IICHEMRC e-NEWSLETTER

MUMBAI REGIONAL CENTER November 2019

FROM CHAIRMAN'S DESK

Dr. U. Kamachi Mudali
Chairman IIChE-MRC

Indian Institute Of Chemical Engineers is a confluence of streams of professionals from academia, research institute and industry. It was founded by Dr. Hira Lal Roy before Indian Independence in order to cluster stalwarts in Chemical Engineering from various professions to support the chemical industries as well as Institutes by providing a forum for interaction and joint endeavors.

IIChE- MRC conducts and supports many events through out the year and feels it prudent to share its achievements with all members. Hence, IIChE-MRC decided to publish this quarterly e-newsletter for the benefit of all members from academia, research institute, industry and student chapters to gain acquaintance with current events, technical articles on Industry and upcoming events of IIChE-MRC.

I hope that this e-newsletter proves beneficial to the chemical engineering as well as allied sciences readers and encourage them to take up joint ventures with immense participation towards the Nation building.

Dr. U. Kamachi Mudali

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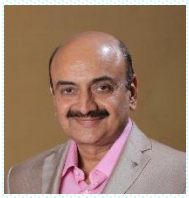
Editor's Corner



I would like to begin this column with greetings to my Seniors/Colleagues in the IIChEMRC and to all the IIChE Members, wishing them happiness and prosperity. As far as IIChEMRC is concerned, we had a busy schedule during last few months. INAE, IITB, IIChE & IEA organised national workshop on Management of Solid Waste in India at IIT Bombay. Students' CHEMCON (SCHEMCON), one of the most important events in the calendar of the Institute, organised at SRICT, Bharuch. The IIChE Students Chapter of TSEC conducted CHEMERGENCE'2019 with participation from ten colleges across Mumbai and Pune. Founder's day celebration, 131st Birthday Celebration of Dr. Hira Lal Roy, organised at MRC Office. "Networking Visit 2019" also conducted on Gandhi Jayanti at Swan Club Thane.

I am happy to present one article "Role of Reverse Osmosis in Zero Liquid Discharge" and one report on Theme Meeting on "Non-nuclear application of Deuterium/Heavy Water". Members are reminded of one important forthcoming event, Theme Meeting on "Specialty Chemicals" by Heavy Water Board & IICHEMRC on 13/03/2020. All said and done, IIChE is a non-profit organisation. Hence, at the end of the day, the Institute needs active support of industry houses, academic and research organisations, and, indeed, the individual members for its effective and meaningful sustenance. I request all our Members to take the initiative to bring in more and more Members (Individual and Organisations) to the IIChE family. Happy reading.

Jagdish Nageshri
Editor, IICHEMRC e-Newsletter

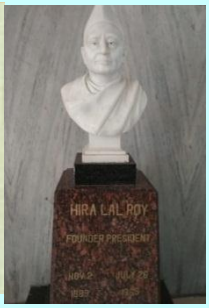
INAE-IITB WORKSHOP

INDIAN NATIONAL ACADEMY OF ENGINEERS, in association with INDIAN INSTITUTE OF TECHNOLOGY BOMBAY, INDIAN INSTITUTE OF CHEMICAL ENGINEERS and INDIAN ENVIRONMENTAL ASSOCIATION organised one-day national workshop on urban & rural challenges in Management of Solid Waste in India.

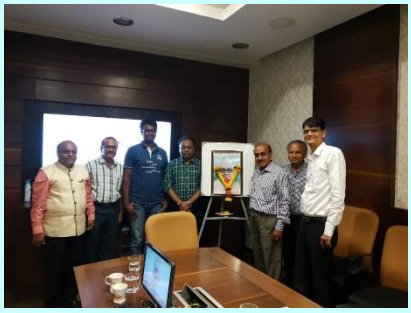
INAE, IITB, IIChE and IEA organized a workshop at IITB on 24/09/2019 with delegates of Municipal Corporation of Greater Mumbai, plastic manufacturers and users, housing societies, real estate developers, corporate organisations engaged in providing processes and products, waste management companies and academic institutions and it received enthusiastic response.

The event was well attended by about 150+ delegates from industry, academia, government officials & students fraternity. It was inaugurated by Dr Anil Kakodkar, former Chairman AEC and Secretary DAE. IITB Dy. Director Prof Suresh also addressed the gathering. Many dignitaries spoke about solid waste related problems and possible ways to tackle these issue. It was focused around organic, plastic, construction, industrial and municipal wastes etc. The government initiative, incentives and rules were also highlighted. Role of synergy of engineering disciplines including the chemical were also presented. IIChEMRC objectives and activities were briefly presented by Prof. V.K. Shrivastava during valedictory function of the event.

Founder's Day
131st Birthday Celebration of Dr. Hira Lal Roy



131st Birthday of Dr. Hira Lal Roy (Founder's day) was Celebrated on 9th November 2019 at MRC Office. Dr. Hira Lal Roy, was born in 02/11/1889 in village Panchpaika of Dhaka District in East Bengal. He inherited strong Nationalistic Feelings from childhood and was greatly influenced by Rabindranath Tagore, Mahatma Gandhi and other contemporary national leaders. He went abroad for higher studies in Chemistry and received magna cum laude (equivalent to higher honours degree) in Industrial Chemistry from Harvard in 1913. He introduced Chemical Engineering as a distinct discipline first time in Asia in 1921 in Bengal Technical Institute (later on became Jadavpur University in 1955). The Chemical Engineering course was designed following the syllabus of MIT, USA. Later he earned PG and Doctorate Degree from Germany.



The Founding Father of Chemical Engineering education and research in India, fulfilled one of his treasured dreams in establishing in Calcutta, the Indian Institute of Chemical Engineers in 1947, a professional society. In 1958, the Council of the Institute formed the first two Regional Centres, one in Calcutta and the other in Bombay in order to enlarge and encourage professional activities in the country. It would be no exaggeration to say that it was the result of Dr. Roy's foresight and persistent effort that the Institute became what it is today. Today with several thousands members on its roll, the Institute has emerged as an important national platform overseeing the interest of academics and the industry in multifarious fields of Chemical Engineering. Its activities are spread across the country through its HQ and 34 Regional Centres as well as 94 Students Chapters.

ChEMERGENCE'2019 - Resonating Revolution

Thadomal Shahani Engineering College, Bandra (West), Mumbai

The Students Chapter of Indian Institute of Chemical Engineers of Thadomal Shahani Engineering College successfully conducted the 14th edition of their annual technical symposium, ChEMERGENCE'19, on 20&21/09/2019. This year, ChEMERGENCE witnessed an outstanding participation from the students of ten colleges across Mumbai and Pune. Keeping up with the promise of IIChE-TSEC to bridge the gap between the students and the industries, the college invited multiple dignitaries to interact with the students and guide them.

The Inauguration ceremony took place in the Old Building Seminar Hall in presence of **Dr. G. T. Thampi**, Principal of Thadomal Shahani Engineering College enlightening the students. The Chief Guest was **Mr. B. S. Nagarkoti**, Deputy General Manager of Research and Development, Hindustan Petroleum Corporation Limited. The Guest of Honor was **Mr. Praveen Saxena**, Director, Blast Carboblocks Pvt. Ltd. Other dignitaries on the dais were **Dr. Anita Kumari**, Head of Department of Chemical Engineering and **Prof. Ravindra Joshi**, of TSEC.

The first day of CHEMERGENCE'19 was filled with excitement as the students awaited in anticipation of the Panel Discussion. The topic of **Panel Discussion** was 'Whether the Chemical Engineering Industry needs an image makeover?' **Mr. V. K. Joshi**, Senior General Manager and Head of Business Development, thyssenkrupp Industrial Solutions (India) Pvt. Ltd, **Mrs. Aparna Khurana**, Managing Director, Azelis India Pvt. Ltd., **Mr. Dhawal Saxena**, Associate Director, Blast Carboblocks Pvt. Ltd. Were amoung the Panelists. The Discussion was moderated by **Mr. Praveen Saxena**.

There was a **Technical Poster Presentation** competition where undergraduate students of chemical engineering presented their research. The Heat Exchanger prototype making competition, **HeatX**, took place on the first day with seven teams. The students designed and fabricated their own heat exchangers to match the problem statement given to them. The prototypes were judged on the basis of their efficiency.

Continued…

ChEMERGENCE'2019 - Resonating Revolution

Thadomal Shahani Engineering College, Bandra (West), Mumbai

HAZOP analysis competition conducted for the first time in ChEMERGENCE'19. There were two rounds in HAZOP. The first round was a general HAZOP aptitude test related to industrial safety. In the second round the participants had carried out HAZOP of a process equipment given to them.

The second day of ChEMERGENCE'19 began with debate competition, **ChemDebate**, on 21st September. There were 12 teams competing from four different colleges and topics were related to environment, law and chemical industry.

ChemQuiz competition is a flagship event of ChEMERGENCE and this year it was conducted by Mr. Anansh Prasad, Founder and Managing Director of Skillsphere Education Pvt. Ltd. There were four rounds in which the first two rounds had general chemical aptitude questions, third and fourth round were buzzer rounds moderated by the Quizmaster.

Cooling Tower prototype making competition (**CoolIT**), with nine teams competing, challenged the students to design and fabricate cooling tower satisfying the problem statement given to them. ChEMERGENCE'19 proved to be of great help for the students of chemical engineering. It was a platform for the students to interact with the professionals from diverse industries.

S-CHEMCON 2019

Students' Chapter of Shroff S. R. Rotary Institute of Chemical Technology (SRICT) Ankleshwar

S-CHEMCON2019 (Students' Chemical Engineering Congress) was organised by the Students' Chapter of Shroff S. R. Rotary Institute of Chemical Technology, Ankleshwar on 17&18/10/2019.

S-CHEMCON was introduced back in 2005 to offer a platform to students of Chemical Engineering for updating themselves with the latest knowledge. At the same time, this forum was initiated to encourage students to demonstrate their out-of-the-box creative ideas before an erudite gathering. S-CHEMCON2019 too has witnessed enthusiastic participation by large number of students.

S-CHEMCON 2019, Students' Chemical Engineering Congress, is an annual event organized by the Students' Chapter of Indian Institute of Chemical Engineers (IIChE) under one of its Regional Centres. It provides a platform for the Chemical Engineering Students to interact, learn and gain exposure to the expanding arena of Chemical Engineering. The theme of the S-CHEMCON 2019 was Engineering Technologies for Green Environment.

NETWORKING VISIT

Golden Swan Club at Yeoor Hills, Thane

This year, the annual Networking Visit was planned at the Golden Swan Country Club, located in the Yeoor Hills in Thane. It was organised on Wednesday 2nd October, being a public holiday. Golden Swan Country Club is Mumbai's first Country Club. It is located at 1300 feet above sea level and spread over 26 acres of lush and tranquil greenery, The Club has a nine-hole Golf course, two US Open Championship standard tennis courts, unique indoor / outdoor sports facilities which include billiards, pool, table tennis, carrom and badminton courts and Mumbai and Thane's only golf learning academy.

Members & family members participated enthusiastically in the Networking Visit for a day of great fun and interaction. Participants reached the venue by a chartered bus. After breakfast, the participants paid homage to Mahatma Gandhi by singing some of his favourite bhajans. They then went on small trek through a forested hilly area.

After the trek, some participants opted for a swim, others tried at table tennis. Some indulged in nostalgia by checking out whether they still remembered a skill learnt during childhood – riding a bicycle. Once you learn to ride a bicycle, you never forget it. Having worked up an appetite with all physical activity, everyone got together for the tasty lunch. Now it was time for the most popular game, Antakshari. Everyone enjoyed singing along to all the songs, irrespective of their "party affiliations". After high tea, at around 5 pm, everyone reluctantly took leave of each other and reached home rejuvenated to face the world once again !

Forthcoming Major Events

CHEMCON 2019,

15 - 19 December 2019 at IIT New Delhi,

Our Members must be aware that the 72nd Annual Session of IIChE, CHEMCON 2019, is going to be held during 15 - 19 December 2019 in New Delhi, to be organised by the Northern Regional Centre in association with the Department of Chemical Engineering , IIT Delhi along with international partners. This year's central theme, for CHEMCON is 'Advances in Chemical Engineering for Industrial Applications'. Keeping with the tradition, academic luminaries from India and abroad, industry bigwigs and technocrats of top order will grace the occasion. CHEMCON continues to be the biggest congregation of Chemical Engineering fraternity in India. Apart from its tremendous academic and professional value, CHEMCON happens to be the most opportune ground for our Members and other participants to network with fellow professionals, which is undeniably an important prerequisite for professional growth today. If not done already, please chalk out your plans for attending CHEMCON.
All details are available on www.chemcon19.com.

Theme Meeting on Specialty Materials

Solvents (Organic Extractants) & its Industrial Applications

13 March 2020 at DAE convention centre, Anushaktinagar Mumbai

Heavy Water Board (HWB), a constituent unit of Department of Atomic Energy (DAE) has been mandated for production of Specialty Materials, which are required for the department. HWB has successfully mastered the challenging task of converting laboratory or bench scale processes to industrial production facilities for various specialty materials such as Solvents (Organphosphorous & Amide based metal extractants) and Boron (isotopic enriched) compounds.

HWB has set up industrial scale facilities and is producing various Solvents required for Chemical, Hydrometallurgical and Nuclear Industry employing Solvent Extraction or Liquid-Liquid Extraction unit operation. This includes solvents such as TBP (Tri Butyl Phosphate), D2EHPA (Di-2 Ethyl Hexyl Phosphoric Acid), TOPO (Tri Octyl Phosphine Oxide), TAPO (Tri Alkyl Phosphine Oxide), DNPPA (Di-Nonyl Phenyl Phosphoric Acid), Di-Hexyl Octanamide (DHOA), Tri-iso Amyl Phosphate (TiAP) and Monoester of Di-Ethyl Hexyl Phosphonic Acid, TEDGA (Tetra -2 Ethyl Hexyl Di glycol Amide), D3ODGA (Di-Do-Decyl Di Glycol Amide) and Calix Crown 6 X.

A theme meeting on specialty materials particularly Solvents (Organic Extractants) is proposed to be organized by HWB to enhance the awareness of Indian industry and enable better utilization of Solvents and related technologies produced by HWB. This meeting will focus on applications of Solvents in various sectors of Chemical, Hydrometallurgical and Nuclear industry. This included producers of Agrochemicals, Corrosion Inhibitors, Flame Retardants, Hydraulic Fluids, Mining chemicals, Printing Inks, Water Treatment Chemicals, Hydrometallurgical industry using solvent extraction process for production of Nickel, Cobalt, Zinc, Copper, precious metals and their derivatives, Rare Earth producers and Nuclear reprocessing.

The theme meeting will be one day programme and will include talks from experts selected from industry, academia and research centers. The programme will facilitate networking between researchers, producers and users of Solvents to consolidate the views and obtain a comprehensive assessment of demand-supply scenario and gaps in technology development.

Six Sigma Trainings & Certifications by IIChE

IIChe in association with training & certification partner Anexas Consultancy Services is pleased to offer Lean Six Sigma trainings and certification and has the following objectives.

- To have a better understanding of Lean Six Sigma Methodology and Processes
- To understand the techniques used by Lean and Six Sigma
- To apply the knowledge and techniques used by Lean and Six Sigma
- To be able to track data, analyse errors and conduct root cause analysis
- To understand the benefits of statistical tools to improve analytical ability
- To be able to solve problems in the organization's processes
- To drive a higher level of service on key deliverables for customers

Identified participants would be given the trainings in Lean Six Sigma Yellow Belt training for 1day, Green Belt training for 2 days. The Green Belts would be given 4 more days of training in Black Belt topics to become Black Belts. The Minitab software training can be conducted using organization's data. By the end of the training participants would be able to…

Lean Six Sigma Yellow Belt

- Comprehend fundamental methodologies utilized for Six Sigma.
- Apply the basic improvement tools and techniques of Six Sigma.
- Work as a team member for an individual project or multiple projects.
- For BE/ B.Tech/M.Tech Chemical Engineering students

Lean Six Sigma Green Belt

- Track data, analyse errors and conduct root cause analysis
- Understand the benefits of statistical tools used to improve analytical ability
- Apply different tools to solve problems in the organization's processes
- For Quality Managers, Production Engineers, Operations Managers, Team Leads, Process/ Business excellence Managers, Executives, Auditors

Lean Six Sigma Black Belt

Make a roadmap for six sigma implementation across the organization

- Alignment of the six sigma initiatives with quality management system
- To drive a quantifiably higher level of service on key deliverables for customers
- For Vice Presidents / Directors / General Managers, Team Leads , Business excellence Managers, Executives, Quality Analysts,

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Theme Meeting on Non-Nuclear Applications of Deuterium/Heavy Water

April 30, 2019, DAE Convention Centre, Anushaktinagar, Mumbai

The Theme meeting on Non-Nuclear Applications of Deuterium/Heavy Water was organised by Heavy Water Board (HWB) in association with Indian Institute of Chemical Engineers (IIChE-MRC) and Indian Chemical Council (ICC) in Mumbai on 30th April 2019. The theme of the meeting was "applications of deuterium in various scientific fields including life science, technology development, pharma field etc". With many research activities now taking on a global dimension, it was envisaged to discuss possible approaches towards inculcating best research and technology and also to decide upon the role of academic and R&D institutes to support in basic research and role of private industries to meet the technology challenges in this field in the near future. The focus of the theme meeting was to update the participating delegates about the latest applications of deuterium chemistry in various fields. This meeting aimed to integrate the expertise available with different groups for accelerating the work on development of non-nuclear applications of heavy water and deuterium. Many Indian start-up speciality chemicals companies has taken up industrial scale synthesis of Deuterated compounds and showing robust growth in this direction.

This meeting has endeavoured to be a good platform for industry-academy interaction in the field of deuterium chemicals and networking with experts in this field.

The One-day event started with the Opening Remarks by Shri V.K.M. Parthiban, Executive Director (Operation) followed by keynote address by Dr. U. Kamachi Mudali, Chairman and Chief Executive, Heavy Water Board. At the outset, Shri Parthiban welcomed all the delegates attending the meeting and briefed about the theme of the meeting. In his keynote address, Dr. Mudali addressed how various applications of deuterium in different technological fields are getting momentum day by day and the opportunity that Indian industries can grab to become part of "Make in India" campaign.

Dr. Srikumar Banerjee, Former Chairman, AEC & DAE Homi Bhabha Chair who graced the occasion as Chief Guest said that heavy water production in the history of INPP is a true example of indigenization of technology starting from its inception to the maturity …. from Drops to Drums.

He also mentioned about the diversified activities of Heavy Water Board and congratulated HWB on the modified mandate of HWB with inclusion of the diversified activities of HWB where HWB has already proven its technological capability by setting up of various industrial units. He also showed the path on which HWB can further expand its technological horizon by taking up various industrial scale projects which are presently on high demand viz. production of high purity Silicon required for solar panel, desalination technology for producing quality water, hydrogen production etc in collaboration with BARC. In the context of the theme meeting he acknowledged HWB for taking up the initiative to integrate R&D with industry and for taking the collaborative projects with them.

He also recognized HWB's effort in this field which started with developmental work on themo-stabilaization of OPV in heavy water media and continued then with broader aspects viz. synthesis of deutertaed compounds at HWP Baroda, D_2 gas generation, collaborative work with Indian Industries, working with R&D units on deuterium medicinal chemistry etc, supply Heavy Water to promote academic research activities while taking care of the aspects associated with supply of heavy water being a prescribed substance. He said that there exists huge opportunity for HWB to expand the horizon in this non-Nuclear field and the work on Non-Nuclear Applications of Deuterium/Heavy Water is definitely going to impact both R&D and industrial progress in the coming years.

In his address, Shri R.G. Rajan, Chairman, IIChE-MRC talked about mutually rewarding association of IIChE with HWB in organizing the theme meeting.

Shri Karangle, Director General, ICC, Mumbai reminiscences his association with HWB and acknowledged HWB's technological capability in taking up industrial challenges in isotope separation and other diversified activities.

The Inaugural Session of the meeting concluded with the Customary Vote of Thanks by Shri R.R. Anwardekar, Executive Director, Operation, HWB.

INAUGURATION OF THE EXHIBITION

An exhibition was also arranged in the foyer of the DAE Convention Centre by Heavy Water Board. This was inaugurated by Chief Guest Dr. S. Banerjee, Former Chairman, AEC & BARC Homi Bhabha Chair. Through this exhibition, HWB showcased its products (samples) with display of its activities and interacted with various participants/other exhibitors.

This enabled to successfully attract relevant people across various areas of the Chemical industry and academicians/researchers, providing a good platform to engage with new prospects, awareness and generate new leads.

RELEASE OF SOUVENIR

A souvenir containing messages from the dignitaries, abstract of the talk, advertisement from the suppliers etc. was released on this occasion by the Chief Guest of the meeting.

RELEASE OF SHORT FILM ON HWB

A short film on journey of HWB during the 50 years has been released by the Chief Guest then projected.

RELEASE OF UPDATED WEBSITE OF HWB

Updated website of HWB (www.gov.in) with many useful features and information has been launched.

INDUSTRY-ACADEMY INTERACTION (PARRALLEL SESSION IN THE AFTERNOON)

HWB in association with IIChE organised one interactive session with students from Engineering Colleges in Mumbai viz. MGMCET, Jhondale College and Gharda Institute of Technology along with the faculties of the colleges. This included visit to the HWB's Exhibition Stall by the students followed by showing of HWB's short film and long film containing the overview of HWB's activities.

There was an interaction session (question-answer model) where student's queries on the technical matter pertaining to HWB's activities were answered by the officials of HWB.

The meeting was carried out through various sessions, in which the discussions were held on the following major scientific tracks:

- Heavy Water Production technology
- Overview of applications of Heavy Water and deuterium in Non-Nuclear field
- Role of DDW in cancer therapy-exploratory study
- Marketing strategy for deuterated compounds in the country
- Applications of deuterium in medicinal chemistry
- Deuterated compounds/ NMR solvents

Various applications of deuterium in different fields have been addressed by the eminent speaker from reputed organizations.

The meeting was concluded with the projected roadmap on developmental work with deuterium in non-nuclear field through collaborative project work with Indian research institutes and industry.

At the end, Shri V.K. Khilnaney, Director, Operation summarised the proceedings of the day. He has assured the industry that HWB initiatives would continue to contribute to the growth of the chemical industry working in this deuterium field in the country. He also mentioned that HWB will support R&D initiatives in this direction and also will help in sorting out policy related issues while dealing with deuterium. He appreciated all the speakers who put their efforts in presentations and wished all the participants success in future endeavours.

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

Prof. V.K.Srivastava

Adjunct Professor, MEMS, IIT, Bombay & Former Head, Thermal Desalination Section, Bhabha Atomic Research Centre, Trombay, Mumbai

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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).

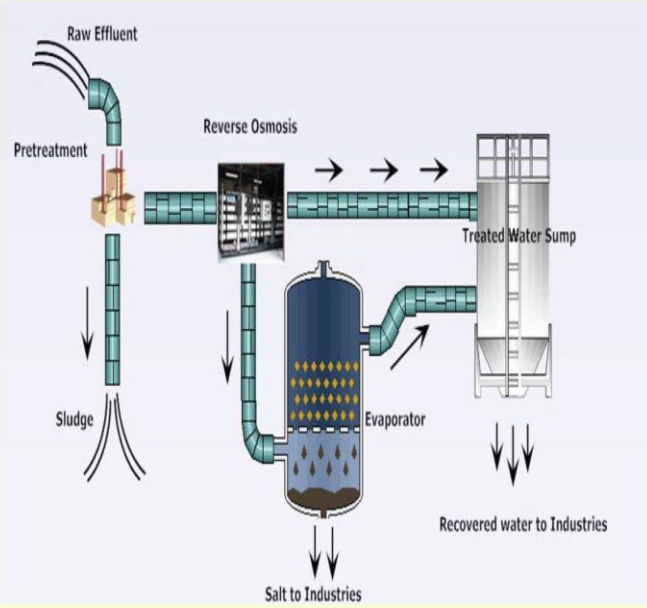

Fig 1: Basic Concept of Zero Liquid Discharge (Ref. 1)

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.

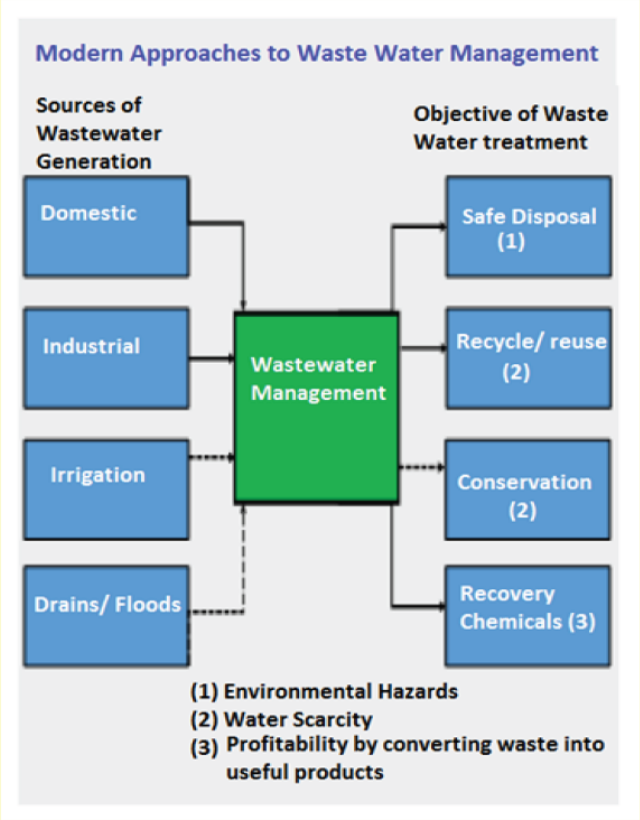

Fig 2: Modern Approach Towards Waste Water Treatment

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