THE ENVIRONMENT MANAGEMENT

A Quarterly E- Magazine on Environment and Sustainable Development

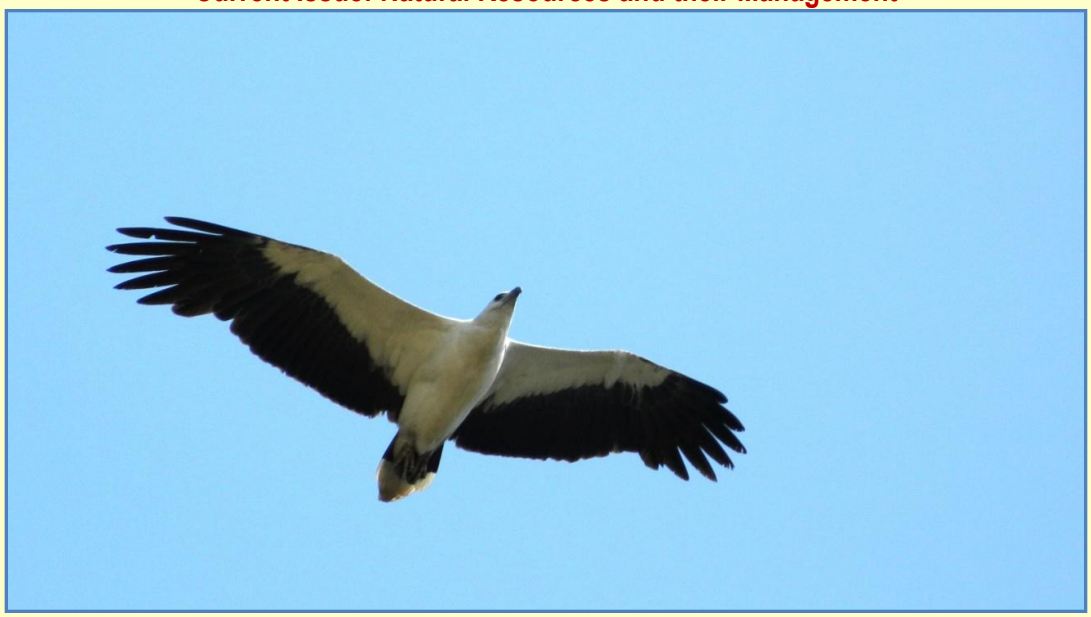
Indian Institute of Environment Management
SIES RISE WITH EDUCATION

पर्यावरणो रक्षति रक्षितः

(for private circulation only)

Vol.: II | January – March 2016 | Issue: 1

Current Issue: Natural Resources and their Management



White Bellied Sea Eagle at Chiwla Beach, Malwan Coast, Maharashtra
(It signifies the presence of fish in the sea)
Photo Courtesy: Mr. Sunil Belvekar, SIES- IIEM Alumni (PGDSEM 2013- 2014)

CONTENTS

From Director's Desk

Every nation's basic wealth and progress has stemmed in large measure from its natural resources. Our entire society rests upon and is dependent upon our resources viz. water, land, forests, and minerals. How we use these resources influences our health, security, economy, and well-being. With a projected world population of more than 9 billion people in 2050 and rapid economic growth across developing and emerging economies, demand for natural resources, especially raw materials, is expected to continue to rise strongly. Against this background, increasing resource efficiency is an important factor in delivering environmental and climate protection, employment, social benefits and sustainable green growth. Today, unsustainable patterns of consumption and production are one of the major causes of the continued deterioration of the global environment. It is time now that this problem is addressed in right earnest and in an inclusive manner. Also, an enabling framework needs to be put in place for the same. The 2030 Agenda for Sustainable Development adopted at the UN Summit on Sustainable Development in September 2015 expresses a clear recognition of the importance of sustainable resource management, and of the maintenance and safeguarding of natural capital, if humanity's hopes of sustainable development for all are to be fulfilled. In COP 21 at Paris in December 2015, emphasis was laid on sustainable utilization of resources within the carrying capacity of the ecosystem. In this regard, research and development will remain a driving force in improving the resource efficiency and reducing its exploitation for a sustainable future. The current issue of 'The Environment Management' focuses on the theme, 'Natural Resources and their Management' with aim to share latest knowledge, perspectives and news to bridge gap between researchers, academicians, industry, students and common people.

Season's greetings.

Dr. Seema Mishra

Air Pollution and its Monitoring: Role of GIS

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Problem of air pollution is increasing in a number of cities in India including Navi Mumbai. Different air pollutants include particulate matter, carbon monoxide (CO), sulfur dioxide (SO_2), nitrogen oxides (NOx), Ozone (due to photochemical reactions between NOx and VOC species), and Volatile Organic Compounds (VOCs). Anthropogenic sources for the urban air pollution include vehicular emission from transport sector, industrial emission, dust from construction sector as well as combustion of fuel for domestic heating and cooking purposes. Amongst different pollutants, particulate matter (PM) of size less than 2.5-micron ($PM_{2.5}$) and 10 micron (PM_{10}) have emerged as pollutants of concern due to its adverse impact on human health (US EPA, 1995, 2000).

In order to reduce air pollution, there is a need to do its monitoring. In air pollution study, large amount of data need to be collected from different locations through samplers and other authentic sources and GIS has the advantage of analysing spatial data and handling large spatial databases. Various thematic air pollution maps can be generated. For detailed analysis of air quality data, there is a need to integrate spatial data with non spatial data. GIS provides a platform to link both spatial and non spatial data and it provides opportunity for planners and decision makers to understand the complex information and data in a simple way.

Problems of air pollution in Navi Mumbai has increased to such an extent that the city's Air Quality Index (AQI) has slipped into the `poor' category according to the real-time data made available by System of Air Quality and Weather Fore casting and Research (SAFAR) the AQI on Jan 19 2016 and was 212. An AQI between 201 and 300 is considered `poor'.

Various sources and literature reveal that there is problem of increasing air pollution in Navi Mumbai. The reports of the Ambient Air Quality Monitoring (Maharashtra Pollution Control Board) show that, the values of RSPM and SPM frequently exceeding the quality norms prescribed by Central Pollution Control Board. This may be because of the regular road traffic and the construction activities in this area.

Various researchers have carried out research about spatial distribution of air pollutants and its concentration. They have attempted to review emissions from road transport and examined possible emission mitigation strategies. Some have studied estimation of vehicular emission inventories using GIS methodology. Some have evaluated air pollution (CO_2, SO_2, and NOx) from fossil fuel combustion. A link between emission of pollutants and their impact on human health has to be analysed. The associated health risk may vary from person to person. Exposure to air pollution may result in asthma, bronchitis, eye irritation, headache, cardiovascular diseases.

Therefore, monitoring of air pollution, field survey and its detailed emission inventory is required in order to effectively recommend measures to reduce air pollution. Monitoring provides raw data and information about the concentration of air pollutant, which can then be analysed and interpreted using GIS. This information can be linked with meteorological data to analyze whether pollution levels are rising or falling. All this information of air quality if linked spatially can be used by the decision makers and policy makers from government agencies as well as local agencies to make informed policy decisions.

Indian Initiatives for Environment Conservation

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Society, at large, has to realize the gravity of environmental degradation and participate fully in the mitigation of environmental problems. The commitment of the Indian Government to the cause of public awareness of environment conservation is reflected in its outreach and educational programmes involving its ministries, environmental monitoring agencies, NGOs, academic and research institutions. The Ministry of Environment and Forests (MoEF) has played a leading role in the national priority programmes of environmental monitoring, assessment and pollution control. All the stake holders have succeeded to some extent in creating public interest in environmental issues but much more needs to be done.

This article discusses the Indian initiatives and the important milestones in the path of environmental protection and pollution abatement. Some of the initiatives of far reaching consequences are:

1. Setting up of a full fledged Ministry of Environment and Forests (MoEF) in 1985. This was a sequel to the establishment of the Department of Environment in 1980 on the recommendation of the N.D.Tiwari Committee,
2. Wild Life Protection ACT of 1973 for setting up of National Parks and sanctuaries,
3. Water Pollution and Control Act of 1974 and Air Pollution and Control Act of 1981.
4. The Environment Protection ACT of 1986, passed by Parliament after the Bhopal Isocyanate gas tragedy, was a complete and comprehensive legislation covering all aspects of pollution and protection of the environment,
5. Making Environment Impact Assessment (EIA) mandatory for all proposed development projects and industries to evaluate their possible impact on the environment,
6. Biological Diversity Act of 2002 for conservation of biological diversity of the country
7. National Green Tribunal Act of 2010.

National level institutions like NEERI, NIO and TERI are actively involved in research to find feasible solutions to our environmental problems and in dissemination of relevant information through their publications. In our country, voluntary organisations and NGOs have been contributing immensely to environmental causes. Following the directive of the Supreme Court in 1991, environmental education is a compulsory component of school and college curricula. India has contributed significantly to the deliberations at COP (Conference of the Parties) especially the recently held COP 21 at Paris. Our suggestions for creating a pollution free world have always been welcomed by the participating countries specially the developing countries.

Some of the environmental problems which demand urgent action are;

1) development of Green technology based on the 12 Principles of Green Chemistry and Technology,
2) cleaning up of our rivers and water bodies,
3) disposal of e-waste,
4) development and greater use of biofertilisers and organic manures,
5) reduction in emission of green house gases(GHG),
6) development of sensitive analytical methods to detect and estimate pollutants in water, air and soil at micro gram and nanogram levels.

Highlights of the National Conference on Environmental Monitoring, Assessment and Pollution Control 2015 (EMAPCO-2015)

A two day 'National Conference on '**Environmental Monitoring, Assessment and Pollution Control**' was organized by SIES-Indian Institute of Environment Management jointly with Chromatographic Society of India and SIES- Arts, Science and Commerce College, Nerul during December 10th -11th, 2015 at SIES Educational Complex, Nerul, Navi Mumbai. The conference was sponsored by **Maharashtra Pollution Control Board** and supported by RCF Ltd., Chemtrols Industries Ltd., Mettler Toledo and Mumbai Waste Management. It was inaugurated by Prof. Shyam R. Asolekar, Centre for Environmental Sciences and Engineering, IIT Bombay, Mumbai as a Chief Guest and Mr. K. Nandakumar, Chairman & Managing Director, Chemtrols Industries Ltd., Mumbai as a Guest of Honour. Total hundred delegates from Industry, Academic Institutions, Research Institutions, Government departments participated in the Conference. Major deliberations and recommendations in the conference were:

- Implementation of online monitoring of waste water at various stages of its treatment.
- Process optimization for the photochemical method and anaerobic treatment of waste water.
- Utilization of GIS as a tool for the identification of water recharging zones.
- Need for the application of bio- nano particles in the treatment of waste water.
- Integration of pollution data being collected by various agencies in the states.
- Data from SAFAR project and MPCB can be used by research students/ participants for carrying out scientific analysis of increasing pollution in Greater Mumbai.
- More research requirement on indoor air pollution monitoring.
- Implementation of mechanization for the segregation and management of municipal solid waste.
- Proper characterization of hazardous waste for pollution control.
- Need of standards for soil or land pollution.
- Characterization of soil for physico-chemical properties before amendment of industrial wastes.

Dr. Shyam R. Asolekar, IIT Bombay, speaking during inauguration of EMAPCO 2015

Release of Souvenir (Dignitaries left to right : Mr. S. V. Viswanathan, Dr. Shyam R. Asolekar, Mr. K. Nandakumar, Dr. G. Ramakrishnan and Dr. Seema Mishra

Inauguration of Exhibition stalls by Mr. S.V.Viswanathan, Joint Honorary Secretary, SIES

Session in progress

Panel Discussion

Evaluation of poster papers

Valedictory session (left to right : Dr. G. Ramakrishnan, Mr. M.V. Ramanarayan, Mr. S. Ganesh, Mr. S. V. Viswanathan, Dr. Seema Mishra)

Students with best paper award certificates

Critically Endangered Fauna of India

Forest Owlet (*Heteroglaux blewitti*)

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Forest Owlet is a typical owlet endemic to the forests of central India, specifically north-western Maharashtra and south-east Madhya Pradesh, which is now on the verge of extinction. It was considered to be extinct as it was not seen for more than a century after 1884 until it was rediscovered in 1997. It is now declared as Critically Endangered species by IUCN.

Subsequent surveys revealed that the species is showing continuous decline at a rate of 10-19% over ten years. Around 50-250 mature individuals are estimated to be present in the wild. Habitat loss is a major threat to the existence of the bird. In addition to other threats such as hunting by people for body parts and predation by other raptors, decline in forest cover by illegal tree cutting for firewood and timber, encroachment for cultivation, grazing and settlements too has greater contribution to the decline in its population.

Some of the Conservation actions needed are prevention of illicit wood cutting and hunting, spreading awareness about importance of species among local communities, control over forest fires and grazing, control over use of pesticides and rodenticides and training to forest staff for conservation and management of forest.

LAUNCH OF E- MAGAZINE 'THE ENVIRONMENT MANAGEMENT'

The E- magazine was launched on 10th December, 2015 on the theme 'Environmental Monitoring and Assessment for Pollution Control' during the inaugural session of EMAPCO 2015.

Approach on Indian Companies' Climate Pledges

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The climate change is recognized as one of the biggest challenges world faces today. Globally, many efforts are underway to mitigate the impact of climate change. Recently, major global companies' CEOs also wrote an open letter on the World Economic Forum's platform to urge countries and the leaders meeting in Paris to encourage accepting the established climate science and take appropriate steps to control the GHG emissions. Now most of the responsible corporates are already doing carbon footprint assessment as part of their CDP, Sustainability Reports etc. Some of these companies also have short and long term targets for the emission / emission intensity reduction. Going further, most companies, especially ones with the products for the export market and suppliers of the large multinational companies will need to be prepared for the global carbon constrained economy (either by regulation or by voluntary pledges).

How companies can set climate targets?

The first steps in this can be preparing comprehensive GHG emission / carbon footprint for the current or chosen base year. This then can be projected for the short (minimum five years) to long term (15-25 years) appropriately with corporate expansion plans, market growth rates etc.

Approach 1)

As a minimum target, the companies emission target should be in line with the country's pledge to UNFCCC.

The Indian pledges

1) To reduce the emissions intensity of its GDP by 33 to 35% by 2030 from 2005 level

2) To achieve about 40% cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030. The company's revenue (for simplicity) or contribution to GDP can be calculated and translated into appropriate emission intensity reduction based on chosen base year and the target year. The emission intensity target of about 1.4% annual can be set to be in line with the Indian INDC.

However, as the industry can contribute much more compared to the Agriculture and Service sectors in India and also the fact that other sectors do not have much emission reduction potential), the emission reduction burden on the industry should be higher.

This further needs to have detailed sectoral study from INDC, India's low carbon group report and National Communication to arrive at the appropriate emission reduction pledge / commitment. These additional references may have further sectoral assumptions / benchmarks to refine the climate pledge appropriately.

Approach 2) Science Based Targets (SBT)

The global scientific community has agreed on limiting the global temperature rise within 1.5°C compared to pre-industrial temperatures. The target was also accepted as global need in the 2009 meeting of UNFCCC in Copenhagen and recently in Paris.

There is an international initiative on science-based target setting for companies initiated by CDP, United National Global Compact (UN Global Compact), the World Resources Institute (WRI), and the World Wide Fund for Nature (WWF). The joint work by these has also given ways to set the climate / GHG emission targets for companies to be in line with the 2° goal or the SBT.

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

ABOUT SIES IIEM

- SIES IIEM was established in 1999. It has been contributing in the fields of R&D activities and Academics in the areas of Environment Management and Biotechnology.
- IIEM is recognized by Department of Scientific and Industrial Research for research activities and has successfully completed various research projects with funding from DST, BRNS, DBT, ICMR, MOEFCC, MMREIS and several other agencies.
- IIEM also conducts consultancy services, organizing seminars, workshop and providing community service through research and creating awareness.




INFRASTRUCTURE AND FACILITIES

State of Art Facilities to conduct R & D and consultancy in the areas of Environmental Science and Management. Laboratories are equipped with the advanced equipments (HPLC, AAS, GC, HVS etc.)

CONSULTANCY SERVICES

GREEN MANAGEMENT

Environmental Monitoring and Analysis

- Water, Soil, Air, Waste
- Eco-toxicity studies

Conservation of Resources and Biodiversity

- Eco restoration of Resources
- Biodiversity mapping and indexing

Waste Management

- Wastewater management for zero discharge
- Solid waste management
- Industrial sludge management
- E- waste management

Expertise in:

- Advanced oxidation processes
- Aerobic and anaerobic processes
- Bio- and phyto- remediation

EIA and Sustainability Solutions for Mitigation of Climate Change Vulnerability

GIS based Environmental Planning and Management

- Natural resource mapping
- Groundwater recharge study
- Site selection
- Database management

GREEN COMMUNICATION

Providing CSR Solutions for Environment and Society

- Environmental Education
- Training and Awareness programme
- Water audit and energy audit
- Carbon footprint mapping
- Capacity building
- R&D proposals and report writing
- Events – workshops, seminars and conferences

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

Pollution Control Measures in Refinery and Downstream Petrochemical Plants

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We all are aware that pollution is a global problem that needs no introduction. With increasing population and pollution of surface & ground water sources, the problem is aggravated with each passing day. Indiscriminate industrial development and exploitation of limited water sources are compelling every industry to seriously address the problem. Availability of water itself has become a serious threat. Therefore, industries are considering various options to reduce their water usage and to recycle water to the extent possible, including selection of manufacturing technologies that use minimum water, produce less waste water as well as other solid and liquid waste. As the cost of water increases, legislation becomes more stringent and enforcement stricter making water recycle a viable option. This article discusses the recycle, zero liquid discharge and solid waste management philosophies and explores their various technologies.

Pollution Prevention in Industry

Prevention is better than cure. This also applies to pollution. Prevention or minimisation of pollution at source is the best control method. Hence, before going into the methods of effluent treatment, we should look at the possibilities of preventing or minimising effluent generation. Pollution prevention is defined as the use of materials, processes or practices that reduce or eliminate the generation of pollutants or wastes at the source. Also known as reduction at source, pollution prevention includes practices that reduce the use of hazardous and non-hazardous materials, energy, water or other natural resources. Pollution prevention in the manufacturing industry can be achieved by changing production processes to reduce or eliminate the generation of waste at the source.

Recycle of Waste Water and Study of its Application in Various Industries

Waste water recycle should take shape at the drawing board stage in contrast to the conventional treatment approach of designing the raw water and waste water treatment plants (end of pipe solutions) separately.

This will enable planning for water recycle at the design stage itself. The benefits are many. Firstly, because water is recycled to the process, raw water consumption reduces. The designer can therefore plan for a raw water treatment plant of lower capacity and cost. Secondly, the effluent treatment plant's capacity is also reduced as we are treating the effluent which is not being recycled and hence the quantity of waste disposed is less, leading to further cost reduction.

Figure 1: CONVENTIONAL TREATMENT

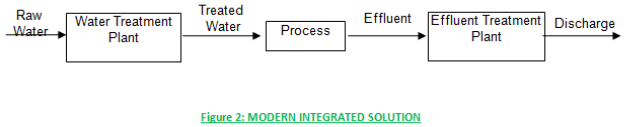
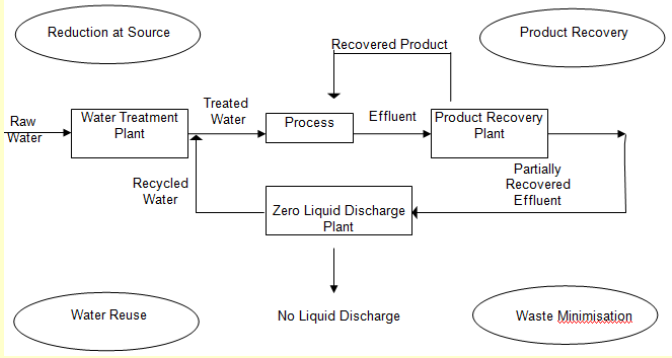


Figure 2: MODERN INTEGRATED SOLUTION



Investment is certainly required for product recovery, water recycle plants and advanced technologies to handle even higher concentrations of contaminants. However, the life cycle and return on investment is quite attractive.

Pollution is not just abated but prevented; pollutants are separated not destroyed; energy is saved and the total cost of water and waste water treatment is reduced.

Hence, we can use this experience of on/offsite recycle and integrated solutions for water and waste water treatment in large industries to achieve the goal of '**Total Water Management'** at the design stage.

We need to only apply these approaches in a complex industry in multiple ways.

Guidelines for Selection of Recycle Scheme

1. Study the manufacturing process thoroughly and identify areas where reduction of water consumption is possible.
2. Identify the process where reduction of pollution load is possible by changing raw material or adopting cleaner manufacturing process.
3. Proper analysis of various streams especially targeting the contaminants which are process specific.
4. Identify streams that can be segregated and treated economically. For example, in electroplating, the rinsed water can be segregated and treated for recovery of plating metal. This not only reduces the overall cost of recycle but also facilitates the recovery of valuable products from the waste water stream.
5. Identify effluents which are relatively clean and can be treated with simple processes so that they can be recycled internally without letting the water out into an effluent treatment plant.
6. Identify the quality of water required at various manufacturing stages. For instance, steam generation may require high quality water and washing or cooling water make-up may not require high quality water. It is always economical to design a recycle system to produce water suitable for lower end usage.
7. Select a technology that is easy to implement, operate, maintain & service.
8. Look for the availability of spare parts that may be needed in the future.
9. Reliability of performance in the long run is extremely important.
10. Low in operating cost.
11. Good service network of the plant supplier.

Recycle Technologies

Any waste water recycling plant requires four stages of treatment as follows:

1. Effluent treatment
2. Tertiary treatment
3. Advanced tertiary treatment
4. Zero liquid discharge

Effluent Treatment

For a good effluent recycle system, a good effluent treatment is a pre-requisite. Unless we remove the easily removable pollutants with cost-effective methods, it would be difficult to recycle the effluents economically. Usually effluent treatment plants (ETPs) are designed to meet statutory requirements for disposal. When recycling is considered, the ETP should also be designed considering overall requirements of treatment. For example, in India, disposal standards do not require complete removal of nutrients and dissolved salts. But, when we are installing a downstream reverse osmosis system, it is better to remove

nutrients and dissolved salts in the biological system of the ETP. This will help reduce fouling of the reverse osmosis system.

There are different technologies available for effluent treatment to remove different pollutants. The table below lists some generic technologies applied in effluent treatment.

Effluent Treatment Technologies (Primary and Secondary)	
Pollutant	**Treatment Technology**
Floating matter	Manual bar screens, mechanically cleaned screens, drum screens, etc.
Grit	Manual grit chambers, aerated grit chambers, deaerator, etc.
Oil & grease	Oil & grease traps, API oil separators, TPI oil separators, dissolved air floatation (DAF) systems, tubular ultra filtration, etc.
Acidity/alkalinity	Neutralisation using acid/alkali dosing
Suspended solids	Clarifiers, clariflocculators, high rate solids contact clarifiers (HRSCC), lamella clarifiers, tube settlers, DAF, ultra high rate clarifiers, pulsating clarifiers, etc.
BOD/COD/ NH_4/TKN/TP/Phenol/CN/SCN	Biological systems such as activated sludge process, trickling filters, sequential batch reactors (SBRs), membrane bio-reactors (MBRs), etc.
Heavy metals	Precipitation using solid contact clarifiers, ion exchange processes, membrane systems for metal recovery, etc.
Toxic substances	Different treatment technologies are adopted based on the nature and concentration of toxic substances. For example, phenols can be removed with biological systems at low concentrations whereas chemical oxidation may be required for higher concentrations.
Recalcitrant compounds/ COD	Photo-chemical oxidation is used to remove or break recalcitrant and complex organics such as phenols, benzene, pesticides, etc.

Tertiary Treatment

Treatment beyond disposal norms for reusing effluents for low end usages is called tertiary treatment. It acts as pretreatment to advanced treatment for complete recycle of effluents. Following table enlists some generic technologies applied in tertiary treatment.

Tertiary Treatment Technologies	
Pollutant	**Treatment Technology**
Turbidity	Gravity sand filters, pressure sand filters, dual media filters, multi media filters, continuous sand filters, auto valveless filters, etc.
Bacteria	Chlorine dioxide, chlorination, ozonation, ultraviolet sterilisation, mixed oxidant systems, etc.
Colour	Oxidation, precipitation, adsorption, nanofiltration, etc.
Residual chlorine	Activated carbon filtration, dosing of reducing agents, ultraviolet treatment, etc.

Advanced Tertiary Treatment

Further treatment of secondary treated effluents is required for conforming to the requirements of high end usages (boiler feed, process, etc.) of treated water. Following are some of the technologies available to remove various pollutants in advanced treatment:

Advanced Tertiary Treatment Technologies	
Pollutant	**Treatment Technology**
Hardness	Chemical precipitation, ion exchange softeners, nanofiltration, etc.

Silica	Chemical precipitation, ion exchange processes, reverse osmosis, etc.
Turbidity, SDI	Sand or multimedia filtration, ultra filtration, microfiltration, etc.
Dissolved solids	Reverse osmosis systems, ion exchange processes, electrodialysis, etc.

There are various other technologies which are contaminant and end use specific such as fluoride removal.

Zero Liquid Discharge Treatment

(Evaporation and recovery of waste water containing highly soluble salts)

The highly concentrated reject from the process is further treated in multi effect evaporator (MEE) system generally after reducing dissolved salts by RO processes and the advanced tertiary treatment.

The MEE process uses either mechanical or thermal vapour compression using forced circulation evaporators, falling film evaporators or in combination. Thus, evaporation is increasingly considered for the treatment of refinery and downstream petrochemical waste water to recover more than 95% of water, or as a part of the zero liquid discharge (ZLD) process.

Water Management in Refinery - Case Studies

1. Reliance Industries Limited

Reliance Industries Limited (RIL) has enhanced the capacity of the Jamnagar Refinery to 12,00,000 barrels per stream per day (1200 KBPSD) with the commissioning of the Jamnagar Export Refinery Project (JERP) in Gujarat.

Waste water treatment is carried out in a dedicated state-of-the-art completely automated and PLC operated effluent treatment plant supplied by Ion Exchange. The effluent treatment area is designed to contain and treat all internal process/utility waste water and storm/fire water with the objective of zero discharge from the new refinery complex. The treated water is recycled back as cooling tower make-up and partially used as process water after reverse osmosis treatment to the high total dissolved solids treatment train or guard tanks, as required. Effluents are segregated into four identical waste water streams designed for a treatment capacity of 500 m^3/h each and maximisation of reuse.

The scope of treatment also includes three by-product streams generated during the treatment of refinery waste water (skimmed or slop oils, oily sludge and biological sludge). Skimmed oil is chemical and heat treated, with recovered oils transferred back to the refinery for reprocessing.

Each of the above streams employs identical equipment for treating effluents, namely:

- Free oil removal facilities including pre-deoiler and API separators with continuous oil skimming and sludge removal facilities
- Dissolved air flotation (DAF) unit
- Two stage biological treatment
- Clarification
- Dual media filtration
- Activated carbon adsorption
- Disinfection – with chlorine and chlorine dioxide

The effluent treatment plant is treating 100 per cent effluent generated by the refinery since its commissioning in December 2008 and consistently produces treated effluent (pH 6 - 8.5, sulphide < 0.5 ppm, COD < 50

ppm, oil and grease < 5 ppm, phenol < 0.35 ppm) meeting guaranteed parameters for reuse for various applications mentioned earlier.

2. **Chennai Petroleum Corporation Limited**

The ZLD plant for the 3 MMTA expansion at Chennai Petroleum Corporation Limited (CPCL) uses advanced membrane processes to reuse water for its process requirement.

CPCL, during its expansion, increased the crude refining capacity at Manali by 3 million metric tonnes per annum. As part of this 3 MMTA expansion project, a new effluent treatment plant (ETP-III) treats effluents generated from the refinery project to meet the MINAS standard. With a view to conserving water**,** a new zero discharge plant (ZDP) was designed and constructed by Ion Exchange. This plant treats the treated water from ETP-III to enable use of the treated water as make-up to the demineralisation plant. The capacity of the ZDP is 200 m^3/h. The plant was commissioned in 2005 and is operated and maintained by Ion Exchange.

3. **Indian Synthetic Rubber Limited**

Another such example of ZLD is for Indian Synthetic Rubber Limited (ISRL). Three streams containing 3000 m^3/d process effluent along with 360 m^3/d cooling tower blow down and 240 m^3/d DM plant effluent are being treated through primary, secondary, tertiary and advanced tertiary treatments. The final reject (from RO) is being treated in thermal MEE, thereby achieving the objective of > 95 per cent water recovery and ZLD.

Conclusion

Waste water recycle and ZLD is mandatory for many industries because of water scarcity, legislation, rising water costs, unreliable water supplies, environmental requirements from buyers in case of exporters, etc. ZLD also gives enormous importance to sludge management (which is not discussed in this paper and which needs separate attention). Apart from these reasons, industries now identify recycle and ZLD as their social responsibility for environment friendly manufacturing of goods.

Many technologies are now available for managing industrial waste water and other waste. It is of utmost importance to involve environment management specialists right from the planning stage of the project so that the best optimum solutions can be developed. Priority should always be given to source reduction and product recovery rather than end of pipe waste water treatment and expensive methods of ZLD. Right technologies should be adopted for recovery and recycle of water from waste water. Final effluents which cannot be recycled should be treated and disposed of in an environment friendly way.

Ion Exchange provides a range of cost-effective technologies. These match the oil and downstream petrochemical's needs for efficient liquid waste treatment, recycle of treated water and zero liquid discharge objectives through tailor made solutions. Ion Exchange can provide advice on the right technology solution through water audit of the project/plant.

Desalination of Sea Water: A Sustainable Solution for Water Crisis

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Water scarcity is one of the most serious global challenges of our time. Presently, over one third of the world's population lives in water stressed countries and this figure is predicted to rise to nearly two third by 2025.

There are several methods to alleviate the stress on water supply including water conservation, repair of infrastructure, improved catchment and distribution systems. The only method to increase water supply beyond what is available from the hydrogeological cycle are desalination and water reuse. Desalination is removal of salts from water such as sea water so as to get freshwater for drinking and industrial purposes. It is also found to be advantageous in the recovery of water from waste streams. There are two basic methods of desalination: thermal desalination and membrane desalination. Thermal desalination uses heat, often waste heat from power plants or refineries, to evaporate and condense water to purify it. Membrane based Reverse Osmosis method makes use of semipermeable membranes and pressure to remove salt and other impurities from water. Desalination technology lacked popularity in the beginning because of its significant use of energy. In many arid areas of the world, however, cost to desalinate saline water is less than other alternatives that exist. Desalinated water is used as the main source of municipal supply in many areas of the Carribean, North America and the Middle East and desalination facilities exist in about 120 countries around the world.

Many factors enter into the capital and operating costs for desalination: capacity and type of plants, plant location, feed water quality and quantity, labour cost, energy cost, financing cost, ease of concentrate disposal, level of instrumentation/ automation and plant reliability. The production cost for a sea water desalination plant varies between Rs. 40-50/m^3 whereas the production cost of desalted water from effluent varies from Rs. 15-50 /m^3 depending upon the TDS load in the effluent stream. India has 33 % scarcity of fresh water. Desalination technology has been useful in water scarce areas like Gujrat, Rajasthan, Tamil Nadu and Andhra Pradesh. Government support from centre and some states have contributed enormously in growing demand for desalinated water in India. Today there are more than 1000 desalination plants of various capacities ranging 20 m^3/day to 1,60,000 m^3/day in the country. Gujarat was once considered a water scarce state but the initiatives of the Gujarat government; the state has the maximum desalinated water generation capacity in the country. Similarly, Tamil Nadu is the second highest desalinated water generating state contributing 24 % in total desalinated water capacity. Increasing population, industrialization and demand for fresh water has been driving Indian desalination market which is set to grow at CAGR of around 22 % for next five years. It is estimated that desalination technology will witness phenomenal growth in the coming years.

XOS: A Potential Biopolymer for Industrial Applications and Environment Management

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The history of agriculture in India dates back to the Rigveda. India being an agriculture-dominant country produces more than 500 million tons of crop residues annually. These residues are used as animal feed, for thatching of homes, and as a source of domestic and industrial fuel. A large portion of unused crop residues are burnt in the fields primarily to clear the left-over straw and stubbles after the harvest. The burning of agricultural residues leads to significant emissions of chemically and radiatively important trace gases such as methane (CH_4), carbon monoxide (CO), nitrous oxide (N_2O), oxides of nitrogen (NOX) and sulphur (SOX) and other hydrocarbons to the atmosphere. The crop residues can be gainfully utilized in the extraction of biopolymers viz. Xylan and subsequently Xylooligosaccharides (XOS) that can be used as a substrate in different industrial processes as well as in the making of biodegradable products.

Characteristics of XOS

Xylooligosaccharides (XOS) are sugar oligomers made up of xylose units, which appear naturally in fruits, vegetables, milk and honey. They are mostly composed of non-digestible xylose-based disaccharide, 35% and 60% total fiber (non-digestible oligomers; n=3-6) with xylose backbones linked by β 1→4 bonds. Their production at an industrial scale is carried out from lignocellulosic materials (LCMs). Besides non-structural components (such as ash), LCMs are made up of three polymers: lignin (20%-30%, with phenolic nature), cellulose (40%-50%, a linear polymer made up of β-glucose units linked 1-4 bonds) and hemicelluloses (20%-40%, branched heteropolysaccharides made up of a variety of monosaccharides, including xylose, arabinose, mannose, glucose and rhamnose). These three polymers are interlinked in a hetero-matrix and their relative abundance varies depending on the type of biomass.

Sources of XOS

The LCM for XOS production comes from variety of feedstocks (forestry, agriculture, industry or urban solid wastes) that show similarities in composition. Among the lignocellulosic plant biomass, hemicellulose, collectively named as non-cellulose polysaccharides, shows large variation within one plant species and its tissues and in between plants. Common hemicelluloses such as xylan, abundant in grasses and angiosperms (hardwoods like birch, etc.), contain xylose sugar. Typical raw materials for XOS production are hardwoods, corn cobs, straws, bagasse, hulls, malt cakes and bran.

Process for the conversation of hemicelluloses to XOS

The degradation of hemicelluloses is faster in comparison to cellulose and it requires enzymatic degradation by xylanase. Several hydrolytic enzymes are required for complete xylan degradation. Endo-1,4-β-xylanase plays a major role in the degradation of xylan by cleaving the xylosyl backbone and releasing short xylooligosaccharides, which are further hydrolyzed into xylose units by xylan 1,4-β-xylosidase. Xylanases are very important in the maintenance of carbon flow in the carbon cycle biomass turn-over in nature and in the reconverting of agricultural residues or waste.

Applications of XOS

XOS show a remarkable potential for practical utilization in many fields, including pharmaceuticals, feed formulations and agricultural applications, but their major market utilizations correspond to food-related applications. They have great prebiotic potential and can be incorporated into various food products to enhance their nutritional values. They can also be used in the production of artificial sweeteners. Xylanase, obtained from xylanolytic bacteria, can be used as an antimicrobial agent and for the degradation of heavy metals and phenolic compounds. The benefits of XOS are immense in industrial applications, however, in depth studies on the process optimization and characterization is required for future exploitations and product development.

Environment in News Headlines

SpaceX launches key climate satellite, botches rocket landing

A key ocean-monitoring satellite on board a SpaceX Falcon 9 rocket was launched from the Vandenberg Air Force Base in California that will continue a nearly quarter century record of tracking global sea level rise.

SpaceX's Falcon 9 rocket (left) took off from the Vandenberg Air Force Base in California and successfully deployed the Jason-3 climate satellite (right)

Source: The Times of India, Jan 19, 2016

Mumbai Pollution mounts to record high, as bad as Delhi's

As the Deonar dumping ground fire raged on there was thick smog and high pollution levels. So high, that they matched those of Delhi the worst seen last year during the Diwali season. Having recorded an Air Quality Index (AQI) of 325 in the morning, Mumbai saw an AQI of 341on evening, exactly what pollution-hit Delhi registered for the entire day, according to real-time data made available by the System of Air Quality and Weather Forecasting and Research (SAFAR).

Source: The Times of India, Jan 30, 2016

Expanding use of recycled water would benefit the environment, human health

Expanding the use of recycled water would reduce water and energy use, cut greenhouse gas emissions and benefit public health in California — which is in the midst of a severe drought — and around the world. A new study found that recycled water has great potential for more efficient use in urban settings and to improve the overall resiliency of the water supply.

Source: ScienceDaily, March 18, 2016

Desert mangroves are major source of carbon storage, study shows

Short, stunted mangroves living along the coastal desert of Baja California store up to five times more carbon below ground than their lush, tropical counterparts, researchers have found. The new study estimates that coastal desert mangroves, which only account for 1 percent of the land area, store nearly 30 percent of the region's belowground carbon.

Source: ScienceDaily, March 28, 2016

Forthcoming Events

- International Conference on Environment Management and Sustainability (ICEMS-2017) in January 2017.

Articles, photos etc. are invited for next issue (April - June 2016) of 'The Environment Management' on the theme 'Environment Management for Sustainable Development'

Published by-

SIES - Indian Institute of Environment Management,
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