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Current Issue: Environmentally Sound Technologies

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From Director's Desk

We are happy to release current issue of our instiutute's newsletter on the theme 'Environmentally Sound Technologies (EST)'. The topic is important in current scenario especially when environmental pollution, climate change and natural calamities are posing threat to the survival of human being. The rapid increase in the complexity of water, air and soil pollution advocates for the identification and application of technologies that require less inputs, generates less pollutant and can be managed in sustainable manner. Environmentally Sound Technologies or clean technologies that protect the environment are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they were substitutes and are compatible with nationally determined socio-economic, cultural and environmental priorities.

The significance of EST was emphasized during Earth Summit in 1992 and was included in Chapter 34 of Agenda 21. In Sustainable development Goals (SDGs) it can contribute to goal 7 on energy, goal 8 on economic growth, goal 12 on sustainable consumption and production, and goal 13 climate action. The Environmentally Sound Technologies provide win - win situation for developing a business model by promoting economic development, industrialization, job creation and innovation.

At SIES IIEM was have significantly developed technologies in the areas of waste management and pollution control and sustainable agriculture by promoting innovation, field application and awareness generation. The current issue of the newsletter will help in developing a platform for knowledge sharing and linkages in Sustainable Environment Management.

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Environmentally Sound Technologies in Building Sustainable Future

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Environmental degradation due to pollution is a major roadblock in achieving the sustainable future. The United Nations Sustainable Development Goals (SDGs) have major focus on reducing environmental pollution. Specifically SDG 3.0 emphasizes to significantly reduce the deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination by 2030. Other SDGs are also related to environmental pollution and its impact on health, loss of biodiversity and natural hazards. For the management of Environmental issues in sustainable manner, a right combination of appropriate technologies, goods, services, instruments, organizational and managerial procedure are required. Furthermore, the requirements for sustainable environment management vary from place to place and conditions. In this regard Environmentally Sound Technologies (ESTs) play significant role in improving the environmental performance.

Development of Concept of EnvironmentallySound Technologies

EST are techniques and technologies capable of reducing environmental damage through processes and materials that potentially develops less damaging substances, recover harmful pollutants before discharge as well as reuse of waste material generated in some other processes or system. These technologies are accountable for their socio- economic and environmental impact. EST provides an integrated system to industries, small and medium enterprises for continuous improvement of their process and operations for smooth transition towards sustainable enterprise. The importance of EST was first emphasized in Earth Summit, 1992 and ever since it has become a major component in policy making and national and international cooperation for sustainable environment management. UN Environment Programme (UNEP) is promoting EST in line with international agreements. A strong science - policy interface is established by UNEP for multi stakeholder partnerships between Government agencies, NGO's, researchers, academicians and private sector.

Environmentally Sound Technologies in Current Sceario

Application of technological innovations in systematic manner improves the efficiency and performance of systems by reducing environmental footprints. Further, implemented technology should be as per the demand of society and improve the economic viability of the system. Some significant area wise ESTs in sustainable environment management are listed as below:

i **In Alternative Energy Production**

There are significant environmental, economic and social impacts associated from energy production and consumption. Renewable or alternate sources of energy offers huge amount of sustainable energy in perpetuity. Most renewable energy systems operate at small or medium scale. However, innovations, economic reforms and removal of institutional constraints have resulted in its enhanced installation capacity and utilization. Currently, implementation of solar and wind energy is increasing in different parts of the world. The development of third generation photovoltaic cells with alternative PV material has improved its environmental, economic and social footprint. Some of the areas that require technological interventions are as below:

a. Maximization in potential of PV cells to enhance efficiency and reduce cost.
b. Gas separation technologies for efficient gaseous fuels generated from waste to energy tec hnology
c. Improved heat resistant material for solar power plants.
d. Improved battery technology for electric vehicles
e. Better fuel cell technology for fuel cell powered vehicles

ii. **In Sustainable Agriculture**

Technological interventions were major driving force in improving agricultural productivity and sustenance of a nation. In the past, the choice of technology and their adoption was for improving production, productivity and farm income. Over many decades, policies for agriculture, trade, research and development and education have strong influence on the choice of technology, the level of agricultural production and farm income. The technologies for sustainable agriculture covers whole spectrum of farming systems – intensive conventional farming to organic farming that suits local conditions with socio- economic viability for regional and national level. The reach of technology at field level depends on the adoption of farmers and the policy framework promoted in the area. To maintain the acceptable level of soil fertility and crop production over a time, organic fertilizers and biofertilizers play very important role. The institute has successfully promoted and developed technologies for the improvement of soil fertility and crop production by utilizing organic and biofertilizers specifically N fixers, P solubilizers and AM fungi. With apparent effects of climate change, the technological advancements, policy and regulatory provisions are important to support farmers. The approach for the application of ESTs in sustainable agriculture is as below:

a. Soil health assessment
b. Promotion of low input agriculture
c. Application of chemical fertilizers as per the limit
d. Promotion of native microbial biofertilizers
e. Utilization of agro residues in some other sustainable process
f. Improvement in the packaging of agro products
g. Policy for farmers for adoption of new technology, support during crop failure
h. Felicitation of farmers for best performance

iii. **In Environmental Purification, Protection and Remediation**

The complexity of environmental pollution is increasing with the urbanization, industrialization and liberalization of economy. The technologies play very important role in sustainable management of environmental pollution, decontamination of polluted sites and eco restoration for economic and social development. The ESTs have supported the waste management and treatment of contaminated sites effectively. Some of the urgent technology requirement is presented below:

Some Technologies required in Environmental Pollution Management

- Collection of biogas generated from Upflow Anaerobic Sludge Blanket (UASB reactor) or sludge digester
- Advanced sustainable nutrient removal process from waste water treatment plants by reducing cost, chemicals and energy consumption.
- Optimization of anaerobic wastewater treatment process for colder climates
- Emergencypreparedness of wastewater treatment plants to deal wi th pandemics, new strains of pathogenic microorganisms etc.
- Use of sludge from WWTP for generating fuels
- To develop waste water treatment model with economic returns
- Gas to liquid fuel technology for curbing air pollution management.

- Hydrogen fuel additives for reduction in emissions
- Application of photo catalytic instruments for control of environmental emissions
- Smog free tower for conversion of smog to clean air
- Standardization of heavy metals and persistent organic pollutants in soil

iv. **Other Applications**

The ESTs have applications in manifold areas to improve the performance of the system and waste management. A few technology interventions required in waste management, smart city etc. are listed below:

- Smart grid- smart lightening for improving efficiency of electricity supply with reduced cost and wastage.
- Smart mobility by promoting hybrid and electric vehicles, smart parking and provision of car pool.
- Technologies for the climate change resilience of cities

Sustainable Implementation of Environmentally Sound Technologies:

Challenges and Future Opportunities The importance of technologies in the management of environmental problems was recognized in 1990s during UNCED. Technological innovations were considered as a threat for environment, now offers new opportunities for reducing environmental degradation and supporting sustainable development. After almost two decades it is observed that still there is a scope for technology identification and application. The major challenges and future opportunities in the application of ESTs are listed below:

Major Challenges

- High cost of buying newer efficient technologies and implementation
- Low top management commitment on the implementation of ESTs
- Limited technical and human resource for ESTs
- Absence of environmental laws with application of ESTs mandate
- Ineffective enforcement due to lack of organizational structure, funds and process for monitoring
- Low public pressure
- Low customer demand

Future Opportunities

- EST based trade development
- Investment model in clean technologies
- Provision of Carbon Credit for eco friendly technologies
- Linkages of laws, enforcement etc. for better implementation of ESTs

The ESTs have very strong role in the total management of environmental pollution, natural hazards and resource conservation aspects. It is desirable to identify ESTs area and application wise periodically for their better impregnation for the management of sustainable environment.

Role of Reverse Osmosis in Implementing the Concept of Zero LIquid Discharge

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Zero liquid discharge (ZLD), today, is not only becoming a buzz word but also an earnest necessity to keep the pollution in control by way of preserving the existing natural aquifer/water bodies from getting polluted out of the man-created industrial effluents. ZLD, generally by definition, is referred to as the installation of facilities and systems which will enable industrial effluents for absolute recycling of permeate (RO) and converting solute (dissolved organic or inorganic compounds/salts) into residue in solid form by adopting method of concentration and thermal evaporation such as MEE. It is being certified and recognized based on two broad parameters such as water consumption vs. waste water reuse or recycle and corresponding solids recovered(% TDS and suspended solids in the effluent).

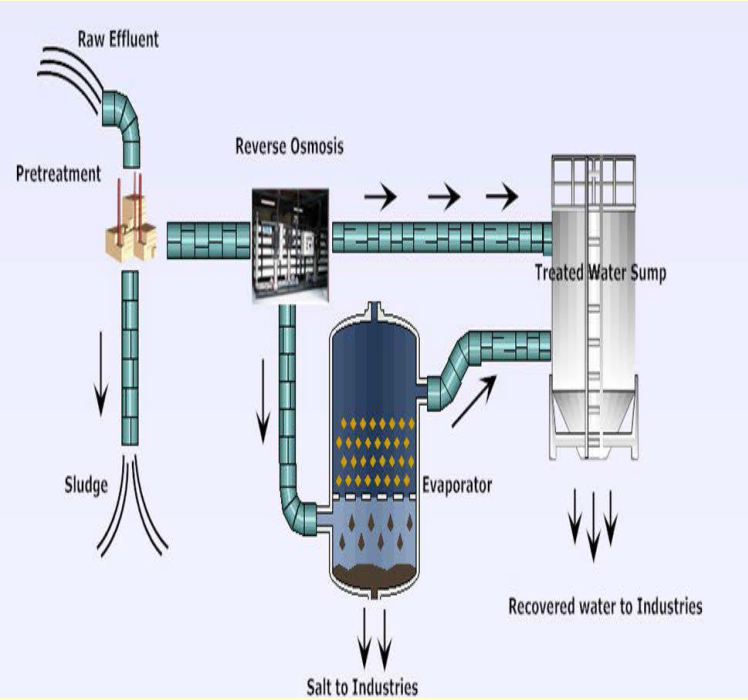


Fig 1: Basic Concept of Zero Liquid Discharge (Ref. 1)

Central Pollution Control Board (CPCB) has been working on this issue since long and prepared guidelines for disposal of industrial effluents for the land based and the coastal located (sea/river) processing plants. For small and medium scale processing units, it was uneconomical and difficult to have their individual sewage/effluent treatment plants.

Thus, the concept of Common Effluent Treatment Plant (CETP) was evolved to look into this problem by locating it in the industrial belts. At the same time, big corporate industries belonging to textiles, pulp and paper, tanneries, distilleries, refineries, fertilisesers, petrochemicals, dye and paints, sugar, food and pharmaceutical etc. were compelled to have their own ETPs and follow the guidelines of ZLD or treat their effluents before discharge.

Such effluent treatment, whether domestic or industrial sewage, have followed the primary and secondary treatment using mechanical, biological and chemical methods for treatment but with an aim to treat and discharge it in nearby natural water bodies, caring for environmental issues only and not looking for the recycle or reuse of these effluents. The invention of Reverse Osmosis (RO) and many more such modern technologies have helped in developing the process flow sheet towards ZLD. The suggested technological options for achieving ZLD may include:

- Bio-methanation followed by RO/ Multi Effect Evaporation (MEE) followed by incineration (slop fired)
- Bio-methanation followed by RO/MEE followed by drying (spray/rotary)
- Concentration through MEE followed by compressing in cement /thermal power plants
- Bio-methanation and RO followed by MEE followed by bio-composting

Municipal sludge hygienation using radiation technologies is also being viewed for sludge treatment of large scale municipal corporation sewages.

In this respect, it is worth referring to the efforts of CPCB and their State regulatory boards for preparing the guidelines on techno-economic feasibility of implementation of ZLD for water polluting industries under the Ministry of Environment, Forests and Climate Change issued during January, 2015.

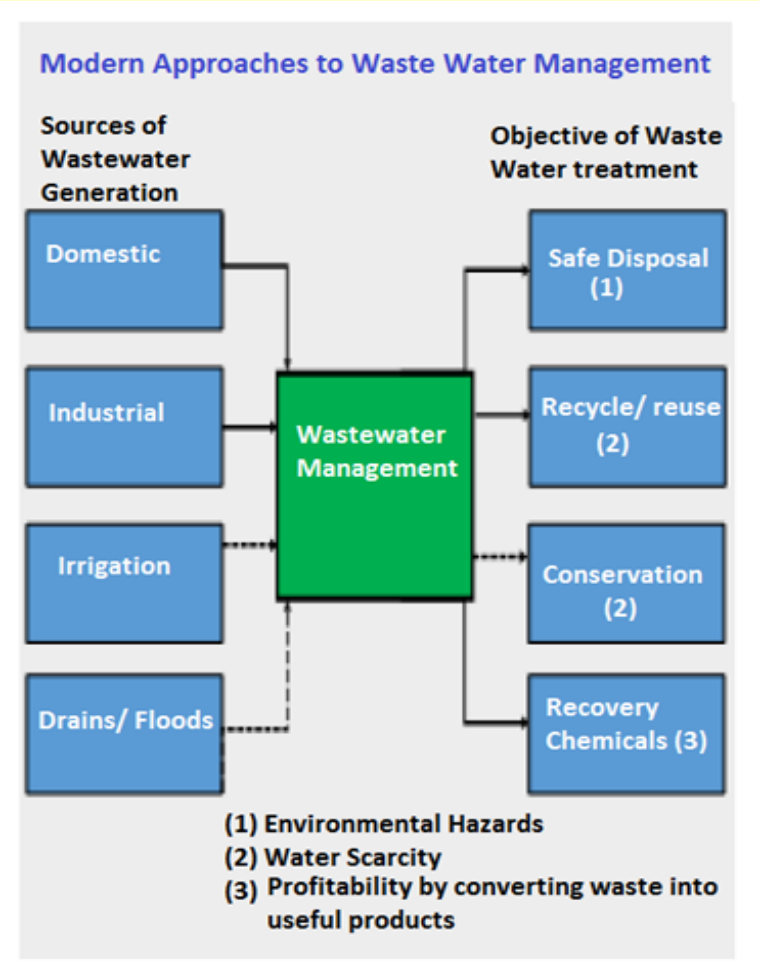


Fig 2: Modern Approach Towards Waste Water Treatment

As is evident from various technological options, RO is not only a common process in all but also plays an important role as tertiary treatment for recovery of water for its reuse. Lot of literature is available on this subject for the design, fabrication, installation, O&M of such plants. The basic objective of RO in ZLD implementation is volume reduction by optimizing the recovery of RO system design and also salt rejection characteristics, giving dual advantage by concentrating major salts in the reject stream and making the permeate useful for any process and application in industry. Recovery of 50%, 90%,,95%,98% and 99% gives a volume reduction factor of 2,10,20,50 and 100 respectively and helps in treating much smaller volume for the chemical precipitation and the recovery of valuables from reject stream of RO. For high salt rejecting membranes (99-99.6%), the concentration factor are also same fold and thus high salt rejecting membranes and highest possible recoveries in the RO system design is most desirable. Often the term Recovery and the Flux are confusing. Recovery is a rate in per cent of permeate to feed rate whereas the flux is the rate of permeation of water per unit area of membrane and are generally given by units such as litres per square meter per day (LMD) or gallons per square foot per day(GFD). The flux depends on pressure, temperature, flow and feed concentration of the effluent and intrinsic parameters such as membrane materials and membrane morphology. Membrane science has grown leaps and bounds in the last four decades and so also RO (membrane technologies). The improved system design has given lot of importance for ZLD implementation in industries along with many other unit operations such as clarification, filtration, MEE ,membrane bio-reactors etc. The choice of membrane materials, modules and various other considerations (Tables 1&2) are very important considerations.

Reference

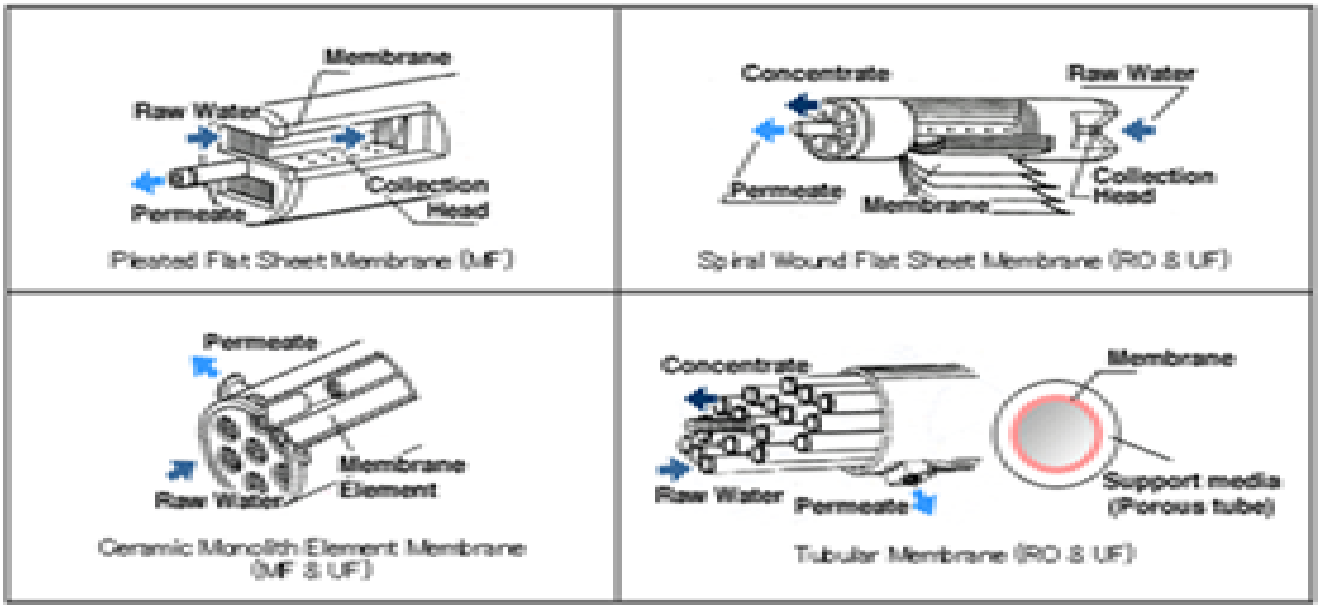
1. Zero Liquid Discharge (ZLD) - India Environment Portal, CPCB, 2015

TABLE 1: MEMBRANE MATERIALS USED IN PRESSURE DRIVEN PROCESSES

PROCESS	MATERIAL
MICRO FILTRATION	Regenerated Cellulose, CA, PS, PC, PP, PTFE,PVDF, PA, PVC
ULTRA FILTRATION	Regenerated Cellulose, CA, PA, PAH, PAN, PS, PVDF
NANO FILTRATION	Modified PA, PAN, Sulfonated PAH, CA/CTA Blend, PVA Derivatives
REVERSE OSMOSIS	CA/CTA Blend, PA, PI, PAH, PU/PA Composite

TABLE-2

Types of Membrane Modules



Electrolytic Salt Splitting using Bipolar Membrane Electrodialysis

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Saline waters, if discharged from process industries cause serious environmental damage in addition to causing precious loss of resources. Effluents laden with high amounts of salt are generated from chemical industries and disposal options of such high brine streams to the environment are limited. Environmental regulations are putting more stringent limitations on the amount of solid and liquid waste that may be discharged. Various options have emerged in recent times for optimal utilization of these streams, such as water recovery by membrane based dewatering, power production by forward osmosis and generation of acids and alkali by salt splitting etc. Salt splitting of such streams into its corresponding acid and alkali using membrane technology is an interesting alternative from the point of view of resource recovery, cost reduction and pollution abatement. Recycling salt solutions as acids and bases not only avoids a waste disposal problem, but also provides credit in lieu of the raw material that would otherwise need to be puchased.Salt splitting is a relatively new technology dependent on the availability of modern membranes. Its development has usually been driven by one of two major factors, both environmentally based. The first is the desire to produce caustic soda without the co-production of chlorine, and the second is the increased cost of disposing of heavily laden salt solutions. Caustic soda is produced in the USA at a rate of 14 million tons per year, almost entirely by the electrolysis of brine. In this process chlorine is produced at the anode and caustic soda at the cathode in stoichiometric quantities. There is a growing awareness of the need for new processes for the manufacture of high purity sodium hydroxide that do not lead to co-production of chlorine. This requirement exists because the chlorine and sodium hydroxide markets are rarely in balance. Despite the high demand for chlorine in the last two years, it is still expected that environmental pressures on chlorine will lead to an increased demand for caustic over the coming decade. Predictions are for a long-term trend in which the demand for sodium hydroxide will outstrip that for chlorine. Several present markets for chlorine are expected to experience significant downturns due to environmental pressures or concerns about health hazards . Sodium sulfate can be effectively split electrochemically into sulfuric acid and sodium hydroxide in a three compartment cell comprising of one set of anion selective membrane and cation selective membrane. Sodium sulfate is passed through the central compartment; under the influence of the potential field, the sulfate is transported through the anion permeable membrane into the anolyte and sodium ions pass through the cation permeable membrane into the catholyte. The anode and cathode reactions generate proton and hydroxide respectively and hence the sulfuric acid and caustic soda accumulate in the anolyte and catholyte. As the acid concentration builds up in the anolyte

compartment proton starts migrating through the anion exchange membrane towards the cathode which lowers the pH of the middle compartment and also results in lowering the alkali concentration in the catholyte compartment. This is a serious limitation in the conventional electrodialysis setup. Several strategies have been used to mediate the effects of proton back migration. One approach is modification in anolyte compartment to instantaneously neutralize the acid generated togenerate salt which may have commercial value. A classic example is salt splitting of sodium sulphate generates sulphuric acid in anolyte compartment which could be simultaneously neutralized by passing ammonia to produce ammonim sulfate. This prevents the central compartment from becoming acidic and, therefore, improves the current efficiency for caustic production. The anode product in this process, ammonium sulfate, is used extensively as a fertilizer. An alternative method for salt splitting utilizes bipolar membranes . These membranes allow for the formation of hydroxide and protons from the splitting of water without the coproduction of hydrogen and oxygen.

The basic aspect of electrodialysis with bipolar membranes (EDBM) is the combination of electrodialysis for salt separation with electrodialysis water splitting for the conversion of a salt into its corresponding acid and base. The bipolar membranes enhance the splitting of water into protons and hydroxide ions. Bipolar membranes are a special type of layered ion exchange (IX) membrane where the two polymer layers one is only permeable for the anions and the other only for cations. Unlike membrane processes EBM isn't applied for separation purposes but to get a reaction in the bipolar junction of the membrane where the anion and the cation permeable layers are in direct contact. Water splits into hydroxide ions and protons. The produced hydroxide ion and proton are separated by migration in the respective membrane layer out of the membrane. Unlike a water splitting at electrodes during electrolysis, no gases are formed as a side product to this reaction, nor are gases used. Electrodialysis with bipolar membranes (EDBM) can replace electrolysis with water splitting at the electrodes and can also have a wider variety ofapplications. Obviously, electrochemical salt splitting has much wider applications and may be appropriate to virtually any salt providing the economics are favorable. Salts, MX, could include those for example where M is Li+, Na+, K+, ammonium, quaternary ammonium; and where X is halide, nitrate, phosphate, borate, formate, acetate,etc.

An example of salt splitting is the recovery of lactic acid from sodium lactate. The latter is produced from starch in a fermentation process and the lactic acid is traditionally isolated through several liquid extraction steps, an esterification process and an ion exchange process. All of these steps are replaced in the electrochemical process by use of a salt splitting cell incorporating bipolarmembranes.

Salt splitting processes have been around for several decades. During that time considerable advances have been made in bringing the power requirements down to a viable level. Commercial viability of electrolytic salt splitting depends on commercial value of the products generated and environmental credit for waste minimization.

Advanced Oxidation Processes

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Waste water treatment in an environmentally sound and cost-effective manner can be said to be one of the most pressing challenges in the present century. Activated sludge process (ASP) has proved to be very efficient and time-tested for sewage water treatment. In this process, the organic matter in sewage water is oxidised by bacteria in the presence of air to CO_2 and water. Inorganic pollutants in the sewage water are removed by chemical and physical processes like precipitation, coagulation, adsorption and filtration. Success of ASP with industrial waste water is not as much. It is due to the fact that not all organic compounds in the industrial waste water are easily bio-degradable under the conditions prevailing in the ASP. Many of these are highly toxic and their discharge limits are very low(few ppb). Phenols and their derivates, pesticides, BTX are some examples. These pollutants are, usually, present in low concentrations (ppm levels). With the widespread synthesis and use of many such compounds in the industries, industrial waste water treatment has become a challenging issue. Advanced oxidation process(AOP) has been developed to address the issue of oxidative degradation of non-biodegradable toxic organic compounds in waste water in environmentally sound manner. By definition, AOP is a process mediated by strongly oxidizing hydroxyl radicals(OH). These radicals have standard oxidation potential of nearly two volts with reference to standard hydrogen electrode(for comparison, chlorine standard oxidation potential is 1.36V). These radicals react very fast with organic pollutants at diffusion controlled rates. Rate constant is typcially10^8 -10^{10} $M^{-1}L^{-1}$ at room temperature. This is an important advantage because, as mentioned before, the concentration of organic pollutants is, usually, in the milli to micro molar range. Another characteristic of these radicals is that they react almost with equal rapidity with wide variety of organic compounds non-selectively leading to their total oxidation to CO_2 and water(mineralization). Since the reactions are diffusion-controlled with negligible activation energy requirement, AOP occurs at ambient temperature and pressure. Hydroxyl radicals are highly unstable with life times of the order of microseconds. They should be generated in-situ in the waste water. They can be produced by environmentally sound methods such as the following:

• Fenton reaction between ferrous iron and hydrogen peroxide
• ultraviolet(uv) photolysis of hydrogen peroxide at 253.7 nm
• Fenton reaction in the presence of uv/visible light
• ozone/uv light
• ozone at alkaline pH
• ozone/ hydrogen peroxide reaction
• photo-catalytic methods employing semi-conductor materials like titanium dioxide in the presence of uv light
• Electrochemical anodic oxidation at boron-doped diamond anode(under development)

As can be seen from available AOPs, OH radical generation involves the use of green oxidants such as ozone or hydrogen peroxide as the reduction products from their usage are oxygen and water. Selection of an AOP among the listed options depends on several factors: pH of the waste water, nature of organic compound(aromatic or aliphatic) and their concentration. For example, if the pH of the waste water is acidic, Fenton or photo-Fenton reaction may be the right choice. If the waste water is alkaline, ozone/peroxide or ozone/uv can be considered. If the waste water contains carboxylic acids, photo-Fenton reaction could be used. If aromatic pollutants are present, ozone/uv or ozone/peroxide are preferred, the reason being that ozone breaks mainly aromatic rings faster. In the photo-catalytic AOP employing semi-conductors like TiO_2, OH radicals are produced from water or hydroxide in the medium. Air serves as secondary oxidant in this system. That is the main advantage. However, the quantum yield of the photo-catalytic heterogeneous reaction is low(3%) as of now. AOP is mainly used to address the treatment of non-biodegradable toxic organic-bearing waste waters. Many times, AOP is used to render the non-biodegradable organic compound bio-degradable. Therefore, a combination of AOP-Biodegradation process is the ideal choice in many circumstances. It should also be noted that AOP is almost exclusively used for treatment of low,viz., ppm levels of organics present in waste water. This is because AOP is relatively expensive process and should be used as a polishing step.

The author has developed photo-Fenton process for treatment of high energy explosive-bearing waste waters arising from defense facilities and ozone/peroxide process for treatment of problematic organic radioactive waste water. The processes were adopted at engineering scale. In conclusion, AOP is evolving as an environmentally sound option for treatment of troublesome waste waters arising from industries such as pharma, refinery, defense/nuclear facilities etc.

Workshop on Beneficial Effects of Nuclear Radiation and Nuclear Energy Programme

On 14th September 2019, Indian Women Scientists Association in collaboration with Indian Association for Radiation Protection [IARP] organised a one day Workshop on the Beneficial Effects of Nuclear Radiation and Nuclear Energy at ICICI Multipurpose Hall of IWSA, Vashi, Navi Mumbai. The programme started with Inauguration of the IARP Workshop. The President welcomed everyone and addressed the gathering. Dr. S. Murali gave a brief overview about Nuclear energy and the misconceptions that people had about the nuclear reactors. First lecture was conducted by Smt. Rupali Karpe, BARC. She made the participants familiar with radiation quantities, its units, and the effects. She categorised radiations as Ionizing Radiations and Non-Ionizing Radiations. Ionizing Radiations are α (alpha), β (beta), γ (gamma) and X rays. Their penetration capacity, effects and uses were also discussed.In the next lecture, Dr. S Anil Kumar explained the principle of radiation detection. The types of detectors which can be used to detect the radiations such as Craseous, Scintillator and semiconductor detectors were also described.

The third session was on the Applications of Radiation Technology which was conducted by Dr. Pramila Sawant. She explained the different applications of radiations in industries, agriculture, medicine, food preservation, consumer goods, etc. Further, Dr. S. Murali conducted a lecture about the Nuclear Energy Programme in which he talked about the energy production aspect of nuclear energy and the reactors which are operational in India. After a short lunch break, a practical / demonstration session was held. We were explained how the gamma rays are detected and measured in gamma spectroscopy. They also explained about the personal safety equipments (PPEs) which are used while detecting the ionising radiations.The last session was a special lecture by Dr. K.P. Mathe, BARC. He made us familiar with the job opportunities in the radiation field. This workshop was of great help for us to understand the value of nuclear projects for the increasing energy demand.

Report on ISRO Exhibition

On September 18th, students of M.Sc. SDEM visited an exhibition organized jointly by SIES and ISRO in SIES High School,Matunga. The exhibition was divided into two parts. In the first part, models of rockets were placed and high school students enthusiastically explained various parts of rockets such as the communication system, solar panels, remote sensing, etc. In the second part, the visitors were shown a documentary which explained how research on space began, how experiments were conducted in the past and gave information about the Chandrayan 2 mission and the Vikram lander.

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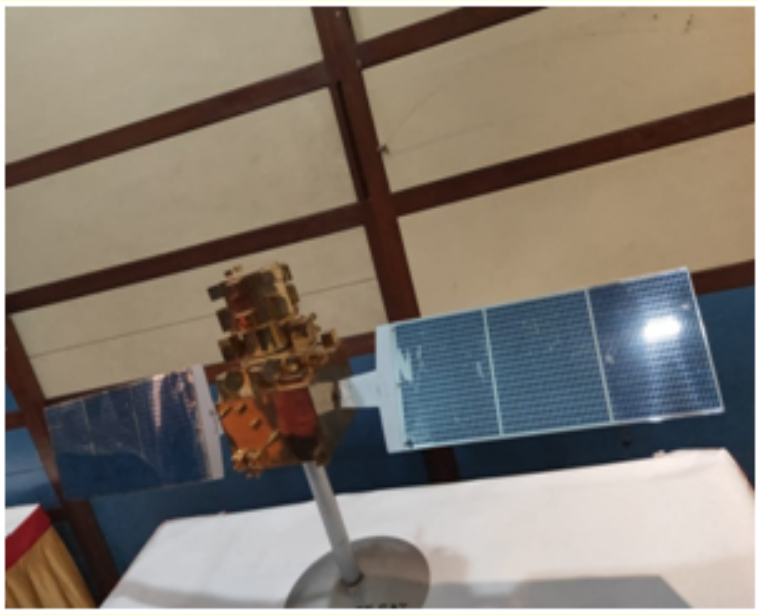

Solar Panel used in a Satellite

Environmentally Sound Management of Waste Cooking Oil

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Cooking or frying of food involves heating of oil which changes the physicochemical, nutritional and sensory properties of oil. It also increases the amount of total polar compounds in oil. This increase is associated with several diseases such as hypertension, atherosclerosis, Alzheimer's disease, liver diseases, high levels of bad cholesterol, etc. Therefore, oil with more than 25% Total Polar Compounds is considered as unfit for consumption. Besides adverse impact on human health, it also has a negative impact on environment. Discharge of used cooking oil (UCO) into sewage leads to choking of lines and malfunctioning of sewage treatment plants. Further, it can percolate and create groundwater contamination, damage to surface of ground soil, killing plant, marine life and oil floating over sea line can cause spoiling of the beautiful beaches.

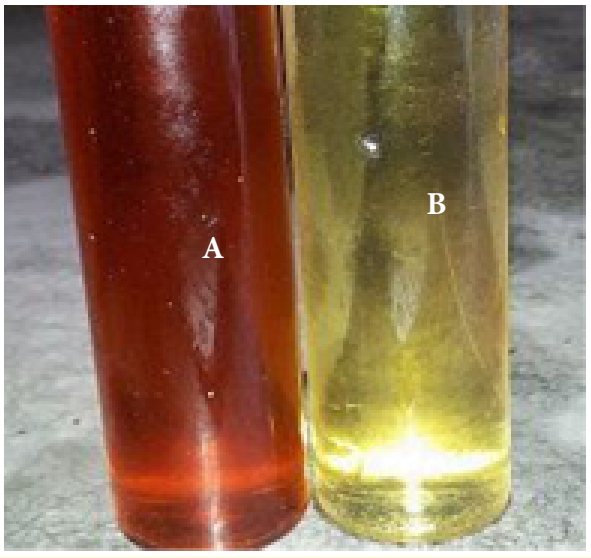

Fig. 2: Waste Cooking Oil (A) and Biodiesel (B) (Ref. Abdulla et al., 2013)

Used cooking oil is a valuable resource rather than a waste product. It can be very easily converted into a useful product "biodiesel". The term 'Biodiesel' refers to vegetable oil-edible or non-edible or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, ethyl, or propyl) esters. Biodiesel is made through a chemical process called trans-esterification whereby the fat or vegetable oil is chemically reacted with alcohol in presence of a catalyst to generate two products -- methyl esters (the chemical name for biodiesel) and glycerin (a valuable by- product usually sold to be used in soaps and other products).

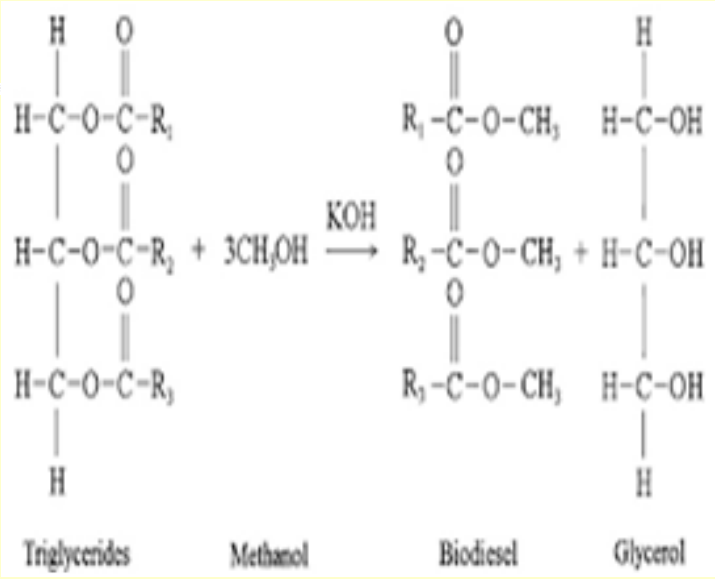

Fig. 1: The reaction in conversion of used cooking oil to biodiesel

The process has 80 % conversion efficiency. The biodiesel, so produced, is a clean fuel which can be directly blended with diesel.

It is better than conventional diesel fuel as it has higher Cetane number and improved lubricity. After combustion, it provides significant reduction in particulates, total unburnt hydrocarbons, aromatic hydrocarbons, carbon dioxide and carbon monoxide than conventional diesel fuel. Its use does not require any modification in engine design or no change in refueling infrastructures and spare part inventories and maintains the payload capacity and range of conventional diesel engines. Moreover, it is non-toxic based on Ames mutagenicity tests, and reduces the risk of cancer. Thus, conversion of used cooking oil to biodiesel is an environmentally sound technology. It has also proved to be a successful business model in many countries. Biofuel policy of India, 2018 strongly promotes conversion of used cooking oil to biodiesel. About 4 million tones of used cooking oil is expected to be annually converted to biodiesel and a 5% biodiesel blend will save foreign exchange of 10 billion dollars annually. Presently, around 200 units have beeen established in the country to produce biodiesel from used cooking oil. The industry is also expected to provide half a million direct jobs and one million jobs to ancillaries. If managed in a proper way, biodiesel production from used cooking oil can become a sustainable solution to the problem of disposal of used cooking oil.

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3.Abdulla et al., (2013). Biodiesel production based on waste cooking oil (WCO). Int. J. Mat. Sci. Engg. Vol. 1(2), pp. 94-99.

Report on World Environment Day 2019

The World Environment Day, 2019 was organized on 6th June, 2019 on the theme 'Beat Air Pollution' with students and senior citizens of My Retired Foundation. Dr. A. K. Sengupta from My Retired Foundation has welcomed all the participants. Dr. Seema Mishra informed about the significance of event in current scenario. Dr. Devayani Savant has presented a lecture on the topic, 'Causes of air pollution and technologies for control'. A lecture on the topic, 'How to management outdoor and indoor air pollution' was given by Dr. Seema Mishra. A movie on air pollution was screened on air pollution. Ms. Nikita Ubbu has presented Vote of Thanks. After workshop plantation drive on indoor plants was organized for the participants.

Ballast Water Treatment System : BWTS Electro-Chlorination Systems

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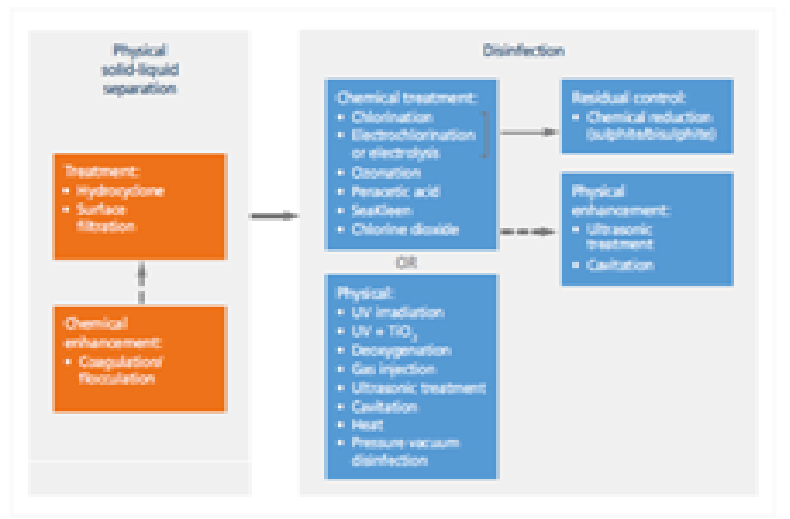
Shipping, the life line of the world economy, not only transports the goods, but also a few unwanted organisms in the ballast water. The Ships, after their discharge of cargo, need to take in sea/port water, to maintain their stability and ensure propeller immersion. The danger is when this water is discharged in a foreign port, introducing alien species in the environment. These Alien species sometimes become invasive, upsetting the local ecological balance. The major types of plants used onboard adopt Filtration (50 Microns) and the UV technology or the Electo-chlorination/ Chlorination. Challenges associated will be the other environmental impacts like excess chlorine discharge or other chemicals. Fresh water or Brackish / Muddy water operations challenges are still to be overcome by a large number of plant manufacturers.Filters reduce the organism size there by reducing the disinfection load. While it is required to achieve the Plant discharge standard, the technology to be adopted is left to the manufacturer and the owner. This article illustrates the Electro Chlorination Type of ballast water tretment systems (BWTS).

RESIDUAL EFFECT:- The residual effect is the continued effect of the treatment even after the Water has passed through the plant and when it is stored in the tanks.



The presence of residual effect will not only prevent any regrowth of the organism but may continue to kill or disinfect the water long after passing through the BWTS. The residual effect will depend upon the type of disinfection process and the value of the process variable. The residual effect may taper down with time. As mentioned above the Ultraviolet system does not have any residual effect. The residual effect of the Chlorination type of system is significant and the disinfection continues in the tanks. Any organisms due to eggs hatching in the tanks are killed/ sterilized.

CHLORINATION and ELECTRO-CHLORINATION

The challenge to the Filtration and UV technology are Chlorination (chemical dosing) and the Electro- chlorination systems. Both these plants may employ a primary filter of which electro-chlorination filter not as fine as the UV ones and hence the Pumping losses are lesser. Chlorination process uses Active substances and this has resulted in raising questions on safe operations and discharge control measures. Apart from Cl ions, other hypochlorite and hydroxyl ions are also formed and all these radicals have “oxygenation” property (Total Residual Oxidant TRO) and also have a residual effect in the tank.

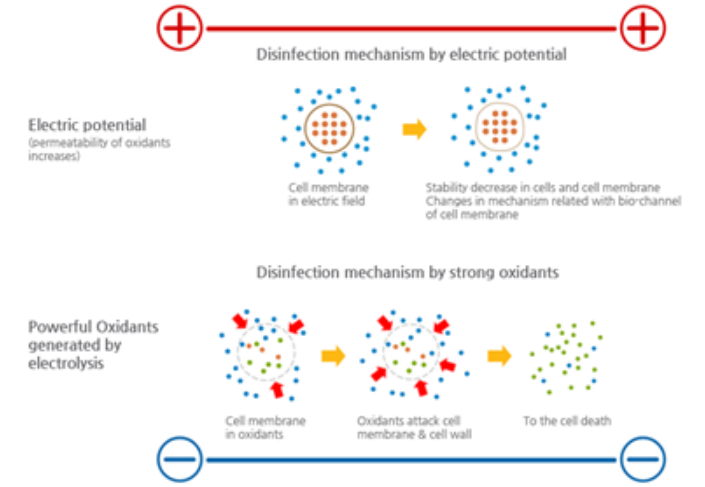
CHEMICAL CHLORINATION:- The simplest and the oldest technology of sterilization was to add Chlorine Tablets or dose Sodium Hypo Chlorite into the water. This is a strong disinfectant and has been used in Municipal water supply systems and swimming pools and it KILLS the organisms. The Chemical dosing amount can be Slug/ Batch dosing or Continuous/Online dosing. In BWTS, continuous online dosing in carried out and the dosage rate depends upon the Total Residual Oxidant (TRO) value to be maintained. Since there is residual effect remains in the treated water, prior deballasting the water is DECHLORINATED or NEUTRALISED. Sodium ThioSulphate compound is used to remove the TRO and bring values to 0.1 to 0.2 ppm values. The Chlorination dosage does not depend upon water type or organic load and is effective in Fresh, Brackish and Marine Waters. It has trouble free operations under various water intake quality and salinity.

ELECTROCHLORINATION:- As the name suggests, the Chlorine is generated electrolytically by the Electrolysis process of sea water. When current is passed through the electrodes immersed in the water, the Electrolysis results in the generation of Chlorine, PROVIDED THERE IS CHLORIDE (SALINITY). The Electrochlorination principle is applied in a number of plants and they employ a coarse filter of 2 to 3 mm mesh size which does not generate back pressure on the Pump. Hence the pumping load is nominal. The plant is set to generate and maintain a certain Cl ppm (TRO value) in the Ballast Water. The current injected (intensity) in the Electro - Chlorination Chamber will depend upon the following factors:

1. The Present Cl value (as measured by a online Cl/ TRO measuring unit).
2. The Flow through the unit (measured by the flow meter)
3. The Salinity / Conductivity of water. (Salinity/Conductivity sensor).

The Salinity plays an important role in the operation of the plant. As the Water salinity starts to decrease, the current to the electrodes decrease. In fresh water, it becomes difficult to operate the plant unless the vessel is capable of mixing some pre stored Ballast water with the incoming fresh water to generate some chlorine ions. THIS IS ONE OF THE MAJOR NEGATIVE FACTORS OF THE PLANT: OPERATION IN FRESH WATER INTAKES IS NOT POSSIBLE UNLESS MIXING WITH EXISTING SEA WATER.

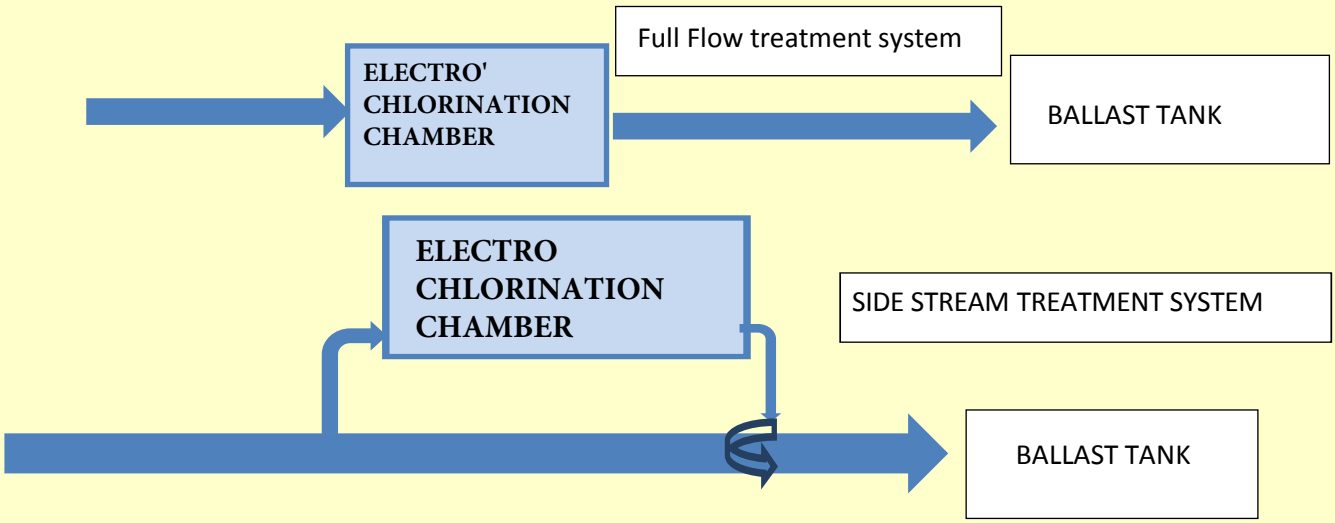
Another disadvantage is the generation of Hydrogen gas inside Electro Chlorination chamber under full load condition which can be a major hazard.
As mentioned in the Chemical Chlorination system, during the deballasting the TRO value is reduced to acceptable limits of less than 0.5 ppm (0.2 ppm of Cl) by injection of the Sodium ThioSulphate. Hence the plant load during the deballasting phase is limited to operation of a dosing pump only. But the advantages of this plant is the nominal BWTS load during Ballasting and nearly negligible load during Deballasting.

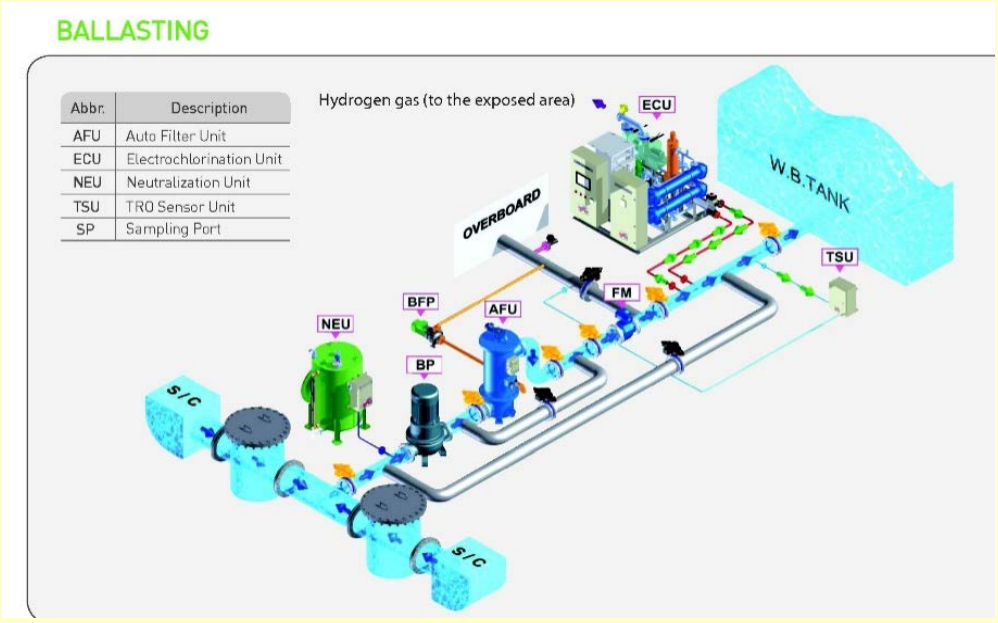


In the Chlorination process, BWTS have adopted 2 different methodologies to generate final TRO values in the Ballast water. The plants are similar in terms of operations and load characteristics.

Full Flow Method:- The Complete Ballast water passes through the Electro Chlorination unit and TRO is generated to the required value.

Side Stream method:- Only a part of the Ballast water is passed through the Electro Chlorination unit which raises the TRO values to a very high level (by high intensity Electrolysis) and this side stream high TRO water is mixed into the main stream of Ballast water to achieve the required TRO value.





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.

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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.)

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

Conservation of Resources and Biodiversity

- Eco restoration of Resources
- Biodiversity mapping and indexing

Waste Management

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- Solid waste management
- Industrial sludge management
- E- waste management

Expertise in:

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

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GIS based Environmental Planning and Management

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- Groundwater recharge study
- Site selection
- Database management

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- 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




Disclaimer:

Editors have taken utmost care to provide quality in this compilation. However, they are not responsible for the representation of facts, adaptation of material, and the personal views of the authors with respect to their compilation.

PM Modi sets 2022 as deadline to eradicate single-use plastic from India

Giving up single-use plastic will benefit the environment, help prevent blockage of roads and sewer lines of our cities, and also protect our livestock and marine life, said PM Modi

Source: Business Today, 2nd October, 2019

Researchers at IIT-Madras find eco-friendly way to degrade plastic

The IIT-Madras team led by T Pradeep has found a way to successfully degrade several varieties of plastic-like Teflon, polyethylene, and polypropylene.

Source: The Hindu on September 14, 2019

India saves 7 billion units of power, 5 mt of CO_2 emission with 10 million LED street lights

'Energy Efficiency and conservation are important pillars of India's efforts in moving towards a sustainable future'

Source: Times of India October 1, 2019

Climate change is the defining issue of our time and now is the defining moment to do something about it

Source: UN Climate Action Summit, September, 2019

Desertification setting in across a quarter of India

Another 30% of the county's land is undergoing degradation. What does this mean for the country where more than 60% people depends on agriculture?

Source: Down to Earth, 29th August, 2019

Government to launch climate vulnerability map of India

A common set of indicators will be used for vulnerability-profiling and ranking of 650 districts all over the country The map is being developed under a joint project of the Department of Science and Technology (DST) under the Union Ministry of Science and Technology and Swiss Agency for Development and Cooperation (SDC)..

Source: Down to Earth, 28th September, 2019

Articles, photos etc. are invited for next issue (October-December, 2019) of the Newsletter on the theme ''Environmental Policy and Law in Sustainable Development

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