

Current Issue: Water Treatment Technologies



5280 Cubic meters/day ultrafiltration membrane based plant in BARC Facility (Source: Article 1; page 2)

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From Director's Desk



Water is one of the vital resources that are prerequisite for the existence of human being. Lack of clean drinking water is responsible for more deaths in the world than war. Availability of clean drinking water is the greatest human development challenges of the early 21st century. About 1 out of every 6 people living today especially in developing countries do not have adequate access to water, and more than double that number lack basic sanitation, for which water is needed. In addition, most of the water we use is for agriculture and industry that contributes to the generation of waste water or pollution in natural water bodies. The application of innovative water treatment technologies and water resources management systems, optimal water use, as measured by qualitative and quantitative criteria, is sought in the respective stages of water supply, discharge, reclamation, and resource recovery in different water uses including drinking water, sewage, industry, and agriculture. This necessitates that the researches should contribute to sustainable water use from the most rational of many perspectives, including energy consumption, socioeconomic impact, environmental load, public health, and/or site-specific circumstances of targeted areas. We are releasing the current issue of 'The Environment Management' newsletter on 'World Water Monitoring Day' that falls in September with focus on sustainable water treatment technologies. Desalination, membrane bioreactors and decentralized distillation units are some of the technologies that are required in current scenario and are included in this issue. The mission of our institute is to train and develop professionals and find pertinent solutions to the problems in the areas of sustainable environment management through need based research, education and training programmes. In January 2017 we are organizing our first International Conference on Environment Management and Sustainability (ICEMS- 2017) with broad scope and themes. We seek your active participation and support in conference for deliberations on pertinent issues in the areas of sustainable environment management.

Dr. Seema Mishra



Membrane Based Water Treatment Technologies for the Ganga Rejuvenation: Challenges & Opportunities

Dr. P. K. Tewari

Professor, Homi Bhabha National Institute (HBNI) &RRF,
Bhabha Atomic Research Centre (BARC), Trombay, Mumbai 400085

E mail i.d.: pktewari@barc.gov.in

The Ganga basin accounts for a little more than one-fourth (26.3%) of the country's total geographical area covering the entire states of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand, and parts of West Bengal. The primary sources of pollution are untreated sewage and industrial wastewater. Non-point pollution sources from agriculture and livestock, religious activities at various locations along the river, as well as poor solid waste management, also contributes to pollution. In addition, substantial abstraction of water, primarily for irrigation, leads to low flows and associated poor water quality in the critical middle stretch of the river. There are about 764 industries in the main stream of Ganga and tributaries, out of which, 687 industrial units are in UP followed by 42 in Uttarakhand. Sector wise distribution of industrial units shows that number wise tanneries are dominant industries followed by sugar, pulp & paper and textile, dyeing and bleach. Tannery industries use chromium as a tanning agent and discharges liquid effluents containing chromium, cadmium, arsenic, mercury, nickel, sulphide etc in the Ganga. The stretch of Kannauj-Kanpur-Varanasi is the significantly polluted stretch of Ganga with higher chromium levels. The presence of arsenic in and around groundwater sources has been detected in all five states that the Ganga flows through. In Bihar alone, this includes most of the towns situated along the banks of the Ganga as well as around 1,590 villages spread over the state's thirteen districts in the Ganga Basin.

Sewage is a major source of pollution. There are about 223 cities/ towns (Municipalities/ Corporation) generating significant amount of sewage in the Ganga basin. These cities/ towns generate about

8250 MLD (million litres per day) of wastewater, out of which about 2460 MLD is directly discharged into the Ganga, about 4570 MLD is discharged into its tributaries/ sub- tributaries and about 1220 MLD are disposed on land or in low-lying areas. Out of 8250 MLD of wastewater generated in the Ganga basin, the treatment facilities are available only for 3500 MLD of wastewater.

Though industrial pollution constitutes around 20% of the total pollution load by volume, its contribution to polluting the river Ganga is much greater, due to the higher concentration of pollutants. Any industrial unit, discharging effluent (into the river) having BOD load of 100 kg/day or more and/or involved in the manufacture and use of hazardous substances, is classified as grossly polluting. At present, about 154 grossly polluting industrial units have been identified on the main stream of the Ganga. Of these, around 94 units have Effluent Treatment Plants (ETPs) operating satisfactorily, 22 industrial units have ETPs but they do not operate satisfactorily and 38 units have closed down. The total number of grossly polluting units along the Ganga and its tributaries is 478. Of these, 335 units have ETPs operating satisfactorily, while in 64 units ETPs do not operate satisfactorily and 79 units have been closed down.

Membrane based effluent treatment, either as stand-alone process and/or integrated with other primary and secondary processes in individual plant level, can play an important role in controlling critical parameters of the effluent and discharge the treated effluent as per Central Pollution Control Board (CPCB) norms. Bhabha Atomic Research Centre (BARC) has expertise in designing effluent treatment systems required at individual plant level based on the effluent characteristics of the

plant to achieve safe discharge. Ultra filtration (UF) membrane based water treatment plants for turbidity, pathogenic and organic removal are operating in BARC facilities with capacities ranging from 100 to 5000 cubic meters per day (Fig.1). These technologies are scalable on both higher and lower capacities. BARC developed membrane based technologies have been transferred to private entrepreneurs on non-exclusive basis both on domestic scale and commercial scale and the technologies are continuously being upgraded.

Before zeroing down to particular membrane based technology, it is necessary that the effluent discharge from industry be analyzed in detail to identify the type of contaminants and extent of contamination so that membranes/ technologies could be specified which are appropriate and optimum for that particular industry. Membrane based treatment of effluent normally generates two streams: one

which is fit to be discharged as such and a concentrate/ reject stream (low volume) which consists of the contaminants in higher concentrations than the feed effluent stream. The concentrate/ reject from membrane process normally does not have process-added chemicals and generally reflects the characteristic of the feed effluent as it simply redistributes the contaminants. Management of this concentrate/ reject from membrane processes depend upon the feed effluent water composition and the membrane process being used. This reject/ concentrate slurry emanating from the individual type of industry like tannery, pulp & paper industry, textile industry etc is treated in different ways. Processes like dilute and discharge, chemical post-treatment, solar evaporation ponds, incineration, deep-well injection etc may be used for the treatment of membrane effluent/ reject treatment. Though low in volume, it is an involving process and cannot be generalized.



Fig.1: 5280 Cubic meters/day Ultrafiltration membrane based plant in BARC Facility

Reader's Corner

Thanks for sending the quarterly SIES-IEM Newsletter. It is well designed, simple to read and I enjoyed reading the News Letter.

Dr. K. Bhanumurthy, Visiting Professor, Metallurgical Engineering and Material Science Department, IIT Bombay, Mumbai



Radioactive waste water treatment in India

Dr. C. Srinivas

SIES-Indian Institute of Environment Management, Nerul, Navi
Mumbai-400706

E-mail: srinivasc@sies.edu.in

Radioactive waste water is characterized by the presence of radioactive substances in the waste water. The radioactive substances (element to be precise) decay with a characteristic half life by emission of energetic ionizing radiation in the form of particulate (alpha and beta) and electromagnetic radiation (gamma rays). The radioactive waste water is, therefore, potentially hazardous. Discharge limits for aqueous alpha and beta emitters are 3.7 and 37 Becquerel's/L respectively. There are limits on the annual cumulative discharges of alpha and beta emitters as well. These discharge limits are set by Atomic Energy Regulatory Board of Department of Atomic Energy in our country. They are in line with international standards. The source of radioactive waste water is nuclear facility handling radioactive substances. In the entire nuclear fuel cycle operations in our country, from nuclear fuel mining in the front end to nuclear fuel reprocessing in the back end, different kinds of radioactive waste waters are produced. Conventional classification of aqueous (liquid) radioactive wastes is shown in table-1.

Table-1: Conventional classification of radioactive liquid waste

Category	Nature	Radioactivity*
Low Level Waste(LLW)	Near Neutral	<1 mCi/L
Intermediate Level Waste(ILW)	Alkaline	1mCi-!Ci/L
High Level Waste(HLW)	Acidic	>1Ci/L

*Radioactivity is conventionally measured in curies (Ci); 1Ci=1000 mCi=3.7E10 Bq

LLW is generated in very large quantities (thousands of cubic metres/annum) with low radioactivity content and low dissolved solids content from nuclear reactors, reprocessing plants, radiochemical laboratories etc. ILW arises from reprocessing and HLW operations and is characterized by high content of dissolved sodium salts and alkalinity. ILW generation is few hundred cubic metres per annum. LLW and bulk of ILW contain negligible alpha activity in the water. They contain beta/gamma emitting radioisotopes such as cesium, strontium predominantly and ruthenium to a lesser extent. HLW is generated from nuclear fuel reprocessing operations and it is acidic and contains curie/L levels of beta/gamma activity (predominantly cesium, strontium) and mill curie/L levels of alpha activity. Its generation is smallest among the three types – few cubic metres or less per annum.

Chemical precipitation is the primary treatment option for LLW treatment. It is a relatively low-cost process with the ability to handle different radionuclides. Treatment procedures are based on well-proven standard equipment with high processing rates. Membrane processes such as reverse osmosis are normally used as polishing steps to further reduce the activity of the discharged water to negligible levels.

The objective of a chemical precipitation process is to use an insoluble finely divided solid material to remove radionuclides from a liquid waste. The insoluble material or floe is generally, but not necessarily, formed in-situ in the waste stream as a result of a chemical reaction. A typical chemical precipitation method involves four main stages:

- (1) The addition of reagents and/or adjustment of pH to form the precipitate
- (2) flocculation
- (3) sedimentation
- (4) solid-liquid separation.

Cesium is removed by in-situ precipitation of copper ferrocyanide. Strontium is similarly removed by precipitation of barium sulfate or calcium phosphate. Ruthenium is removed by a combination of ferrous hydroxide and cobalt sulfide precipitation reactions. Trace alpha emitters in LLW are removed by ferric hydroxide precipitation. The radioactive solids produced in the precipitation reaction are encapsulated and immobilized in cement matrix and stored for spontaneous decay of radioactivity in engineered disposal facilities called NSDF.

ILW predominantly contains cesium, strontium predominantly and ruthenium to a lesser extent. Alpha activity in bulk of the ILW waste is negligible. The waste is characterized by high sodium salt content (200-300 g/L) and high pH (11-12). An ingenious process based on selective separation of radioactive cesium ion from molar quantities of chemically similar sodium ion has been indigenously developed and implemented at industrial scale on a routine basis at BARC, Trombay and other DAE units in the country using resorcinol-formaldehyde poly condensate ion exchange resin. Strontium removal is achieved by the use of Poly (styrene-divinyl benzene) resin containing iminodiacetic acid chelating group. By loading and elution cycles, very high volume reduction can be achieved in the treatment. This is an example of '**Concentrate and Contain**' strategy for radioactive waste management. Separation of cesium and strontium from ILW leads to LLW containing ruthenium-106 which has a

Trombay has recently mastered the technology of separating cesium from HLW and is preparing cesium radiation source for therapeutic applications including cancer.

half life of one year. It can be precipitated using ferrous hydroxide/cobalt sulfide precipitation process. Another interesting alternative option exists **which is unique to radioactive wastes**. It is '**Delay and Decay**' strategy for short lived radioisotopes like ruthenium. This option is, sometimes, cost-effective in comparison with others. The short-lived radioactive waste is stored for few years to allow the radioactivity content to reduce to dischargeable levels.

HLW contains several radionuclides, long and short lived, in nitric acid medium. Predominant beta/gamma emitters are cesium, strontium and ruthenium. The waste contains alpha-emitters also. Vitrification is used to chemically immobilize all the radioactive nuclides present in HLW in a vitreous, practically non-leachable borosilicate matrix. This is a highly sophisticated technology involving extensive use of remote handling of process equipments positioned in thick concrete cells called 'hot cells' for radiation protection. India is one of the few countries in the world to have mastered this technology through indigenous effort.

Presently, a paradigm shift is occurring in the treatment of HLW in our country and some countries with reprocessing facilities. Instead of adopting vitrification technology as a blanket approach to immobilize the numerous radionuclides of HLW in glass matrix, selective solvent extraction of valuable radionuclides, cesium, strontium, alpha emitters has, recently, been successfully demonstrated at engineering scale at BARC. This approach is called 'Partitioning'. In this approach, HLW is considered as a rich source of valuable radionuclides. Cesium, for example, is used in therapeutic applications and the demand for this source is global. BARC,

Partitioning will simplify disposal issues as well.



Potential of Nanocomposite Membranes in Water Purification

Soumitra Kar,

Bhabha Atomic Research Centre, Trombay, Mumbai-400085

E-mail: soubiswa@barc.gov.in

1. Potential of membrane as a separation device

Membranes are used in a wide spectrum of applications in Chemical Engineering and Technology. The key property that is utilized in membrane based separation technology is the ability to control the permeation rate of chemical species through the membrane; thus, allowing one component of a mixture to permeate the membrane preferentially, while hindering permeation of other components. Membrane separation process enjoys numerous industrial applications with the following advantages:

- Appreciable energy savings; environmentally benign; clean technology with operational ease; operational simplicity; high quality products; can be used stand alone or in combination with conventional separation processes; greater flexibility in designing the systems.

However, it offers following challenges:

- Concentration polarization; membrane fouling (especially biofouling); trade-off between flux and selectivity; low radiation resistance behaviour.

The majority of membranes used commercially are polymeric. The “heart” of a membrane process is the membrane itself. To fully exploit the growing opportunities in the field of liquid phase separation, strong interest exists in the identification of new membrane materials that can offer better

selectivity/productivity. For pure polymeric material, a general inherent trade-off exists between permeability and selectivity, with an “upper-bound”. Not only the inherent trade-off between flux and selectivity, but also the low (bio) fouling resistance properties associated with the polymeric membranes renders their applications limited. In view of this situation, a new approach is needed to provide an alternate and efficient membrane with separation properties well above the upper-bound limit between permeability and selectivity, having better biofouling and radiation resistance behaviour. The answer to all these issues comes from mixed matrix membranes. The mixed matrix membrane essentially calls for the adoption and usage of composite materials for achieving desirable separation. While considering the development of composite system, an unprecedented opportunity is being provided by nanostructured materials with the fact that the building blocks in this dimension makes it possible to design and create unique materials and devices with significant improvements in the physical/ chemical/ physico-chemical properties and flexibility.

Nanocomposites can be understood as a solid structure with nanometer-scale repeat distances between the different phases that constitute the structure. They may typically consist of inorganic matrix embedded in organic phase or vice versa. Though the idea of causing improvement and enhancing the properties of a material by fabricating multi-

phase composites is not recent, the application of nanocomposite system to membrane science and technology is relatively new and is under rapid evolution. The idea of utilizing the benefits of a nanocomposite as a membrane material is targeted to develop an ideal membrane with improved flux, reasonable selectivity and other desirable characteristics for case specific applications. Desalination and water purification of water is one of the key drivers under non-power applications of Department of Atomic Energy (DAE) program. Bhabha Atomic Research Centre (BARC) has been engaged in R&D on various aspects of desalination and water purification technologies starting from basic research work to development and deployment efforts. The research work carried out has mainly focused on technological innovations, quality, reliability and commercialization potential of the product/ technology for deployment over large scale. State-of-the-art reliable technologies have been developed to address the growing need of good quality water for industries and human consumption. BARC has developed a combo domestic water purification device based upon nanotechnology to serve the drinking water requirements of masses.

2. Nanocomposite ultra filtration membrane device for domestic drinking water purification with respect to arsenic, iron and microbial contaminations

BARC has developed a combo domestic water purifier device based on polymeric nanocomposite ultra filtration membrane in cylindrical configuration.

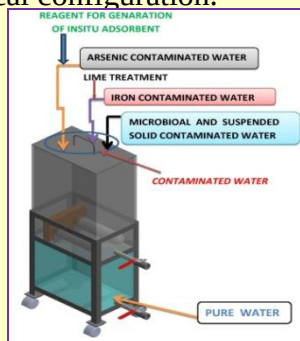


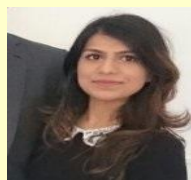
Fig.1: Methodology of Operation of Combo Membrane Device

This configuration/device can be effective for removal of microbial contaminations, arsenic and iron without the need of any electricity and overhead water tank. The methodology of operation of device and the product marketed by one of the licensees of BARC are shown in Fig.1 and Fig. 2 respectively. The device is most suitable for rural and slum areas. The salient features of the device are:

1. The heart of the purifier is nanomaterial impregnated polymeric ultra filtration membrane in candle configuration.
2. The device stand alone can remove suspended materials and microorganism.
3. The device can remove arsenic contamination by an in situ generated sorbent with simple addition of two pre-formed reagents and subsequent membrane filtration to provide product water with arsenic contamination < 10 ppb as per WHO standard.
4. The device can remove iron contamination by addition of slaked lime and subsequent membrane filtration to provide product water with iron contamination < 0.3 ppm as per WHO standard.
5. Electricity & tap water connection are not essential.
6. Extremely useful in rural & slum Areas.
7. The simple two compartment device can treat 25-30 Liters of contaminated water per day and cost about Rs. 2000-3000 /- per unit with membrane life of about 2-3 years.



Fig.2: Combo domestic water purification device marketed by licensee of BARC.



University Students Finding a Solution for Water Scarcity in World's Vulnerable Regions

Fatimah Khatoon and Philip Davies*,
Aston University, Birmingham, UK

*E-mail: p.a.davies@aston.ac.uk



Water Insecurity – an alarming issue

Water is a valuable resource that plays a vital role in global sustainable development, affecting a number of social, economic and environmental factors. Unfortunately, water insecurity is becoming an increasingly alarming issue with rising water scarcity and stress levels in a number of regions around the world. The urgent and effective management of water resources in a more sustainable manner is vital to combating this issue and this involves the safe treatment and fair distribution of water amongst all communities. Currently, approximately 41% of the world's population lives in regions experiencing high levels of water stress and up to 1.1 billion people lack access to safe drinking water. If this issue is not addressed effectively, it has been predicted that by 2025, half of the world's population will be living in water stressed conditions with up to 1.8 billion afflicted in regions of absolute water scarcity.

Water is primarily used for irrigation purposes (up to 70% of global water use) and also for industrial applications and domestic use. There are many factors that drive the rapid depletion of water resources and these include; climate change, rapid population growth leading to an increase in per capita water consumption in water-scarce areas and industrialisation. Those living in rural and arid conditions are typically affected more severely than others, as displayed by **Figure 1**, which shows the predicted water stress levels around the world by 2040.

The MENA (Middle East & North Africa) region and South Asia are the most

vulnerable to water scarcity and must take precedence when

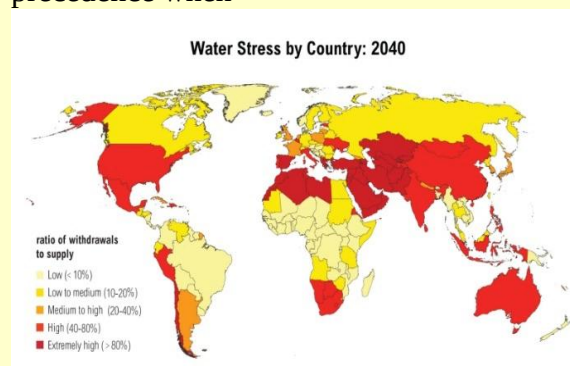


Figure 1- Predicted water stress levels by 2040

addressing the global issue. Over 100 million people in India live in areas that have poor water quality and it has been reported that a shocking 97% do not have access to a piped water distribution network. A rising demand for fresh water in India, which is predicted to grow by 22% over the next five years, has been mainly driven by huge industrial and economic growth along with a rapidly increasing population size. Water stress levels are highest in rural and arid regions away from the coast, such as Rajasthan which comprises most of the Thar Desert. This highlights a major concern when discussing water security in India, as 73% of rural villages across India primarily rely on brackish groundwater as their main source of drinking water. Up to a quarter of India's population lives in rural villages that have an unreliable and/or limited access to the electricity grid and areas that experience high solar irradiance have also been reported to correlate with areas that suffer the highest levels of water stress. This suggests the potential to design and implement a low-cost and renewable-powered desalination unit, as

a feasible method of treating groundwater to produce potable water.

Desalination Technology Overview

When discussing potential water treatment methods, it is important to consider the cost, water output, energy supply and consumption, and the size of the system. Desalination technology is primarily based on thermal distillation or pressure-driven membrane processes, such as Multi-Stage Flash (MSF) distillation and Reverse Osmosis (RO). When comparing membrane based plants to thermal based plants, membrane plants are 23% cheaper at treating water and this has led to approximately 85% of desalination plants in India being based on RO membrane technology [4].

Current developments in desalination technologies are now focused on reducing the energy consumption and cost of the system, whilst minimising any negative environmental impact and ensuring reliability. The deployment of conventional small-scale RO desalination plants in rural regions is extremely limited, due to the high capital cost investment and running costs of the system. However, to counteract this problem, the integration of a renewable energy source to power the system could lead to a more cost-effective and environmentally friendly solution, due to lower operating costs and providing a safe water supply that is off the grid. Modified design configurations of conventional desalination systems can also lead to improved efficiencies, enhanced recovery rates and thus provide a higher fresh water output.

Aston University's Solution

Students of Mechanical Engineering at Aston University in the United Kingdom have designed and made an innovative and highly efficient small-scale desalination plant that is powered by solar energy and fully automated. The PV-RO system operates on the basis of batch-RO and is designed to treat brackish water (of salinities up to 5000 ppm) with high recovery rates of

up to 80%, depending on the feed water salinity. It is successfully able to produce potable water with salinities below 500 ppm and has a rated water output of up to 1 m³/day (depending on the weather conditions and feed water quality). Batch production is considered the most energy-efficient RO process, as opposed to continuous production, as the cyclic operation recirculates pressurised concentrate, thus maintaining a high pressure throughout the system and utilising this to further drive the RO process and increase fresh water output. This ensures a high energy recovery for the system with minimal wastage, thus providing higher energy efficiency.

The system operates with a highly efficient double-acting pressure exchange vessel, which means the refill stage previously required in batch-RO processes is eliminated, as the system is constantly alternating between pressurisation and purging. This leads to a reduction in the overall specific energy consumption which was found to be less than 0.4 kWh/m³. The external design of the desalination unit was kept as simple as possible and standard off-the-shelf components were used along with commonly available materials, to allow ease of manufacture and feasibility of material acquisition for those that wish to manufacture the machine themselves. The system is fully automated, to ensure low labour costs would be incurred and minimal technical training and operator interference is required. **Figure 2** displays the detailed schematic for the described concept.

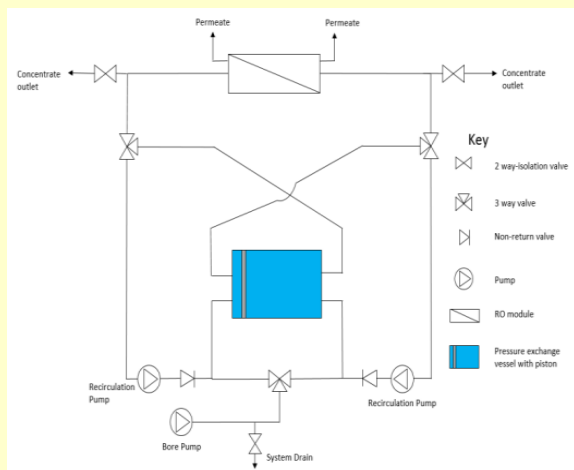


Fig 2: Design Schematic of a Desalination Unit
Building on the Success

To exploit the technology, it is planned to launch a company - DeSolarTech - to provide technical assistance in the implementation of desalination products in rural regions around the world and encourage customers to self-manufacture the desalination plant whenever possible, as this provides vital economic growth for rural areas.

DeSolarTech will work towards further developing its innovative technology and deploy initial prototypes in regions that require small-scale desalination units. The authors are interested in speaking to potential partners who may wish to join them in this endeavour.



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Recent Trends in water Management Research

Dr. V. Ramachandhran

Ex. Associate Director, SIES IEM &

Scientific Officer (Retd.),

Bhabha Atomic Research Centre, Mumbai

E-mail: raman25@yahoo.com

Water - An Important Issue

Half of humanity now lives in cities, and within two decades, nearly 60 per cent of the world's people will be urban dwellers. The exploding urban population growth creates unprecedented challenges, among which provision for water and sanitation have been the most pressing and regrettably lacking. The exploding urban population growth creates unprecedented challenges, among which provision for water and sanitation have been the most pressing and painfully felt when lacking. Energy and water are intricately connected. All sources of energy (including electricity) require water in their production processes: the extraction of raw materials, cooling in thermal processes, in cleaning processes, cultivation of crops for biofuels, and powering turbines. As water quality degrades or the quantity available has to meet rising demands over time, competition among water users intensifies. This is nowhere more destabilizing than in river basins that cross political boundaries. In a green economy there is emphasis on the pursuit of opportunities to invest in sectors that rely upon and use natural resources and ecosystem services. Investing in green sectors, including the water sector, more jobs and greater prosperity can be created. Arguably, these opportunities are strongest in areas where people still do not have access to clean water and adequate sanitation services.

Emerging Point of Use Devices

Water treatment systems employing composite nanoparticles are increasingly promoted as a low cost water treatment alternative. Specially designed filters are known to remove microbes, bacteria and other matter from water using composite nanoparticles, which emit silver ions that destroy contaminants.

Newer Areas of Research for Sea Water Desalination

One solution being explored in Singapore, which opened its first seawater desalination plant in 2005, is biomimicry - mimicking the biological processes by which mangrove plants and euryhaline fish (fish that can live in fresh briny or salt water) extract seawater using minimal energy. Another new approach is to use biomimetic membranes enhanced with aquaporin: proteins embedded in cell membranes that selectively shuttle water in and out of cells while blocking out salts.

Low Cost Alternatives for Conventional Water Treatment

Most water treatment facilities employ a variety of physical/chemical treatment processes and involve the addition of a variety of chemicals for an array of purposes, such as to oxidize iron and manganese, coagulate suspended solids, render the water less corrosive and disinfect the water. There are a number of "natural" low-tech treatment strategies that when used alone, or in conjunction with conventional strategies, can reduce chemical usage and sludge production, and lower operation and maintenance costs. Limestone is a naturally occurring rock that can be crushed and processed to produce a uniform granular material, which, when used in a properly designed limestone contactor, will allow the pH finished water to be in the range of 7.2 - 8.3. With a limestone contactor there is no chemical feed facilities to maintain and no concern for over feeding a chemical such as caustic soda. One natural way to pre-treat the water and improve the quality of the water entering the treatment plant is to employ bank filtration. Bank filtration involves installing a well near the surface water source to allow pulling water through the ground to effect some natural filtration.

This concept requires granular soils adjacent to or under the surface water source. Where these conditions exist, there can be significant benefits with employing bank filtration. Another low-tech way to filter surface water is with a slow sand filter. Slow sand filter not only physically filters the water, but also provides biological treatment from an organic mat which naturally forms on the filter surface. A slow sand filter can reduce microbial contaminants without the high cost of coagulation or pre-treatment chemicals. Iron and manganese have been major aesthetic concerns in many groundwater supplies for years. Use of "natural" bacteria to remove iron and manganese are one of the better alternatives. Bacteria can be grown on a filter media that will remove iron and manganese. The bacteria are aerobic and require dissolved oxygen and an appropriate pH range. The benefits of this type of removal include less chemicals and less sludge generated in the process.

Urban Sewage Management

Many people living in urban areas, even in advanced economies, still do not have their sewage adequately treated and wastewater is often discharged, untreated, into rivers and estuaries or used as irrigation water. New technologies are promising to transform wastewater into a resource for energy generation and a source of drinking water. Modular hybrid activated sludge digesters, for instance, are now removing nutrients to be used as fertilizers and are, in turn, driving down the energy required for treatment by up to half. Natural constructed wetlands are considered very effective to rehabilitate polluted rivers. It involves a series of

bypasses, or channels, that divert domestic and industrial waste water from the river to cleanse it naturally, and make it drinkable by the time it flows back into the river.

River Water Treatment

A river is a complex body of water. When most people think of rivers and streams, they think of water moving rapidly and flowing freely. However, what is not as well known is that beneath the surface of a river is a stagnate body of water. A graph of velocity vectors of river water is parabolic, with zero flow at the bottom and maximum flow at the surface. The surface water of a river is oxygenated by the atmosphere, while the bottom water area is usually near-zero mg/l dissolved oxygen. To aid in river improvement and restore water quality, a river restoration inversion system is necessary to bring river water from the bottom to the surface.

Water Management Issues

In developing countries alone, it is estimated that 45m cubic metres are lost every day in distribution networks. Leaks are not only costly for companies, but increase pressure on stretched water resources and raise the likelihood of pollutants infiltrating supplies. New monitoring technologies help to ensure the integrity of their vast water supply networks. Water recovery is another important area to augment industrial water needs which is increasingly explored in our country. Rain water harvesting is becoming an urgent need in our country where fast receding of ground water table is posing a real danger for coming days.

**All previous issues of 'The Environment Management' can be viewed at:
[http:// www.siesiiem.net](http://www.siesiiem.net)**



Water Management Technologies for India

Dr. Raj Rajaram,

CCJM Engineers Ltd., Chicago, Illinois, USA

Email: raj2468@comcast.net

Global warming and climate change are having disastrous results in India. Several states are facing severe drought in the hot season, and many farmers are committing suicides since they cannot grow crops and feed their families. In the monsoon season, severe floods affect many parts of India. The suffering, death and property damage resulting from these droughts and floods can be alleviated by using currently available water management technologies in all parts of India. This article analyzes the various ways the private sector can work with government agencies to manage water systems effectively, and provide adequate clean water to communities as well as serve the needs of the agricultural and industrial sectors. In particular, reduction of leakage in water and wastewater pipes, water efficiency, techniques to minimize water usage in agriculture and industry, and innovative technologies for decentralized wastewater treatment and reuse will be highlighted in the article.

Maintenance of Water Infrastructure

Our aging water infrastructure for delivering water and conveying wastewater to treatment plants is resulting in water losses due to leaking pipes. The amount of water wasted, and the money spent in fixing the leaking pipes can be avoided with a preventive maintenance system. With GIS technology, the water pipes in our cities and rural communities can be mapped and a preventive maintenance system developed to repair or replace the leaking pipes. Israel has developed such a system and their water losses have reduced to less than 5 percent compared to almost 50 percent in many cities in India.

Several leak detection technologies are available and these should be used along with regular inspection of pipes conveying

water and wastewater. The open nallahs conveying wastewater from communities should be inspected at a regular interval and repairs of the concrete lining made to prevent leakage of dilute sewage into our groundwater. There are several pipe lining technologies available which can be used to restore structural integrity of the pipes, eliminate leaking joints, and increase pipeline flow capacity. Trenchless technologies can be used for small diameter water distribution lines.

Water Conservation and Efficiency

If water is conserved and used efficiently, shortages of water during droughts can be managed without adverse impact on the community. The areas where waste use efficiency can be increased in homes and buildings include:

- Grey water recycling for use in toilets and gardens;
- Repair of leaks in taps and joints;
- Minimizing water use in toilets and showers;
- Using gardens that use native vegetation and need minimal water; and
- Minimizing water use in cooling towers and window washing.

Innovative water saving technologies using sensor activated valves are being used in public toilets and can be used in home settings also. Water saving products are available commercially for the kitchen and bathroom and should be used extensively to conserve water.

Water use in Agriculture and Industry

Agriculture and Industry use up to 80% of the water available in India. Efficient practices that minimize commingling of different waste streams in an industrial operation will permit more water recycling by industry. Regular water audits in manufacturing companies will lead to

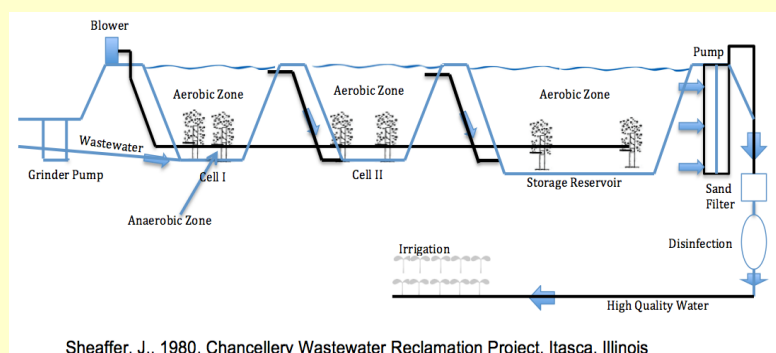
identifying the operations where water can be saved. Coca-Cola switched to washing their cans and bottles with air instead of using water and saved a lot of money. Water use in agriculture can be reduced significantly by using sensor activated drip irrigation systems which deliver water to the root system when needed. Israel has developed many such technologies and should be adopted in Indian agriculture.

Treated wastewater contains nutrients essential for plant growth. By recycling the treated wastewater from treatment plants for agricultural use, fertilizer use can be reduced and a lot of water can be conserved. This will prevent our farmers going deeper for groundwater and depleting our groundwater resources. An example of such innovative use is the city of Hammond, Indiana, USA, which has high nutrients (up to 20 mg/l of nitrates) in the treated wastewater. A system was designed to take this clean water containing high level of nitrates to farmers and other public lands in the vicinity of the treatment plant. Using this source of water, a whole economic system was developed to create jobs and improve the economy of the State. The system is shown in Figure 1 (Report to the US Environmental Protection Agency, Center for the Transformation of Waste Technology, 2011).

Decentralized Wastewater Treatment Systems

Managing wastewater through decentralized stabilization ponds in communities will allow treated water to be recycled for reuse. This will also reduce the cost of piping wastewater to centralized large wastewater treatment plants. A simplified layout for a decentralized treatment system is provided in Figure 2. It has been used effectively in a large commercialized development in Chicago. The system uses the Sheaffer Modular Reclamation and Reuse System, and has many benefits. A remarkable feature of this system is the minimal formation of sludge at the bottom of the stabilization pond. The reclaimed water can be used for irrigation, and with filtration and disinfection, for drinking water.

In summary, it is clear that water can be managed effectively, minimizing the cycle of droughts and floods that has been causing a lot of suffering and death in India. Water management should be an integrated system with the objective of 100% recycling of wastewater for reuse by consumers, industry and agriculture. Water leakage should be minimized and water conservation efforts widely adopted by consumers, industry and agriculture.



Report on the event on ‘World Environment Day’ on 5th June, 2016 at SIES, Nerul Campus

SIES-Indian Institute of Environment Management has celebrated World Environment Day on 5th June, 2016 at SIES, Nerul Campus in a grand way at SIES Nerul Campus. It has organized a seminar on ‘Environment Management for Sustainable Development’ on the occasion and alumni meet. Thirty three participants, including alumni of IIEEM were present during the seminar.

Chief Guest of the function was Mr. Mohan Dagaonkar, Chief Engineer, Navi Mumbai Municipal Corporation (NMMC). The celebration started with tree plantation by Chief Guest, Shri S.V.Viswanathan, Joint Honorary Secretary, SIES and a wide cross section of people from the campus. Nearly 120 trees (20 of Ashoka and 100 of Champa) were planted in and around the SIES campus at Nerul

Dr. Seema Mishra, Director, SIES-IIEEM welcomed the gathering and gave a presentation on the academic, research and training activities of IIEEM since its inception. Chief Guest, in his key note address, spoke about the commitment of NMMC for environment and the steps it has undertaken in the recent past. He released soft copy of the volume II, issue 2 of the IIEEM’s Environment Magazine on the occasion.

As a part of the seminar, lecture session started with the one by Shri Viswanathan. He talked about ‘Environment Management for Sustainable Development’.

Ms. Vaibhavi Shitut Amle, Head, WWF-India gave a lecture on role of CSR

Activities in Wildlife Conservation. She said there is a greater need for enhanced CSR support to address this menace.

Mr. Prathamesh Raichura, Director, Climate Change and Sustainable Services, of KPMG, Mumbai gave a presentation on ‘Current perspectives and future challenges in climate change and sustainability’. He said that unless the humanity takes urgent actions in this regard, the consequences will be beyond control.

Mr. Pramod Dabrase, Director, Centre for Sustainable Environment and Development Initiatives gave a lucid presentation on ‘Current issues and Challenges in Sustainability’. He said that, in principle, more than 99% of the municipal solid waste can be recycled for good use and emphasized its indispensability for safe management.

Mr. C.V.Gopalakrishnan, Purchase Director, SIES, talked on ‘Efforts in Energy Conservation at SIES, Nerul Campus’ including installation of 100kW solar power pilot plant. He said that there is substantial reduction in electricity charges because of the initiatives taken in energy conservation at the SIES campus, Nerul.

Dr. Devayani Savant, Deputy Director, SIES-IIEEM, has inaugurated the Alumni interaction session after the technical lectures. She gave the details of the various diploma courses and the student numbers conducted by IIEEM in the previous years.

Dr. Saumya Singh, Faculty, IIEEM, has proposed vote of thanks.



Plantation by Chief Guest Mr. Mohan Dagaonkar, Chief Engineer, NMMC



Plantation by Mr. S. V. Viswanathan, Joint Hon. Secretary, SIES



Plantation by Security Guards of SIES, Nerul



Plantation by a Senior Citizen from Seniors' Home, SIES, Nerul

WORLD ENVIRONMENT DAY EVENT AT SIES-IIEM: TREE PLANTATION AT SIES, NERUL CAMPUS

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

ABOUT SIES IEM

- SIES IEM 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.
- IEM 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.
- IEM 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 | • Capacity building |
| • Training and Awareness programme | • R&D proposals and report writing |
| • Water audit and energy audit | • Events – workshops, seminars and conferences |
| • Carbon footprint mapping | |

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



FIRST CIRCULAR
First International Conference on Environment Management and Sustainability
(ICEMS-2017)



ORGANISED BY
SIES Indian Institute of Environment Management



CONFERENCE DATE & VENUE
4th – 6th January, 2017
SOUTH INDIAN EDUCATIONAL COMPLEX, NERUL, NAVI MUMBAI 400 706

Chairman, Organizing Committee

Dr. Seema Mishra
Director, SIES IEM

Organizing Secretaries

Dr. Devayani Savant

Dr. C Srinivas

Dr. Saumya Singh

SIES Indian Institute of Environment Management
Sri Chandrasekarendra Saraswati Vidyapuram,
Plot 1E, Sector V, Nerul, Navi Mumbai - 400 706, India

Conference details are available in the website: [Website:http://siesiiem.net](http://siesiiem.net)

REPORT ON AWARENESS PROGRAMME ON PLASTICS IN THE ENVIRONMENT

An awareness programme on 'Plastics in the Environment' was jointly organised by Indian Centre for Plastics in Environment (ICPE), SIES-Indian Institute of Environment Management (IIEEM), and SIES-School of Packaging(SOP) on 9th June 2016 at the auditorium of SIES School of Packaging to spread awareness about plastic waste management. Around 45 participants were present in the awareness programme including scientist from MPCB, Faculty members from SIES, and students.

Session started with the screening of ICPE Film on "Listen Plastic has something to say". This was followed by a brief presentation on 'Benefits of Plastics, Issue and Solution' by Mr. T.K.Bandopadhyay, Technical Director, ICPE. Dr. C. Srinivas, Adjunct Faculty, IIEEM gave presentation on

"Plastics: Boon or Bane". He shared valuable information and facts about plastic use and effects of plastics on environment. Mr. T.K.Bandopadhyay conducted open discussion and interactive session with the participants and students. Prof. P.V.Narayanan was the moderator for this awareness programme. Students actively participated in the discussion. Few of the students who gave practical solutions for plastic waste management also got prizes. Dr. Seema Mishra, Director, IIEEM, Prof. P.V.Narayanan, Chairman and Director SOP and Mr. T.K.Bandopadhyay, Technical Director, ICPE felicitated the winners with saplings and gifts. The session ended by vote of thanks. The whole session for awareness programme was conducted by Dr. Saumya Singh, Adjunct Faculty, IIEEM.



Participants in the Programme



Prize Distribution to Students

Mumbai, Far Interiors to bear brunt of climate change

The Times of India, Mumbai, July 26, 2016

Maharashtra, including Mumbai, is set to get significantly warmer and wetter in the next few decades according to projections by The Energy and Resources Institute (TERI), which could have profound implications for crop growth, water resources and disease. In Mumbai, by 2030, distinct shifts in climate expected. Minimum Temperature to rise by 1-1.4°C. Extreme rainfall events to rise by 10-14%.

India lost 1.4m lives due to air pollution in 2013: Study

The Times of India, Mumbai, September 9, 2016

India lost 1.4 million lives to Air Pollution while in China, the toll was 1.6 million according to World Bank Report. The report released by World Bank and the Institute for Health Metrics and Evaluation (IHME) shows that in 2013, more than five million deaths worldwide were attributed to health conditions caused by air pollution. Exposure to air pollution increases a person's risk of contracting ailments such as lung cancer, stroke, heart disease and chronic bronchitis.

10-20% rise in ozone levels in India, harmful for lungs and crops: Report

The Times of India, Mumbai, September 9, 2016

While Indian cities are still grappling with the impacts of severe particulate matter pollution, a new report by World Bank and the Institute for Health Metrics and Evaluation (IHME) estimates that the concentrations of ozone has increased by 10 to 20% in India between 1990 and 2013. The trend is similar in neighboring countries and Brazil, while a declining course was seen in US, Indonesia among others. The increase is harmful for lungs and crops.

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Forthcoming Events

International Conference on Environment Management and Sustainability (ICEMS-2017) in January 2017. Details are in [Website:http://siesiiem.net](http://siesiiem.net)

Articles, photos etc. are invited for next issue (October-December, 2016) of the Newsletter on the theme 'Environment Management and Sustainability'