf

Carbon tetrachloride, dioxins, DDT etc. and break them into simple compounds.

5. Green Manufacturing: Use of environment friendly materials for construction purpose so that there is elimination of toxic waste products.
6. Removal of heavy metal pollutants from water and converting it into valuable nano- products using various species of bacteria like *Bacillus* species for production of silver nanoparticles and species of fungus like *Fusarium oxysporum* for various other nano particles. When waste water is treated with microbes, they act as source of extracellular enzymes that promote biosynthesis of nano particles.

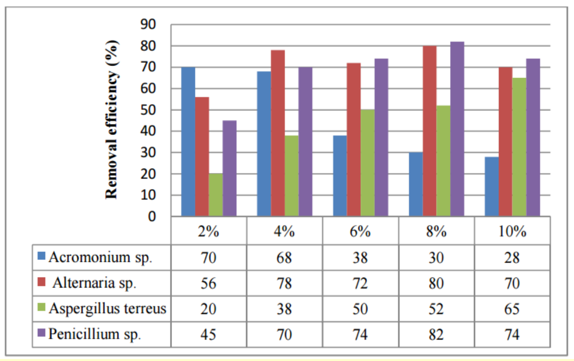

Figure 3: Some fungal nanoparticle used in bioremediation of initial concentration with 2%, 4%, 6%, 8%, 10% petroleum oil Source: http://www.jmaterenvironsci.com/Document/vol8/vol8_N2/78- JMES-2831-Yadav.pdf

7. Use of Caron Nano Tubes for storage of hydrogen gas in cars that use stored hydrogen as fuel. This reduces the emission of greenhouse gases like carbon monoxide etc. It also reduces the requirement of fossil fuels to be used as fuel.
8. Nano-size iron oxide particles and carbon nanotubes can be used for photo-catalytic killing of pathogenic microbes from drinking water and hence reducing the requirement of any unwanted chemical treatment of potable water.
9. Catalytic conversion of plastics into lubricating oil, bags and wax has been observed. Catalytic properties of various nano materials have been well exploited in this case. This will help to solve the problem of disposal of plastic that has been increasing at an alarming rate.
10. **Green Energy:** Nanotechnology has already proved very promising in the field of Green & Renewable energy. Few benefits of product based on nanotechnology compared to conventional technology are: enhanced lighting and heating efficiency, better electrical storage capacity, evidently decreased polluting by products from energy usage.

- *Dye-sensitized nano solar cells* can be used to generate electricity directly from sunlight in a more efficient and cheaper way as compared to the traditional silicon based solar panels.
- *Solar fuel cells* work on the principle of photo-reduction of carbon dioxide with water that results in production of hydrocarbons that can be directly used as fuel. This technique reduces the CO_2 footprint of the atmosphere.

Conclusion

Though the future of Green nanotechnology is highly promising, there are a few constraints ion this field as well. Lack of acceptance of new technology by common people as compared to the conventional measures. There might be few potential hazards related to use of nano materials. But still, the amazing benefits that nanotechnology has contributed to conservation of our environment are ever increasing.

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Basement Air Filtration System for Parking Lot

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Introduction:

Indoor air pollution is one of the top five environmental health risks. Thus there pose a need to control or eliminate the sources of pollutants and ventilate indoor with clean outdoor air. Many Environmental control practices (ECPs) that is a group of measures recommended to reduce exposure to different indoor allergens such as dust mites, household pets, cockroaches, mold, mice) or nonallergic triggers (e.g. environmental tobacco smoke [ETS], wood smoke, volatile organic compounds, particulate matter [PM]).

Air filters and other air-cleaning devices are specially designed to remove pollutants from indoor air. Air-cleaning devices are categorized depending on the type of pollutants such as particulate and gaseous so that the device is designed in a manner to remove or destroy pollutant. Air filtration is mostly recommended as a component of environmental control measures for patients with allergic respiratory disease.

Ambient air quality is affected due to air pollutants generated from both motor vehicles and stationary sources. Ventilation of air from the garage could potentially result in air quality impacts. Typically, motor vehicle generated carbon monoxide (CO), PM (PM_{10} and $PM_{2.5}$), emission of Volatile Organic Compounds (VOCs) and nitrogen oxides (NO_x) predominantly influenced by mobile source emissions. Car parking garage, parking lot of building or structures of indoor parking especially basement is mostly affected by emission from vehicular source. To control air pollutant of basement parking lot indoor air filtration unit has been designed.

Basement Filtration System:

It can be designed as an integrated unit to remove CO, PM, NOx and VOCs or different units for each pollutant. The design is based on the following concept:

- Photo-catalysis for CO and VOC
- Diffusion, Interception, Inertial impaction, Electrostatic attraction for PM
- Photo-catalytic oxidation for NO_x

Air pollutants such as CO, NOx, Volatile organic compounds (VOC), hydrocarbons, undergo photo catalytic induced advanced oxidation, thereby converting into harmless molecules of CO_2, H_2O and N_2. Photo-catalysis is the increased rate of photoreaction in the presence of a catalyst. In photo-catalytic process, catalyst gets converted to oxidative radicals such as hydroxyl radicals in presence of light. These radicals can react with chemical species such as organic pollutants and destruct them.

TiO_2 is the most suitable material for photo-catalysis. It has the most efficient photo-catalytic activity, highest stability and cheap. It has been used from the ancient time and guarantees human and environment safety. TiO_2 surface irradiated with UV light proceeds to two photochemical reactions:

- Photo induced hydrophilic conversion of TiO2
- Photo induced redox reactions of adsorbed molecules.

Basement Filtration Design

The basement filtration unit designed with mild steel as a material of construction. The constant flow rate is maintained for proper functioning. The technology features designed are as follows:

- **Particulate matter separation**

Initially air enters on the left (black arrow) as shown in figure, through the front non woven fabric pre-filter, which would capture large portions of dust and particulate matter of size up to 10 μm. Next it will pass through a fine filter with an MERV rating of 9 – 12, that can capture biological entities and fine particulate matter. For this system to work efficiently strength of the total air flow will determine the removal efficiency.

- **Advanced oxidation process**

Filtered air will then enter into a cylindrical unit, where the advanced oxidation of air pollutants (VOC, hydrocarbons, NO_x) will occur. The cylindrical unit consists of an aluminum sheet with good UV reflectance and UV lamp. Aluminum sheet acts as the support material for the TiO_2 coating. Up on UV irradiance, OH radicals on the surface of TiO_2 will be generated, which would initiate the desired oxidation process.

- **$CaCO_3$ neutralization**

Following are the advanced oxidation reaction that takes place on the aluminium sheet

i. Photo catalytic oxidation of hydrocarbons

$$HC + {}^{\cdot}OH^{-} \rightarrow CO_2 + H_2O$$

ii. Photo catalytic oxidation of NO_x: This involves a series of oxidation step

$$NO + {}^{\cdot}OH^{-} \rightarrow HNO_2 \xrightarrow{{}^{\cdot}OH^{-}} NO_2 \xrightarrow{{}^{\cdot}OH^{-}} HNO_3$$

iii. As a result NO_x gets ultimately converted to HNO_2 or HNO_3. To trap it within the filter unit, a $CaCO_3$ deposited pad will be kept beneath every cylindrical unit, such that the produced HNO_3/HNO_2 will react with $CaCO_3$ and form

$$HNO_3 + CaCO_3 \rightarrow Ca(NO_3)_2 + CO_2 + H_2O$$

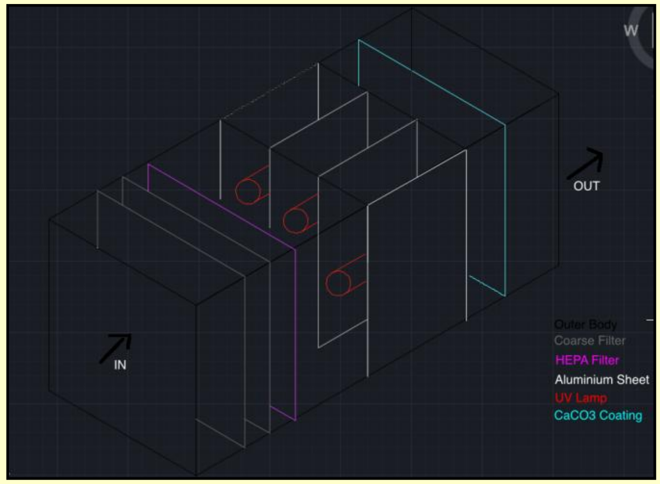

Figure 1: Basement Filtration System

Factors affecting Redox Reaction Rate

There are various factors affecting redox reaction rate:

- **UV radiations:** Production of hydroxyl radicals (${}^{\cdot}OH^{-}$) and superoxide ions (${}^{\cdot}O_2^{-}$) are the backbone for the advanced oxidation to take place. This depends upon the energy and radiation intensity of ultraviolet radiations.
- **TiO_2 Crystalline Structure:** TiO_2 exists in mainly three different crystalline structures: anatase, brookite and rutile. The crystalline structure selected will determine the efficiency of the photo-catalytic activity. For the proposed filtration unit, TiO2 with the following characteristics is chosen
- **Binder or Doping Element:** Formed holes (h+) and electron (e-) pair, have a tendency to go back to their initial state by combining with each other. Doping TiO2 with either d-block element or with Silica improves TiO2 photo-catalytic activity. It reduces band width and also traps the electrons such that they can be used only to oxidize the pollutants. Binder ensures that TiO2 nano-particles are bonded properly with the support material, also to

inhibit any cross reaction with the support material.

- **Concentration of Pollutants:** Pollutant load at site determines the reaction rate. It is directly proportional to the concentration of the reactants. Therefore the advanced oxidation process will be directly affected by the pollutant generation rate, adsorption of pollutants on to the support surface and the generation rate of hole (h+) and electron (e-) pair.
- **Type of Support Material:** Support material chosen should provide optimum surface to volume ratio, such that the pollutants can get adsorbed onto the surface, and have equal access to the electron (e-) and hole (h+) pair. Secondly support material should be porous, non UV absorber, cheap and light weight.
- **Other parameters:** Other parameters such as humidity of the incoming air, concentration of nano-particles and method of nano-particle coating, meteorological parameters, and stability of coating, air movement and eddy pockets generation will also determine the pollutant removal efficiency.

Conclusion

This basement filtration unit is low energy intensive simple unit which requires low capital as well as maintenance cost. This basement filtration unit is very compact hence easy to install hence requires less space requirement. It can be installed in basements of residential buildings, parking lots of malls, hotels, hospitals, institutes and commercial buildings.

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We are pleased to announce that SIES Indian Institute of Environment Management is now recognized as a Research Centre in Environmental Sciences by University of Mumbai

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Biofuel for Energy Conservation: Prospects and Problems

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Energy is indispensable for life and is standout amongst the most critical assets for human civilization and its sustainable development. Without it, many billions of people would be left cold and hungry. Fossil fuel, a non- renewable source of energy, contributes 80% of the world's energy demand. The major source of energy comes from fossil fuels, and the dominant fossil fuels used today by most industrialized and developing countries are oil, coal, and natural gas.Increasing demand of energy leads to more excavation of fossil fuel which further leads to the emission produced by the combustion of fossil fuels and results in more air pollution and global warming.As world population continues to grow and the limited amount of fossil fuels begin to diminish, it may not be possible to provide the amount of energy demanded by the world by only using fossil fuels to convert energy.These create a demand for renewable and clean alternative for current and future utilization.

Biofuelas one promising option to non-renewable energy source has turned out to be progressively essential because of negative ecological consequences of fossil fuel combustion and diminishing petroleum resources. Fuels that have been extracted from plants biomass and crops are known as biofuels. Biodiesel is one of the important biofuel. Biodiesel (Greek, bio, life + diesel from Rudolf Diesel) refers to a diesel-equivalent, a processed fuel derived from a biological source. Biodiesel is the common name for a variety of ester-based oxygenated fuels from renewable biological sources. To date, many vegetable oils have been used to produce biodiesel namely Peanut, Rapeseed,

Prospects

As of now, biofuels cost the same as other available gasoline in market although adding the green cost, biofuel is much cheaper than fossil fuel. It is cleaner fuel produces lesser emissions on burning. Biodiesel can make the vehicle perform better as it has a Cetane number of over 100. Moreover, it prolongs engine life and reduces the need for maintenance (biodiesel has better lubricating qualities than fossil diesel). Biofuels are adaptable to existing engine designs and perform exceptionally well in most conditions. This keeps the engine running for more, requires less maintenance and cuts down general pollution check costs. Plenty of researches on biodiesel have revealed that the fuel made by vegetable oil can be used properly on diesel engines (Usta, 2005; Pedrojevic, 2008; Apostolakou, 2009). In fact the energy density of biodiesel is quite close to regular diesel. Biodiesel can be produced by soybean and methanol via trans-esterification in the presence of acid catalysts. Comparison between the combustion properties (Table1) of biodiesel and petroleum-derived diesel has made biodiesel one of the most promising renewable and sustainable fuels for the automobile. With the increasing demand of biofuels, they may be cheaper and less expensive in future. So the use of biofuel will save your money.

Table 1: Diesel and Biofuels property comparison

Fuel Properties	Biodiesel	Diesel
Density at 15 ^{o}C, g/cm^{3}	0.8834	0.8340
Viscocity at 49^{o}C, mm^{2}/s	4.47	2.83
Sulfur content, %	<0.005	0.034
Carbon, %	76.1	86.2
Hydrogen,%	11.8	13.8
Oxygen, %	12.1	---
Flash point, ^{o}C	178	62
Catane Number	56	47
Net Calorie Value, kJ/kg	37,243	42,588

Source: Benjumea et al., 2008

- Gasoline is refined from unrefined petroleum, which happens to be a non-renewable. They will be exhausted some day. But biofuels are made of crops, naturally are easily renewable and can be produced as per requirement.
- Production of energy from fossil fuels are costly although from biofuel are much cheaper, easier and less time consuming.
- Biofuels emits less greenhouse gasses (CO_2, CO etc) and particulate matter (PM) and hydrocarbon (HC) that resultsin less global warming and air pollution. Studies suggests that biofuels reduces greenhouse gases up to 65 percent (Krahl, 2005)
- All nations do not have huge stores of raw petroleum. For them, importing the oil puts a colossal pressure in the economy. If more individuals move towards biofuels, a nation can decrease its dependence on petroleum imports. A lots of foreign exchange will be saved. That money can be invested for nation development activities.
- Production of biofuel shall not only create more occupations in production, processing and refining industries but developing biofuel industry will keep our economy secure.
- An energy sufficient country is more politically powerful in international market. As costs of raw petroleum is touching sky high, we require to shift from more non renewable to renewable energy sources.
- Biodiesel is fuel efficient, lessin sulfur content, less toxic, highflash point, aromatic content, safe to handle,more biodegradability, non-flammable and non-toxic and reduces tailpipe emissions.
- Other potential benefits includes sequestration of carbon; job creation in rural area; increased cropping diversity;economically sustainable family farms; erosion prevention and soil stability; wildlife habitat protection and ultimately safer to ecology.

Problems

- All though biofuel emits lesser CO2, CO, SO2, PM and HC compared to diesel it emits higher NOx then Diesel (Hassan and Kalam, 2013).
- Biofuel have higher pour and cloud point freezing so in cold weather it causes problems in starting the engine.
- Cultivation of biofuel may induce the problem of food security if a larger portion of land is converted form food crops to biofuel crops.
- Current technology being employed for the production of biofuels is not as efficient as it should be. Scientists are engaged in developing better means by which we can extract this fuel. However, the cost of research and future installation means that the price of biofuels will see a significant spike. As of now, the prices are comparable with gasoline and are still feasible. Constantly rising prices may make the use of biofuels as harsh on the economy as the rising gas prices are doing right now.

Conclusion

To sum up the above points, biodiesel, rich in huge crude materials, brilliant in dynamic properties, has gotten high consideration from numerous nations, and is environmental-friendly. These advantages of biodiesel will keep on ensuring that a generous market exists for this attractive alternative to usual petroleum fuel. Presently numerous countries are attempting to subsidize the biodiesel industry through fiscal and tax policy and set up national standards for the production process, product quality, and production safety in order to standardize the manufacturing. In the mean time, governments ought to effectively comprehend and handle the connection amongst biofuel and uncertain issues, such as food security, land use changes, forest protection etc.

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Green Environmental Precautions and Ways for IT and Technology Area

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Since the advent of artificial intelligence, the usage of IT and Automation is getting increased day by day. We are more dependent on IT and Automation resources and its usage like Laptops, Desktops, Servers, Smart phones, CCTV, Printers and Scanners and many more.

The Positive side is we are having better accuracy and speed of business needs.

The negative side is all these needs Electrical Power to drive and which generates and radiates heat in to the environment.

Today the use of IT and Automation has increased so heavily that we must think of optimizing and minimizing it to save environmental effects of energy and heat radiation and e-pollution.

Bad Effects of IT and Automation Hardware on Environment:

Desktops consume around 200W to 300Watts per hr energy. While it's normal functioning, it generates and radiate heat energy and infra-red/ UV radiation and high frequency radio waves also in surrounding. The heat radiation gives rise to temperature pollution or radiation which increases the environmental temperature as millions of desktops and laptops/servers are used at various places.

Although all hardware is designed with all standards and compliances like CE in to consideration there is some factor which affects the environment in negative direction leading to increased temperature of environment.

In order to cool down the environment around computers and laptops/ servers, we have air conditioning and cooling systems which in turn consume more electrical energy leading to more heat radiation in surroundings.

This leads to even worst environmental heat generation in the environment. Centralized AC makes even more radiation of heat.

Today the electrical power crunch we faced is mainly due to heavy usage of AC and Computers.

On the top of this the human beings are getting affected due to prolonged use of IT assets.

Apart from this, every 5-6 years, the IT assets gets scrapped and generates lot of e-scrap material which is not so easily recyclable especially that which is damaged like mother boards, logic cards and many broken plastic parts. They are not disposable and biodegradable in open environment.

It is noticed that many countries dump theses scraps in to deep oceans but it is causing pollution to the ocean/sea water and cause harm to sea creatures.

Following preventive measures can be followed to control the harmful effects on the environment.

1. Set your devices for Power Management mode to save power automatically when remain Idle. Many people keeps their IT devices ON and when left idle state the device can turn itself into power saving mode if set up for power management. This will save at least 25% of energy radiation and wastage. Now a days, almost all IT devices have power saving mode. So one just needs to select setup for power savings mode. This is the only requirement. You can ask your office IT team to help you enable this.

2. Don't forget to shut down your computers and IT assets while leaving office unless it is shared and used by others.

3. Keep the System Preventive maintenance and regularly get the system cleaned and serviced with assuring its proper cooling and air ventilation.

4. Use genuine branded company spare parts of proper rating for suggested models types. Spares which come with energy star rating can be recommended.

5. Do not print all unwanted documents and emails. Use duplex printing to print both sides of paper.

6. Dispose off the scrap and IT assets to authorized Green channel IT Partners only. They offer you carbon credits and energy friendly certifications also. This helps bring your organization with improved ratings.

7. Try to recycle the IT assets and spares rather scrapping it. It will save your money and environment.

8. Consult proper IT person for proper configuration and softwares to be used for your business.

9. Smart solutions can be applied to the areas like data centers. In data centers, servers produce and consume lot of electrical energy almost 1000W per server. Servers are centralized used IT store system and can be used in efficient ways by proper configuration.

Smart Racks is a refrigerator like structure holding all IT assets like Rack Servers and Switches etc. can be used in data Centre to cool down the Servers and Networking/ Storage devices only and no need to cool the entire Data Center room. So you can save on AC cooling and Electricity Bill.

The Power Dissipation Units [PDUs] can monitor the Power consumption per connection and can help to control it. This will save lot of Energy and control its wastage.

10. Keep on upgrading technologies with better power management tools and services. Make awareness to save energy and prevent heat radiation.

11. Go for Complete Paperless Digitization and use emails and messaging services rather getting the hard copies printed unless it is absolutely necessary. Many CRM/ERP softwares can do this needful so choose wisely.

12. Centralization and optimization of data centers and sharing the common IT resources like Servers and Printers will save lot of energy radiation and consumption.

13. Opt for SAAS [Software As A Service] based Cloud Architecture rather having Own Data Center if you are a beginner to have own Data center. It will save lot of money and energy wastage as well.

Finally, cut down the unwanted IT resources and its use so that you can go GREEN !

Mr. Avick Sil

In Vessel Composting as Sustainable Decentralised Solid Waste Management Treatment

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Introduction

Solid waste management (SWM) is a challenge for the cities' authorities in developing countries all around the world principally due to the ever-increasing generation of waste. The load posed on the municipal budget for SWM as outcome of the high costs associated to its management, the lack of understanding over a variety of factors that affect waste management. Pollution caused by Solid Waste is one of the most adverse form, it requires environmentally sustainable management to reduce overall environmental problems.

Current existing scenario of waste management in urban India

With rapid urbanisation, the country is facing a massive waste management challenge. Over 377 million urban people live in 7,935 towns and cities and generate 62 million tonnes of municipal solid waste per annum. Only 43 million tonnes (MT) of the waste is collected, 11.9 MT is treated and 31 MT is dumped in landfill sites. Solid Waste Management (SWM) is one of the basic essential services provided by municipal authorities in the country to keep urban areas clean. However, almost all municipal authorities deposit solid waste at a dump yard within or outside the city unsystematically. Thus there pose a challenge in waste management due to limited use of recycling activities, inadequate space of landfill for waste disposal and inadequate management of hazardous and healthcare waste.

Current Rules for Waste Management in India

Waste management rules in India are based on the ideology of "sustainable development", "precaution" and "polluter pays". These principles mandate municipalities and commercial establishments to act in an environmentally answerable and responsible manner—restoring balance, if their activities disrupt it. The increase in waste generation as a by-product of economic development has led to various subordinate legislations for regulating the manner of disposal and dealing with waste is made under the umbrella law of Environment Protection Act, 1986 (EPA).

In-Vessel Composting as a decentralized waste management technology

In-Vessel Composter is designed for biodegradable waste treatment at household level. This is a low energy intensive process to manage biodegradable waste arising from kitchen, canteens, garden waste, food courts, etc. Segregation of waste at its source according to its type is necessary. Shredding is required to speed up the process as it allows optimise air exposure to waste material. Daily bio-degradable waste deposited in the In-Vessel Composter. Depending upon the quantity of biodegradable waste 20-25% total waste binding agent like garden waste or compost is added to enhance the process. It is being designed in a rotating drum. Rotate the drums 2-3 times daily for proper functioning. Bio culture can be added once for optimization of process. Depending upon the requirement different sizes of In-Vessel Composter can be designed. Low cost is required for Manpower & maintenance.

Figure1: In-Vessel composter

Advantages of In –Vessel Composter

- No electricity is required for this process
- Low capital investment as well as operation and maintenance cost
- No mosquito or flies or rodent issues
- In situ management of leachate
- Can be managed by unskilled labour
- Good quality compost which can be used for gardening
- No odour nuisance.

Conclusion:

It is concluded that In – Vessel composting could be the future of biodegradable waste technologies as it is found to be most convenient, no odour generation while operation and suitable technology for decentralised or small scale waste treatment.

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Green Technologies for Environment

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Due to increased globalization, changes in the environment i.e., pollution has also increased. Because of the increased level of pollution as well as global warming, human beings and earth will have to face many problems. To avoid all this we have to use green methods for synthesis of various products. Industries producing different products, pharmaceuticals should use chemicals or solvents which are eco-friendly.

Green technology is the application of the environmental science and technology for the development and application of products, equipment and systems to conserve the natural resources and environment, as well as to minimize or mitigate the negative impacts on the environment from human activities. The field of green technology includes a group of environmental friendly methods and materials, from techniques for generating non-conventional energy source such as solar power to management tools that help in auditing greenhouse gas emissions. Green technology development must be sustainable, meaning "balancing the fulfilment of human needs with the protection of the natural environment and resources so that these needs can be met not only in the present, but in the indefinite future". Scheme of sustainable development can be fulfilled at the confluence of three key dimensions, viz. environment-social-economic, thus satisfying 'bearable' environment and social impact, 'equitable' social and economic solutions, and 'viable' economic environmental options.

For sustainable development, principles of green chemistry have to be followed which are as follows:

1) **Prevention:** It is always better to prevent formation of waste than to treat it after it has been created.
2) **Atom Economy:** Methods should be designed such that all the reactants used are completely incorporated into products i.e. there is 100% atom economy.
3) **Less hazardous chemical synthesis:** Synthetic method should be designed such that less hazardous chemical reagents are used or the by-products formed are less or no toxic to the environment as well as human being.
4) **Designing safer chemicals:** Chemical reagents used in the experiments should have little or no toxicity.
5) **Safer chemicals and auxiliaries:** Auxiliary chemicals should be used only when it is necessary and the solvents used should also be safe and easy to recover or recycle.
6) **Design for Energy Efficiency:** Energy requirements of chemical processes should be recognized for their environmental and economic impacts and should be minimized. If possible, synthetic methods should be conducted at ambient temperature and pressure.
7) **Use of renewable feedstock:** the starting material or raw material used should be renewable so that it does not deplete after the process but can be recycled and reused.
8) **Reduce derivatization:** Multistep synthesis should be avoided to prevent or reduce unnecessary derivatization. It is because the derivatization steps require additional reagents and chemicals.
9) **Catalysis:** Use of catalyst accelerates the rate of reaction which also reduces the requirement of elevated conditions. Catalytic

reagents are superior to stoichiometric reagents.

10) **Design for Degradation:** Chemical products formed should degrade after their function is over. They should not persist in the environment.

11) **Real-time analysis for pollution prevention:** Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances. Eg. Pune real-time analyser

12) **Inherently safer chemistry for accident prevention:** Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires.

Let us hope that green technologies will be implemented in pollution control for the protection of our environment.

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SIES IIEM DEDICATED TO ENVIRONMENT MANAGEMENT THROUGH R & D AND OUTREACH ACTIVITIES

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Areas of Research	Specific Areas
1. Total Water Management	1. Purification of drinking water by using low cost techniques. 2. Management of nitrite contaminated wastewater 3. Textile wastewater management. 4. Phytoremediation. 5. Oil spill management by biosurfactants. 6. Management of brine generated from water purification technologies. 7. Assessment and management of marine pollution
2. Solid Waste Management	1. Management of industrial waste. 2. Management of MSW and other solid wastes. 3. Management of agro- residue.
3. Applied Biotechnology	1. Utilization of biofertilizers and biopesticides in soil fertility management and agriculture. 2. Exploitation of beneficial microorganisms in remediation of heavy metals, oil pollution etc.
3. Management of Natural Resources	1. Pollution monitoring and management 2. Ecorestoration. 3. Studies on Climate Change. 4. Biodiversity Studies. 5. GIS & Remote Sensing

MAJOR FUNDING AGENCIES

- Ministry of Environment Forest and Climate Change
- Department of Science and Technology
- Department of Biotechnology
- Board of Research in Nuclear Sciences
- Indian Council of Medical Research
- Mumbai- Metropolitan Region- Environment Improvement Society

OUTREACH ACTIVITIES

Dr. Archana Mohod

Upcycling - A Green Initiative to Tackle the Plastic Menace

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The widespread use of plastic has made it indispensable, contributing largely to municipal solid waste. It can be seen littered across sea shores, nullahs, rivers and waterways. Majority of platic waste is not recycled, and adds to an ever building mass of enormous landfills as a recalcitrant waste. According to an estimate published in Science, a staggering 4 to 12 million metric tonnes of plastic ends up into oceans which accounts for just 1.5-4.5 percent. No one knows what happens to the remaining 99% plastic waste. The figures are only going to double in the coming years according to scientists. India also contributes to the list of the list of offenders who don't manage their plastic waste. We dump 0.6 million tonnes of plastic.

The plastic which enters the oceans, gets degraded and the tiny particles find their way into the food chain and ends up in humans after consumption of sea food. The ingested plastic poses serious threats to the health and well being of humans and marine life forms.

To tackle the plastic menace, increasing awareness about the seriousness of the situation and encouraging more and more people to adopt the R3 ideology (Reuse, Recycle, Reduce) can prove to be effective.

Indians have always been resourceful with their materials be it cloth, vessels, paper or anything else and have always been creatively revamping it. Just that it took a German, Reiner Pilz in the 90's to give it a fancy name Upcycling!

So what exactly is Upcycling?

Upcycling is not the same as recycling, to upcycle is in fact to create something new, of better value and quality. It is a sustainable and green initiative, saving loads

Globally upcycling is practiced on a large scale at a community level with projects such as the giant cube garden which was created at Sydney by upcycling milk crates. In Japan phone booths have been creatively converted into aquariums, Palletfest is Colorado 's green initiative upcycling pallets into seats, art installations etc., the swiss are converting their huge wine barrels into hotels. Bohemian guitars out of waste materials, glass bottles as lamps, railings and décor, the list is endless!!

Terracycle a global brand started off as a fertilizer brand and gradually moved onto upcycling is a brand to watch out for. Re-tread works with tyres building tyre logs and construction materials for earthquake prone areas.

In India too we have Jaggery, a brand that refurbishes Industrial waste, a DIY furniture brand called Ubyld which works with repurposed teak wood, Ka-sha an upcycling fashion brand, Conserve, doodlage, ecowings gradually more and more brands are mushrooming creating products as diverse as wallets, bags from tyre tubes, high end fashion apparels, accessories and more.

Cryptic Hues is a miniscule attempt by me and Bhavana Mohod Thanekar to promote the concept of upcycling in urban India. We upcycle material perceived waste into something functional, something of value. A venture started initially out of hobby to create awareness, inspire and reduce plastic waste from going into landfills or adding to the unsightly litter scattered across streets. Hoping that more and more people get inspired to upcycle and adopt the 3R's and be responsible towards mother earth!!

SIES IIEM published a book entitled

"**Current Perspectives in Sustainable Environment Management**"

Are Bioplastics Really Good??

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Plastic, which had been hailed as a wonder material in the early 20th century, is increasingly becoming the face of all things going wrong with our civilization. This versatile material is unlike anything that is available in nature. It is durable, can be easily shaped, lightweight, waterproof and very cheap. New properties are getting added to it with every passing day resulting in new applications of plastic. But the same benefits of plastic have been the cause for its adverse impact on health and environment. Plastic does not decompose, hence almost every molecule of plastic produced so far is still somewhere in the environment and will continue to be so for hundreds of years. So one can still find almost every used and discarded plastic items somewhere on this earth.

Bioplastics and biodegradable and/or compostable packaging, in recent years, are emerging as a solution to bad littering behaviour of consumer and as a 'sustainable' option.

PlantBottle from Coca Cola Co.

More than 2.5 billion plastic bottles—partially made from plants—are already in use around the world in a bid to replace petroleum as the fundamental building block of everyday plastics. The so-called PlantBottle from the Coca-Cola Co. in 2009-10 was made by converting sugars from sugarcane farmed in Brazil into the polyethylene terephthalate (PET) plastic commonly used in the ubiquitous clear bottles for various beverages. Fully recyclable, the bottles debuted at the 2009 U.N. Copenhagen Climate Conference and Vancouver Olympics, and are now on sale from Japan to Chile and across the U.S.

Can plants become more widely used as building blocks of ubiquitous plastics? In a

sense it is back to the future with biopolymers—the very first plastics were produced by German chemists in the 19th

century via a fermentation processes. Yet, in October 2010, Frito-Lay withdrew a high-profile example of plant-based plastic for the majority of its SunChips bags. Why? Not because it was unsafe or failed to compost as advertised but because the sound of the crinkling plastic was louder than customers liked. Biopolymers, it was said, will be the next generation of plastics.

The PlantBottle might prove that point, helped by the fact that it is a different form of plastic from that which made up the failed SunChips bag. The first step in making it is fermenting ethanol from the sugarcane in Brazil. That ethanol is then exported to India where it is processed as monoethylene glycol, or MEG—which comprises roughly 30 percent of a typical PET bottle. The rest is composed of traditional, petroleum-derived plastic.

Making the PlantBottle saved roughly 70,000 barrels of oil by the company's calculations—and the plastic resin, indistinguishable from its petroleum-based analog, can be exported throughout the world. Of course, plant-based plastics run into the same problem as plant-based fuels—directly or indirectly they have an impact on food production. Whereas making ethanol from sugarcane in Brazil is energy efficient—more energy is embedded in the ethanol than goes into growing and harvesting the plants—replacing a significant fraction of the global demand for plastics, let alone fuels, would require converting large swaths of yet more Brazilian land into sugarcane fields.

Thus far, bio-based plastics have only replaced roughly 1 percent of the hundreds of billions–kilogram global plastics market, according to Lux Research, although that percentage may grow in coming years. The majority of those plastics, like PLA, are not recyclable, but rather compostable using high heat (temperatures of roughly 60 degrees Celsius).It takes 77 million years to make fossil fuels and 45 minutes to use as a coffee cup.

Regardless of the environmental logic, the plant-based plastics remain more expensive. According to PepsiCo, there is a bit of a price-up charge that the company is absorbing, not passing it along to consumers. But if one looks at the volatility of pricing for petroleum—in short order and over the long term—the price comparisons will be at parity, and perhaps better.

That is why Coca-Cola, at least, is working toward a 100 percent plant-based plastic bottle and the company believes that it is technically feasible to make such a plant bottle.

Corn for bioplastics

The conversion of corn into PLA (polylactic acid) polymer had languished as a quaint technology until given impetus by the sustainability era. Since then, and as annually as the fall harvest, the more enthusiastic predictions about growth in PLA have fallen short; nonetheless, corn remains the most utilized feedstock for bioplastics plastics.

Versatile as to the geographical and climate conditions under which it can grow, corn is the most cultivated crop worldwide, with the United States producing about a third of the tonnage. That's a plus, given that a feedstock that's bountiful offers more prospects for large- scale conversion and the economies-of-scale that come with it.

A dead zone is an area of water devoid of certain marine life, principally species that dwell and feed at floor depths. Corn production has been identified as a major cause of dead zones. A frequently cited dead zone is the one in the Gulf of Mexico. Years after its discovery, the area continues to spread, leisurely but insistently, like a lazy oil slick, and some marine biologists and their ilk already have declared it a crisis.

The sequence that results in a dead zone need not play out to its conclusion in order to generate problems. Dead zones create battle zones, not only pitting the interests of the farmer against those of the fisherman, but also pitting rural interests against urban.

Facts

Kudos to whoever coined the name, bioplastics; for, that person demonstrated keen awareness that words carry connotative meanings. No doubt the intent was to leverage the implied association with sustainability. With corn, one has a feedstock that's renewable, from the good Earth, and familiar to all; but, it doesn't automatically follow that the environmental footprint of PLA packaging is smaller than the footprint of-let's say-PET packaging. The latter is the product of a supply chain that's been honed for efficiencies over generations; in contrast, some critics argue that the total amount of resources consumed by the former makes for a poor return-on-investment.

Many factors figure into an objective comparison along sustainability lines, but a factor inevitably cited is that of end-of-life, with PLA and its brethrenbioplastics touting their biodegradability, a term that can invite inaccurate associations. Biodegradability raises a host of questions regarding the required conditions and time, as well as the by-products. PLA, in specific, is promoted as being compostable; however, that's only true with a commercial composting facility. Consumers envisioning throwing their packaging on a backyard compost heap have the wrong idea.

PLA is inferior to some petro-plastics along a variety of performance traits, for example, heat resistance. To narrow the performance gap, manufacturers of the bioplastic are experimenting with various additives, coatings, and the like. How far can the process go and the "bio" prefix remain credible? At some point, similar to soil erosion, the supposed best layer is worn thin.

And how are such hybrids to be disposed of post-consumer, if their "non-bio" component makes them incompatible with composting and their "bio" component makes them a contaminant in certain recycling streams? Landfill is an option, by default; then again, landfill diversion is supposed to be desirable in the sustainability era.

It has become common practice for brand-owners to publicly declare their commitments to sustainability; but, never should any audience lose sight of the fact that brand-owners seek to fulfill their commitments profitably-in the vernacular, they seek to make some bread. It's not dishonorable to regard sustainability as a source of competitive advantage, since sustainability preaches a balanced regard for the Three P's of planet, people, and profit.

That balancing act is situation-specific. Some products, by virtue of their requirements, might not be viable candidates for bioplastics, in general, nor for the corn feedstock variety, in particular. Such compatibility isn't limited to the kind imposed by the makeup of the product. There's also the factor of the production capacity of bioplastics, many times dwarfed by that of petro-plastics; for example, even if every product currently packaged in PET could be packaged in PLA, the supply of the latter couldn't come close to meeting the demand.

The implication is that early movers can seize an advantage, provided that haste does not make waste. For better or for worse, once the decision is made to market a product in PLA or any other bioplastic, that brand-owner becomes associated with all aspects of that particular packaging. Appreciation of that fact should not be just for the present but should extend to the future, reflecting the brand-owner's best predictions across trends and drivers. So to brand-owners casting seeds to the wind in expectation of a profitable harvest, know this: you reap what you sow.

Compiled from

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Dr. Kaushal Lapsiya

Biobutanol: A Rightful Successor to Ethanol as Biofuel

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Biofuel is a renewable and sustainable energy source, produced through biological processes. Biofuels can be derived directly from plants or indirectly from domestic and industrial wastes. Biofuels are gaining popularity in recent times from the society, industry and academy. The main reason behind this attention is the rise in oil prices, along with growing concern about global warming caused by carbon dioxide emissions. Mobility is a major factor utilizing the world's energy resources. This makes biofuels an attractive option to stop the dependence on petroleum based fuels.

Biofuels produced from renewable biomass have the greatest potential for CO_2 neutral production. Biofuels can be produced from biomass either chemically or by fermentation with microbes. Biofuel production using non-food crop biomass or industrial wastes, that reduces competition with food production is an attractive option which also helps in conserving the environment, flora and fauna.

Among the various biofuels available, biodiesel, bioethanol and biobutanol have gained the attention of the commercial sectors. Use of ethanol as a biofuel is well established fact and is practiced in countries like the USA and Brazil. Even biodiesel production through conversion of plant oil is a well established technology. However, at present, biodiesel degradation is a concern because of bacterial oxidation and deposit problems. Another alternative biofuel is biobutanol. It has various advantages over ethanol which makes it a favourable successor. Butanol i.e., n-butanol is found to be superior to ethanol and has many advantages like higher energy content, higher blending rate with gasoline, no engine modification, easy distribution using current infrastructure and a better auto emission performance. It is estimated that by 2020, biobutanol has the potential to substitute for both bioethanol and biodiesel in the biofuel market making its worth $247 billion (Green, 2011).

The first generation biofuels were made from food crops and conversion of food grade oils. These biofuels had limitations because above a certain threshold level the biofuel production threatened the food supplies and biodiversity. The second generation biofuels were able to solve this problem to a certain extent and were sustainable, affordable, and had greater environmental benefits. The second generation biofuels were produced by the conversion of different feedstock that were non-edible residues of food crop or non-edible plant biomass (e.g. grasses, trees and energy crops) and ligno-cellulosic biomass. But requirement of large space for cultivation, processing and storing of the crops during harvest season made the production of second generation biofuel difficult. However, these disadvantages could be overcome by third generation biofuels such as biobutanol. Third generation biofuels could be produced in areas which were not available for growing food (Ndaba et al., 2015).

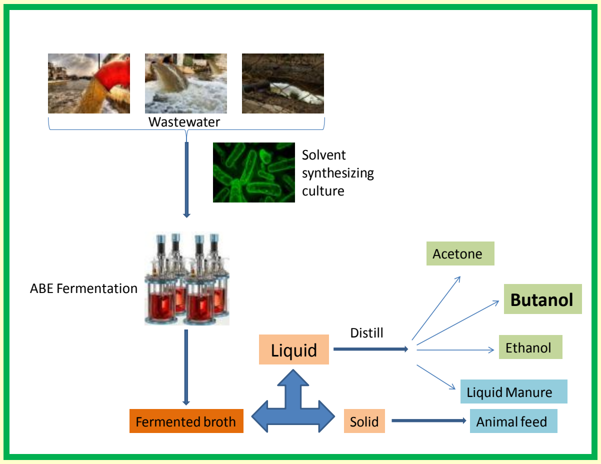
Historically, Acetone-Butanol-Ethanol (ABE) fermentation, one of the oldest industrial fermentations, was used for biobutanol production**.** Chaim Weizmann pioneered the commercial use of n-butanol in 1916. He invented the historic industrial ABE fermentation using a bacterium, *Clostridium acetobutylicum* to convert fermented corn starches into acetone, which could then be used to make dynamite. Till date, *Clostridium acetobutylicum* ATCC824 remains the best studied and manipulated strain**.** However since 1954, in the western countries, as the price of petroleum became lower than that of sugar, fermentative production of n-butanol got replaced rapidly by the chemical process. Butanol was then produced from petroleum via hydrolysis of haloalkanes or hydration of alkenes. However, with the growing demand for crude oil, the "peak oil" was met in 2010. The world recognized the problem of oil reserves depletion. On the other hand use of renewable resources gave a higher security of supply, a higher national value, a better environment and an increase in income in rural regions. Thus the n-butanol production by fermentation was revisited.

However, the solventogenic fermentation process had limitations of substrate inhibition and butanol toxicity in the medium. Apart from these limitations, biobutanol yield was also affected by the ancillary end products like acetone and ethanol. To tackle these problems researchers developed microbial strains with improved biobutanol yield and tolerance by genetic engineering. Also technologies like cell recycle, immobilization of cells, various downstream processing were also tried.

Another limiting factor was the substrate used for fermentation. The substrate for biobutanol production ranges from simple sugars to complex biomass. Biomass, varying from food crops to weeds is used for butanol production. Cheaper, abundant and sustainable feedstocks such as wastes and agricultural residues are being tested to be used as substrates, to improve the production cost (Van der Merwe et al., 2013).

A number of studies have reported bio-butanol production from lignocellulosic biomass including wheat straw, barley straw, corn fiber, corn stover, switchgrass and dried distilled grains and soluble (DDGS). Biobutanol can also be produced from algae (called Solalgal Fuel) or diatoms. Furthermore, there are many reports for the use of various biomass substrates such as a hardwood, domestic organic waste, agricultural waste, palm oil waste, whey and sago starch for ABE fermentation by different Clostridial strains. The substrates like whole grains or lingo-cellulosic biomass unlike simple sugars require pretreatment either in form of hydrolysis using enzymes, acid treatment or gasification. After this treatment, the lysate is used for ABE fermentation.

Waste is currently a major problem in the world, both in the developing and the developed countries. Efficient utilization of waste for fuel and chemical production can positively influence both the energy and environmental sustainability. With the wave of "Swatch Bharat Abhiyan" in our country, the initiative to produce butanol from waste will be greatly acknowledged.



Although promising, production of biobutanol requires investments to assure its implementation. If this problem is checked and worked upon, biobutanol seems to be the focus for the future.

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2.	Instrumentation techniques in Environmental Pollution Monitoring		■				
3.	Corporate Social Responsibility Strategy and Reporting	■					
4.	Internal Auditor Training for Occupational Health and Safety (ISO 18001: 2015)			■			
5.	Environmental Law and Policy		■				
6.	Training programme for CETP Plant Operators					■	
7.	Green technologies in waste water management						■

For further details contact on 022 61196454/55/56/57/60 or e mail id.: iiemoffice@sies.edu.in.
Fee concession will be given on group registrations.

Environment in News Headlines

Portable and ecofriendly water filter

The research team at KTH Royal Institute of technology Stockholm, Sweden has developed a wood based water purification filter that traps bacteria, this does not need any electricity and works on gravity. It offers the advantage of use at remote places where the clean water supply facilities are not there. The filters are derived from wood as the base material which is mixed with the positively charged polymer that would attract the bacteria (negatively charged) and thus trap them on the material surface where they eventually die. The material does not cause leaching of toxic chemicals in water besides, there are no chances of bacteria developing any resistance. The filter can be burnt after use. The material is also being tested for the onsite treatment of water.

Source: Bio-Based World News, 18th April' 17

Biodegradable footwears

The "Futurecraft" trainer from addidas is made from natural biodegradable material which is derived from silk biopolymers, the upper part is made from 'Biosteel" fibre (Research product of TUM and produced by AMsilk) produced by fermentation and hence is biodegradable. Although the shoe is biodegradable but this can only happen when subjected to high concentration of Proteinase.

Source: Business Insiders India, 18th Nov.'16

Volcano as the source of Clean Energy

A drill named "Thor" is used to produce 10 times more energy as compared to conventional fossil fuels. The drill digs in volcanic areas to get the steam, generating clean electricity. The project is named as "Iceland Deep Drilling Project" (IDDP) and is in the experimental phase and has 2 years to demonstrate its economic viability and success.

Source: https://futurism.com/iceland-is-using-extreme-tech-to-harvest-clean-energy-from-volcanoes/ *8th May'17*

Plastics can be degraded by caterpillars-a solution to plastic pollution

It has been discovered that the Wax worms larve of *Gulleria mellonella* that lives as parasites in bee colonies can feed on polyethylene and thus degrade it biologically. This can be scaled up for plastic waste management reducing the burden on landfills. The rate of degradation is extremely fast as compared to the other natural processes using bacteria. The worm converts polyethylene into ethylene glycol through enzymatic process. It was serendipitous discovery made by a beekeeper ad a professional scientist Federica Bertoclhim (IBBTEC). Further experimentation was conducted at University of Cambridge.

Source: University of Cambridge, 24th April'17

Pacific Ocean Cleanup using new technology

The Dutch Foundation "**The Ocean Cleanup**" is planning to clean plastic garbage in Pacific Ocean in 2018 using large floating screens which could be anchored to the bottom. This is a simple & sturdier prototype floatinbarrier and besides is also very economic.

Source: Engadget, 12th May'17

Forthcoming Events

Training program for Certification of Internal Auditor for ISO 14001:2015

Articles, photos etc. are invited for next issue (July-September, 2017) of the Newsletter on the theme 'Wealth from waste'

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