Indian J. Fert., Vol. 11 (12), pp.110-114 (5 pages)

Total Water Management for Fertiliser Industry

'... from Concept to Commissioning'

Ajay Popat
Ion Exchange (India) Ltd.
Ion House, Dr. E. Moses Road, Mahalaxmi, Mumbai - 400 011
ajay.popat@ionexchange.co.in

Water is a scare commodity. Conservation of water is not only necessary to save cost and minimize impact on environment but even to sustain production. The paper discusses various options available for reducing water consumption by proper treatment of raw water and waste water and also by recycle and reuse of water. A variety of new water treatment chemicals and treatment technologies are available to minimize water consumption in fertiliser plants.

INTRODUCTION

Indian Fertiliser industry is likely to witness a growth from the current level of stagnation for the last 15 years to new projects in the pipeline. The factors that have created the need for fertiliser industry's growth are need for higher yield due to diminishing agricultural land, widening gap between demand and supply of fertilisers and above all to ensure food security for a population of 1.25 billion.

The Fertiliser industry is largely governed by the Government of India's policies on Urea production and distribution with focus on reduction in specific energy and water consumption to make it self-sustaining and absorb day-to-day increasing multiple costs. There have been innovations in the technology for sustainable development.

Increased usage and demand for fertilisers will require highly efficient water treatment and management systems that can help produce urea with uninterrupted operation with minimum requirement of raw water. Quality of water has direct impact on production and performance. At the same time water as a resource is increasingly under pressure in our country with respect to its availability and varying quality laid in with high level of impurities – Calcium/ Magnesium, hardness, high total dissolved solids (TDS), excess presence of heavy metals and micro-organisms. Thus recognising this need of the fertiliser industry, Ion Exchange (India) Ltd. has developed customised and standard (predesigned, pre-engineered) water treatment packages using state-of-the-art demineralising, softening, ultrafiltration (UF), reverse osmosis (RO), mixed bed and condensate polishing systems. These units are skid-mounted, completely automated and backed by 24 x 7 service network located at 36 strategic industrial locations in India. This service set up provides our customers in the fertiliser industry with comprehensive operation and maintenance services including supply of genuine critical spares and components like resin, membrane, media, etc.

Whilst Ion Exchange has been providing complete range of water treatment solutions and services, customised to every type of requirement, it also provides a range of waste water treatment, effluent recycle (with the option of resource recovery) and zero liquid discharge systems, not only to meet stringent disposal norms but also economically solving water scarcity problems by conserving vast volumes of water through recycle and zero liquid discharge schemes. These solutions protect the environment by reducing discharge, whilst generating substantial savings from water reuse and resource recovery. Typically our effluent recycle solutions are integrated to yield optimal benefit. For instance, recycle systems are combined with speciality water treatment chemical programmes that substantially reduce water discharge (e.g. cooling tower blowdown, DM plant waste generation, etc.); and state-of-the-art effluent treatment plants are integrated with zero liquid discharge processes.

Water Use in Fertiliser Industry

Water is a key raw material for the fertiliser sector. Unlike other industrial sectors, the fertiliser industry is characterised by a wide variety of products and processes. Different fertilisers are produced, and there can be several routes for manufacture of a given product, so the water used for a particular product might vary significantly across companies. The largest use of water in the Fertiliser industry is for cooling, steam (e.g., heating) and process water being the other significant uses.

Historical data on distribution of water use at the facility level is not available. However, it is estimated that process cooling, process dilution and steam generation instead of production represent the most significant use of water at fertiliser facilities.

Some of the common uses of water in a fertiliser plant are indicated below:

Cooling: Water is used in process cooling (i.e. direct heating and cooling of chemical reactions) as well as cooling of the plant (i.e. in cooling tower). Around 30 to 60 per cent of all the water used in fertiliser industries is for cooling.

The water is conditioned with specialty chemicals to improve the hygiene of cooling tower and heat exchangers, improve cycles of concentration to minimise water waste due to frequent blowdowns.

Steam Generation: Water is used in generating steam for various fertiliser processes. Only mixed bed demineralised water is recommended for generating steam which is also used as boiler feed or make-up water.

Service Water: Water is used for maintenance and plant wash-up activities, flushing, hand washing, etc. in the plant and for safety related activities like fire fighting, deluge system, etc. The service water is generally ground water or municipal supply water. Industries also recycle treated waste water for use as service water.

Potable Water: Water is used for human consumption in plant. Ground water or municipal water after treatment and disinfection is generally used as potable water.

Water Conservation Measures in Fertiliser Industry

Effluent recycle solutions are integrated to yield optimal benefit. For instance, recycle systems are combined with speciality water treatment programmes that substantially reduce water discharge (for example, cooling tower blowdown); and state-of-the-art effluent treatment plants are integrated with zero liquid discharge processes.

These systems with effluent treatment, recycle and zero liquid discharge systems gave an excellent payback on the investment through:

- Assured availability of water for process needs as well as low end uses
- Less requirement of fresh water. Therefore, considerable savings in fresh water costs
- Additional savings through recovery of valuable by-products for re-use in process
- Compliance with pollution control regulations and a clean environment through reduced/ zero effluent discharge

♦ *Creating a Water Balance:* The first step is to document all major water-using equipments and processes at the site with usage amounts and prepare a complete water balance. It would help in identifying the possible areas where water can be saved. Monitoring the water balance on frequent intervals would help in implementing water conservation practices.

♦ *Increasing Cycles of Concentration (COC):* Cooling towers use water in three ways: evaporation, drift, and bleed-off or blow-down. A huge amount of loss occurs in the cooling tower in the form of evaporation, drift and blow-down loss. Make up water is provided to compensate for these losses. Since the water is circulated many times in the close loop, the concentration of dissolved solids in the circulating water increases over a period of time which decreases the cooling efficiency of the tower. Thus, water is intentionally wasted and make up water is used to compensate the loss in order to reduce the concentration of dissolved solids. The cycle of concentration (COC) is the ratio of dissolved solids in the circulating water to the make-up water. Cooling towers are normally designed for a COC of around 3. By increasing COC, the blow down water can be reduced by using *INDION* specialty conditioning chemicals, antiscalant, scale inhibitors, pH controllers and like.

The best way to increase the cycles of concentration between 6-9 in addition to using speciality chemicals is through better monitoring and management of the water chemistry. The first step is to understand the quality of the incoming water and what the controlling parameter should be, such as hardness, silica, or total dissolved solids. There will be a relationship between these parameters and conductivity, based on the water chemistry specific to a site. This relationship can also help to establish type and dosage level of specialty scale conditioning chemicals to maintain set point conductivity. The conductivity controller opens a blow-down valve as needed to maintain your control parameter within acceptable limits.

The circulating waters also require to be conditioned with INDION Biocides to prevent biological

fouling and scaling. Use of speciality bio-dispersants further improve the hygiene.

Special features of towers and water systems that promote water efficiency include side-stream filtration, sunlight covers, alternative water treatment systems, and automated chemical feed systems.

♦ *Reducing Leaks and Over Flows:* Leakages from valves, taps, fire fighting hoses, underground fire fighting lines, cooling towers, gardening hoses account for huge amount of water loss. There lies a possibility of reducing the water consumption by plugging the leakages.

♦ *Equipment Cooling:* Single-pass cooling typically consumes more water than any other cooling method in a Fertiliser industry. In single-pass or once-through cooling systems, water is circulated once through a piece of equipment and then discharged in to the sewer. Single-pass systems use approximately 40 times more water than a cooling tower operating at 5 cycles of concentration to remove the same heat load. The best way to combat the water waste associated with single-pass cooling is to use a process or cooling loop. This loop provides water at a preset temperature to cool equipment. A small packaged chiller or central plant towers can reject the heat from these systems.

♦ *Wastewater Recycling:* Water in Fertiliser industry is used for steam generation, dissipate heat and as a media in certain processes resulting in high amount of wastewater/effluent generation. There is huge opportunity of recycling/ reuse of wastewater/ effluent after necessary cost-effective treatment. It will not only reduce the intake of freshwater but also help in reduction of contamination of nearby freshwater resources.

♦ *Use of Blow-Down Water or Reverse Osmosis (RO) Rejects:* The blow-down water from cooling tower and/ or the Demineralised unit reject is recycled by treating it through membrane processes for process and cooling tower make-up. It can significantly reduce the amount of fresh water intake.

♦ *Use of Treated Municipal Waste Water:* Reclaimed waste water is an option in limited circumstances, when an industry has access to municipal waste water that has been treated to a secondary disinfection level. Reclaimed waste water can be used for some non-potable applications, such as service water, fire fighting water and cooling tower make-up, etc.

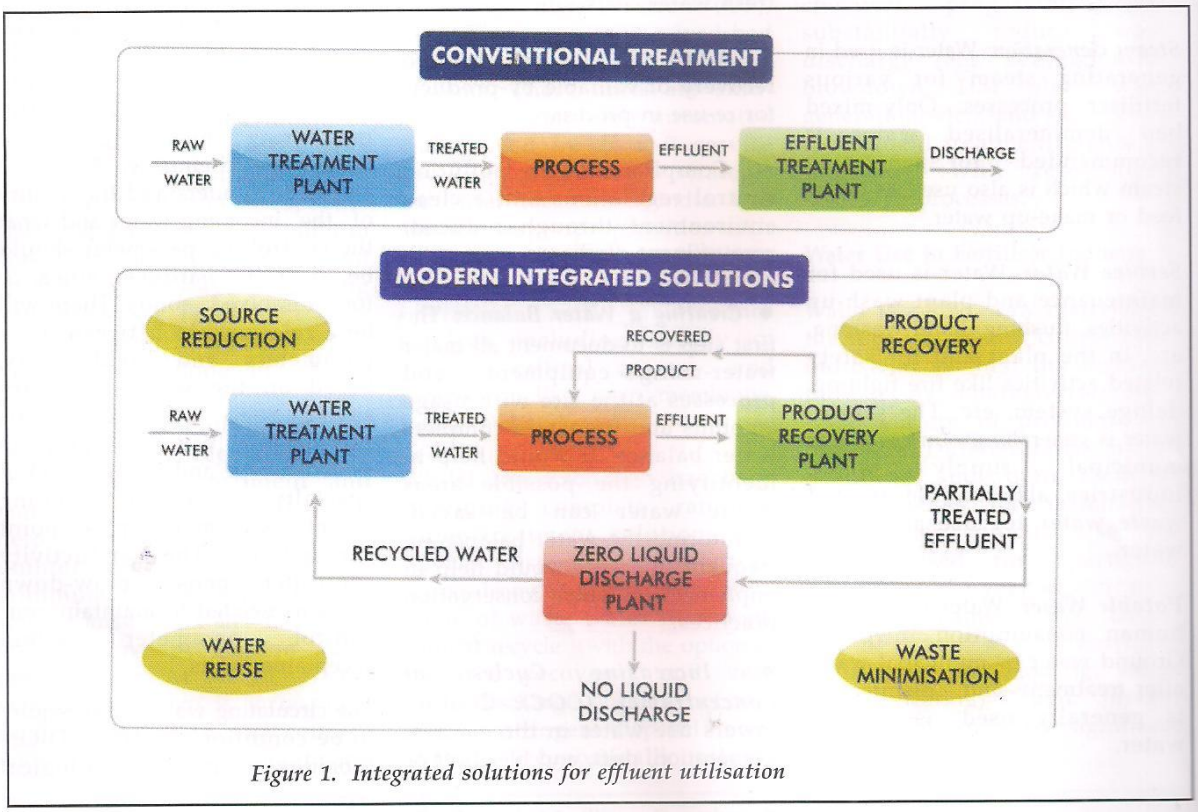


Figure 1. Integrated solutions for effluent utilisation

Further treatment by membrane and ion exchange's processes make it suitable for producing high quality steam for boiler/ power generation.

Effluent Generation and Minimization

Water is mainly used as a media in fertiliser manufacturing processes. Most of water used by the Fertiliser Industry is for return-flow applications which results in large quantity of effluent generation. Effluent becomes a major concern for Fertiliser industries. The effluents produced by this sector often contain organic and inorganic matters in varying concentration.

Effluent Minimization: Effluent minimization coupled with recycling is a very effective strategy to conserve water and solve the wastewater problem. Effluent minimization implies the reduction of quantity and quality of effluent at source by resources (raw material, water, energy, etc.) conservation and the promotion of re-use/recycle.

The flowchart in **Figure 1** describes this concept.

Integrated Water Management

Integrated solutions minimize water wastage and improve efficiency of water assets by providing comprehensive operation and maintenance of:

- Process treatment systems that include DM/RO/MB plants
- Utility water systems that include cooling water management systems, boiler water management
- Effluent treatment system
- Rehabilitation and modification of existing water and waste treatment plants.

CASE STUDIES

1. National Fertilisers Limited (NFL), Vijaipur – RO Plant for Reuse of Cooling Tower Blowdown

The Reverse Osmosis (RO) plant at NFL, Vijaipur was installed in 1991 (shown in **Figure 2**). This plant has two streams of 162 m^3/h (permeate) capacity each, and is designed for automatic operation. This plant was designed to treat inlet TDS of 1800-2000 ppm and produce treated water with TDS less than 150 ppm and with a recovery of 90%. The scheme for this recycle plant consists of Effluent Treatment Plant (ETP)+Pressure Sand Filter (PSF) +Carbon Filter (CF) +Reverse Osmosis (RO).

2. IFFCO Phulpur – Effluent Recycle

At IFFCO Phulpur, Ion Exchange supplied an effluent recycling plant **(Figure 3)** comprising high rate solids contact clarifier, continuous sand filter, chemical dosing system, cartridge filters and reverse osmosis module. Commissioned in 1998, this plant treats inlet effluent with 4,000 ppm TDS and 120 PPM silica comprising cooling tower blowdown and regenerated waste from demineralisation plant. It is designed for 127.5 m^3/h recovered water with TDS less than 400 ppm. Recovery (85 per cent) from the reverse osmosis unit is improved by reduction of silica to 20 ppm using cold lime softening in the clarifier.

3. Madras Fertilizers Ltd. (MFL) - Cooling Tower Blowdown Recycle Plant

Designed to treat cooling tower blowdown that was earlier wasted, the 160 m^3/h recycle plant **(Figure 4)** supplied to Madras Fertilizers Ltd. (MFL) in 2004 incorporates pretreatment followed by ultra filtration which feeds the existing reverse osmosis plant. This plant was designed to treat effluent

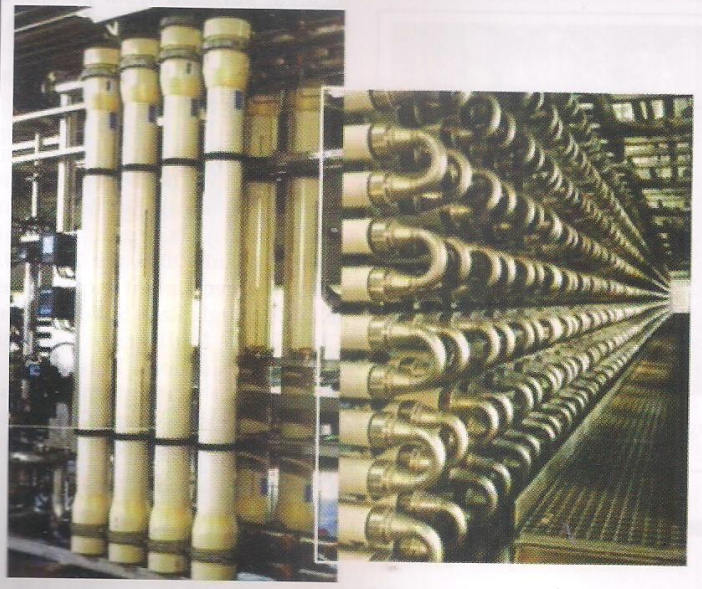


Figure 2. R.O. plant at NFL Vijaipur

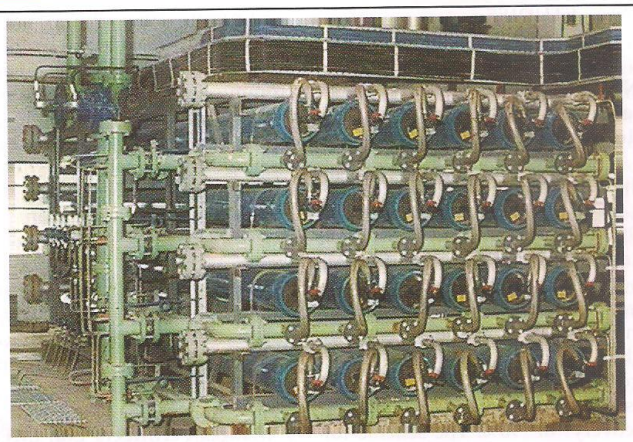


Figure 3. IFFCO Phulpur - Effluent Recycle

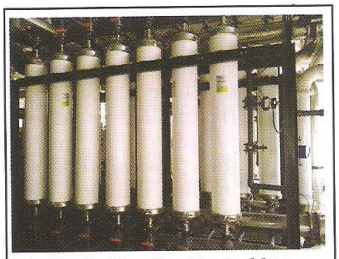


Figure 4. Cooling tower blow down recycle plant

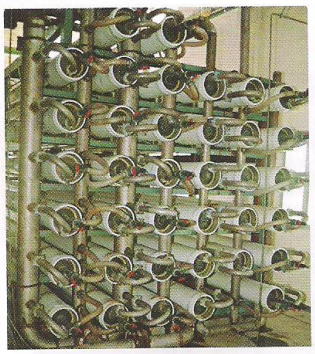


Figure 5. Effluent recycle plant at KFCL, Kanpur

TDS of 3732 ppm and produce water of almost similar TDS with 85-90% recovery; SDI (Silt Density Index) less than 3.5; turbidity less than 2 NTU and TSS less than 5 ppm as a feed to existing RO plant. Besides enjoying the distinction of being the largest ultra filtration plant commissioned in India, this plant has acquired critical importance as Manali, Chennai, where MFL is located, suffered from perennial water shortage.

4. Kanpur Fertilizers & Cement Ltd. – Effluent Recycle Plant

In recent times, Ion Exchange was installed an effluent recycle plant by Kanpur Fertilisers & Cement Ltd. (KFCL), Kanpur. Commissioned in July 2015, the 220 m3/h effluent recycle plant incorporates INDION High Rate Solid Contact Clarifier, Multigrade Filter, Activated Carbon Filter as a pretreatment to ultrafiltration and reverse osmosis system. This plant is designed to treat inlet TDS of 1000 ppm & produce water with TDS of 50 ppm with a recovery of 85% through 2 stage Reverse Osmosis plant. The state-of-the-art completely automated effluent recycle plant is operated & maintained by Ion Exchange. The treated effluent will be reused as cooling tower make-up, feed to existing demineralisation system for producing process and high purity water for steam generation.

5. Oman India Fertiliser, Oman – Condensate Recovery System

A 750 m^3/h Condensate Polishing system in 2003 was supplied for reducing use of scarce fresh water and even more expensive demineralised water. This was integrated with a 288 m^3/h wastewater treatment plant & Condensate Polishing Unit (CPU) comprising of Mixed Beds (MB1+MB2+MB3).

CONCLUSION

Water is a key component in the fertiliser sector and is required in large quantity for multiple processes. Availability of water, stringent pollution control norms have become limiting factors for the sector. By adapting prudent water conservation measures, state-of-the-art effluent treatment recycle and zero liquid discharge technology, integrate water management process that minimises waste, water reuse and source reduction will help facilitate sustainable growth of the industry. The case studies documented in this write-up are examples of the industry adapting technologies which are efficient and cost effective. ■

Zero liquid discharge in the Paint Industry

Ajay Popat

Ajay Popat
Ion Exchange (India) Ltd
Navi mumbai, India

INDIAN paint industry is likely to surge from the current level of about Rs.40,600 crore to about Rs.62,000 crore by 2016 witnessing a breathtaking double-digit compound annual growth rate. The factors that have fuelled the paint industry's growth are the rise in disposable income and education, increasing urbanization, development of rural market and various launches of many innovative products.

The unorganized sector controls around 35% of the paint market. In the unorganized segment, there are about 2,500 units having small and medium sized paint manufacturing plants. Top organized players include Asian Paints, Kansai Nerolac, Berger Paints and ICI. There have been innovations in the paint market both at the product technology and development level on the aspect of "Sustainability".

Increased usage and demand for waterborne coatings, particularly in the premium category of decorative, automotive and even industrial paints will require high purity water and systems that can produce such quality consistently in an automated mode of operation. Quality of water has direct impact on consistency and performance of these coatings. At the same time water as a resource is increasingly under pressure in our country with respect to its availability and varying quality laid in with high level of impurities – Calcium/ Magnesium, hardness, high Total Dissolved Solids (TDS), excess presence of heavy metals and micro-organisms. Thus recognizing this need of Surface Coating Industry for its customers in light, medium and heavy segments, Ion Exchange (India) Ltd. has developed customized and standard (predesigned, pre-engineered) water treatment packages using state-of-the-art demineralizing, softening, ultrafiltration (UF), reverse osmosis (RO), electro-deionization (EDI), etc. These units are skid-mounted, completely automated and backed up by 24x7 service network located at 36 strategic industrial locations in India. These service set ups provide customers in the Surface Coating Industry with comprehensive Operation & Maintenance services including supply of genuine critical spares and components like resin, membranes, media, etc.

Whilst Ion Exchange (India) Ltd. has been able to provide complete range of water treatment solutions and services, customized to every type of requirement, it also provides a range of waste treatment, effluent recycle (with the option of resource recovery) and zero liquid discharge systems, not only to meet stringent disposal norms but also economically solving water scarcity problems by conserving vast volumes of water through recycle and zero liquid discharge schemes, thereby protecting the environment by reducing discharge, whilst generating substantial savings from water reuse and resource recovery. Typically our effluent recycle solutions are integrated to yield optimal benefit. For instance, recycle systems are combined with specialty water treatment chemical programmes that substantially reduce water discharge (e.g. cooling tower blowdown); and state-of-the-art effluent treatment plants are integrated with zero liquid discharge processes.

Thus industries that have installed our INDION water treatment systems integrated with effluent treatment recycle and zero liquid discharge systems have gained an excellent payback on their investment through:

- Assured availability of water for process needs as well as low end uses.
- Less requirement of fresh water. Therefore, considerable savings in fresh water costs.
- Additional savings through recovery of valuable by-products for re-use in process.
- Compliance with pollution control regulations and a clean environment through reduced / zero effluent discharge.

Future Prospects

Growth of premium decorative paints, whose demand was earlier restricted to the urban areas, however, growing awareness and increasing disposable income levels have aided the growth of this category of paints in the rural and semi-urban areas. ■

Queries and Responses:
author.paintindia@gmail.com

WATER QUALITY INDIA ASSOCIATION LAUNCHES SEAL OF PURITY - THE FIRST MICROBIOLOGICAL STANDARD FOR WATER TREATMENT DEVICES

Leading Indian manufacturers to adopt standards that match global norms

Ahmedabad, 30th October 2015: The Water Quality India Association (WQA India) launched the first ever microbiological standard to certify household water treatment devices for consumers in India. These standards have been specifically developed for Indian conditions and match global norms. WQA India also released a recognizable mark, **SEAL OF PURITY,** which will help consumers choose water treatment devices that meet these standards. Leading water purifier manufacturers have pledged to adopt these standards. This development marks an important step towards ensuring genuine standards for water quality in a country where water borne diseases are a major health hazard.

Interesting statistics:

- Statistics compiled by the United Nations show Over 1 lakh people die of water-borne diseases annually in India.
- It is reported that groundwater in one-third of India's 600 districts is not fit for drinking as the concentration of fluoride, iron, salinity and arsenic exceeds the tolerance levels. About 65 million people have been suffering from fluorosis, a crippling disease due to high amount of fluoride and five million are suffering from arsenicosis in West Bengal alone, due to high amount of arsenic.
- The World Bank estimates 21% of communicable diseases in India are water related. Of these

diseases, diarrhoea kills more than a 1000 people in India every day. The highest mortality from diarrhoea is in children under the age of five, highlighting an urgent need for focused interventions

More than 10 Indian Water Purifier manufacturers have pledged to adopt these standards. These include leading brands like Eureka Forbes, Kent RO, Alfaa UV, Filtrex, AO Smith, Ion Exchange, Luminous, Tata Swachh and HUL among others. Together these WQA India members represent more than 70% of water purifier sales in India.

Commenting on this landmark development, President, WQA India, Rajul Parikh of Alfaa UV said: "Microbiological Standard developed by WQA India, which will be recognized as the SEAL OF PURITY, is set to become the trusted mark of the water purification industry and will give consumers assurance that the water purifier they are using is giving them safe drinking water free from microbiological contaminants."

Vikram Surendran, CEO and Sr. VP at Eureka Forbes said: "At Eureka Forbes, our vision has been to provide not just the best, but the most appropriate water purification solutions to our consumers. However, one of the key challenges the industry has faced is the lack of a common standard or certification against which products can be judged. This resulted in many unorganised players making unsubstantiated claims. We believe that the Seal of Purity by WQA India, will bring us a step closer towards creating confidence in the minds of consumers, providing them with a standard against which they can judge products and instilling in them the confidence that they would be using best-in-class technology."

Ajay Popat, President, Ion Exchange India Ltd commented "The unique Microbiology Standard for Water Purifiers is result of WQA India initiative with contributions from Indian Water Purifier Industry. The Standard, first of it's kind, developed using Global methodology will meet the vital need of Global consumers and buyers of Purifiers, to own a Product that delivers Safe, Pure Drinking Water".

About WQA India - The Water Quality India Association is a not-for-profit trade association incorporated in September 2014 under the Companies Act 2013 after running nearly six years as WQA India Task Force with the support of WQA, USA. The main objective of WQA India is to promote and represent the interest of water quality improvement industry including household, commercial, industrial water supplies, represent the interest of water quality industry before various statutory bodies and government authorities, promote water quality standards, by conducting professional certification programs.

Company Profile

ChemTECH GUJARAT WORLD EXPO 2016

Ion Exchange (I) Ltd

Ion Exchange (I) Ltd, a pioneer of water treatment in India with a legacy spanning over five decades, is recognised internationally as a premier company in water and environment management. We are among the largest environment solutions providers, one of very few companies worldwide with a complete range of technologies, products and services, which enables us to offer total solutions for every sector of the society. With sales, production and service footprints across the globe, we serve our markets with a sustained focus on customer satisfaction, technological innovation and dedicated service. Our capability to deliver comprehensive solutions with complete technical support makes us a partner to depend on.

Our Strengths

Complete Solutions for all Sectors

- Specialists in water and waste water, we offer total water and environment management solutions for - infrastructure, industry, institutions, municipal, homes and communities, urban and rural
- 360° environment management adds value across the entire circuit - from influent water through potable and industrial process water to effluent/ sewage treatment and water recycle for zero discharge and waste to energy projects for solid waste management
- Manufacturer of world class ion exchange resins – INDION Resins for water and non-water speciality applications, membranes – HYDRAMEM Membranes, water treatment chemicals and speciality process chemicals INDION Speciality Chemicals, in ISO 9001, 14001 and OHSAS 18001 certified facilities
- Design and supply of water, process liquid, waste water treatment, water recycle plants - packaged, pre-engineered and custom-built, on turnkey, BOT and EPC basis
- Comprehensive 24/7 service support ensures high performance continuity

Wealth of Expertise

- Exports to Africa, Japan, Middle East, Russia, South East Asia, UK, USA and neighbouring countries
- More than 1,00,000 installations worldwide
- Over 1000 installations in the core sector - at thermal and nuclear power stations, fertiliser factories, refineries and petrochemical plants

Extensive Infrastructure

- All India infrastructure – production facilities, sales, service, dealer network and R&D centres
- Largest service network in the water treatment industry in Asia
- Global presence through overseas sales and service operations, subsidiaries and joint ventures

Manufacturing

State-of-the-art units spread across five states of India and in UAE, committed to built-in quality achieved by quality assurance systems, advanced manufacturing processes and continuous training in manufacturing practices, safety and quality issues.

Ankleshwar, Gujarat

ISO 9001 and 14001 certified, fully automated, integrated unit for manufacture of cation and anion exchange resins for water and waste water treatment as well as non-water speciality applications. Also set up here is the US Food and Drug Administration (FDA) compliant and ISO 9001 certified facility for manufacture of pharmaceutical grade speciality resins. This facility has also secured WHO-GMP certification. Several resins used in drinking water and food & beverage applications have WQA Gold Seal and NSF 61 certification.

Hosur, Tamil Nadu

ISO 9001 certified modern 11,000 sqft facility for fabrication and assembly of pre-designed packaged and pre-engineered water and waste water treatment plants; also for manufacture of water quality monitoring instruments.

Patancheru, Telangana

ISO 9001, 14001 and OHSAS 18001 certified facility for manufacture of polyelectrolytes, cooling and boiler water treatment chemicals, RO chemicals, water quality test kits, and fireside and fuel additives. Speciality process chemicals for the sugar, paper, ceramics, oil refining and petrochemical, mining and mineral processing industries are also manufactured.

Rabale, Maharashtra

ISO 9001 certified export oriented unit for skid-mounted assembly and testing of custom-built plants before shipment. Also housing capabilities - design, engineering, project management, consultancy of customised water and waste water treatment systems.

Verna, Goa

ISO 9001 certified centre for membrane manufacture, produces world-class membrane products and systems for drinking and process water and non-water applications.

Wada (Thane), Maharashtra

ISO 9001 certified, modern facility for manufacture of FRP Hand Lay Up (HLP) and FRP Filament Winding (FW) products, RO and UF pressure tubes and composite pressure vessels, and fabrication of steel equipment/ structures and industrial electrical units.

Sharjah, UAE

Facility at Hamriyah Free Zone for assembly and testing of skid-mounted, custom-built water and waste water treatment plants. ■

Pollution Control Measures in Refinery and Downstream Petrochemical Plants

• Ajay Popat, President, Ion Exchange (India) Limited

INTRODUCTION

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

POLLUTION PREVENTION IN INDUSTRY

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

- Pollution should be reduced at the source
- Pollution products that cannot be reduced should be recycled in an environmentally safe manner
- Disposal into the environment should be used only as a last resort and should be conducted in an environmentally safe manner

RECYCLE OF WASTE WATER AND STUDY OF ITS APPLICATION IN VARIOUS INDUSTRIES

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

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

Figure1: CONVENTIONAL TREATMENT

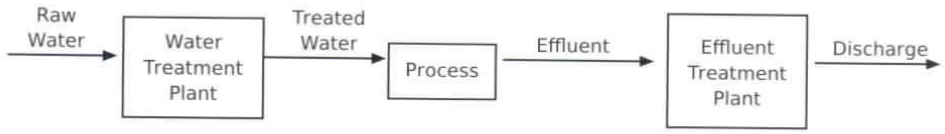
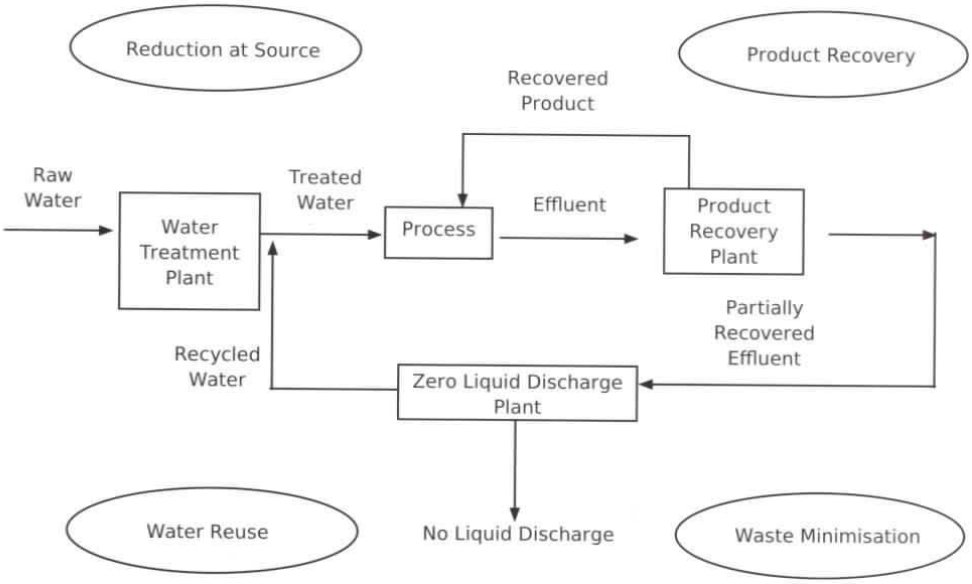


Figure 2: MODERN INTEGRATED SOLUTION



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

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

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

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

GUIDELINES FOR SELECTION OF RECYCLE SCHEME

1. Study the manufacturing process thoroughly and identify areas where reduction of water consumption is possible.

2. Identify the process where reduction of pollution load is possible by changing raw material or adopting cleaner manufacturing process.

3. Proper analysis of various streams especially targeting the contaminants which are process specific.

4. Identify streams that can be segregated and treated economically. For example, in electroplating, the rinsed water can be

segregated and treated for recovery of plating metal. This not only reduces the overall cost of recycle but also facilitates the recovery of valuable products from the waste water stream.

5. Identify effluents which are relatively clean and can be treated with simple processes so that they can be recycled internally without letting the water out into an effluent treatment plant.

6. Identify the quality of water required at various manufacturing stages. For instance, steam generation may require high quality water and washing or cooling water make-up may not require high quality water. It is always economical to design a recycle system to produce water suitable for lower end usage.

7. Select a technology that is easy to implement, operate, maintain & service.

8. Look for the availability of spare parts that may be needed in the future.

9. Reliability of performance in the long run is extremely important.

10. Low in operating cost.

11. Good service network of the plant supplier.

RECYCLE TECHNOLOGIES

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

1. Effluent treatment

2. Tertiary treatment

3. Advanced tertiary treatment

4. Zero liquid discharge

EFFLUENT TREATMENT

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

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

Effluent Treatment Technologies (Primary and Secondary)

Pollutant	Treatment Technology
Floating matter	Manual bar screens, mechanically cleaned screens, drum screens, etc.
Grit	Manual grit chambers, aerated grit chambers, deaerator, etc.
Oil & grease	Oil & grease traps, API oil separators, TPI oil separators, dissolved air flotation (DAF) systems, tubular ultra filtration, etc.
Acidity/alkalinity	Neutralisation using acid/ alkali dosing
Suspended solids	Clarifiers, clariflocculators, high rate solids contact clarifiers (HRSCC), lamella clarifiers, tube settlers, DAF, ultra high rate clarifiers, pulsating clarifiers, etc.
BOD/COD/NH_4/TKN/TP/ Phenol/CN/SCN	Biological systems such as activated sludge process, trickling filters, sequential batch reactors (SBRs), membrane bio-reactors (MBRs), etc.

Heavy metals	Precipitation using solid contact clarifiers, ion exchange processes, membrane systems for metal recovery, etc.
Toxic substances	Different treatment technologies are adopted based on the nature and concentration of toxic substances. For example, phenols can be removed with biological systems at low concentrations whereas chemical oxidation may be required for higher concentrations.
Recalcitrant compounds/ COD	Photo-chemical oxidation is used to remove or break recalcitrant and complex organics such as phenols, benzene, pesticides, etc.

TERTIARY TREATMENT

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

Tertiary Treatment Technologies

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

ADVANCED TERTIARY TREATMENT

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

Advanced Tertiary Treatment Technologies

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

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

ZERO LIQUID DISCHARGE TREATMENT

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

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

The MEE process uses either mechanical or thermal vapour compression using forced

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

WATER MANAGEMENT IN REFINERY - CASE STUDIES

1. RELIANCE INDUSTRIES LIMITED

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

Waste water treatment is carried out in a dedicated state-of-the-art completely automated and PLC operated effluent treatment plant supplied by Ion Exchange. The effluent treatment area is designed to contain and treat all internal process/utility waste water and storm/fire water with the objective of zero discharge from the new refinery complex. The treated water is recycled as cooling tower make-up and partially used as process water after reverse osmosis treatment to the high total dissolved solids treatment train or guard tanks, as required.

Effluents are segregated into four identical waste water streams designed for a treatment capacity of 500 m^3/h each and maximisation of reuse.

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

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

- Free oil removal facilities including pre-deoiler and API separators with continuous oil skimming and sludge removal facilities

Effluent Treatment Plant at Reliance Industries Limited, Jamnagar, Gujarat

Section of Zero Liquid DischargePlant at Indian Synthetic Rubber Limited

- Dissolved air flotation (DAF) unit
- Two stage biological treatment
- Clarification
- Dual media filtration
- Activated carbon adsorption
- Disinfection – with chlorine and chlorine dioxide

The effluent treatment plant is treating 100% effluent generated by the refinery since its commissioning in December 2008 and consistently produces treated effluent (pH 6 - 8.5, sulphide < 0.5 ppm, COD < 50 ppm, oil and grease < 5 ppm, phenol < 0.35 ppm) meeting guaranteed parameters for reuse for various applications mentioned earlier.

2. CHENNAI PETROLEUM CORPORATION LIMITED

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

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

3. INDIAN SYNTHETIC RUBBER LIMITED

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

objective of > 95 per cent water recovery and ZLD.

CONCLUSION

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

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

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

About the Author

Ajay Popat
President
Ion Exchange (India) Limited
Responsible for Corporate Diversification, Corporate Marketing Group, Technology and Corporate Communications.

Ajay Popat pursued his engineering degree in Plastics Technology from the Plastic & Rubber Institute, UK and achieved his MBA specialising in Marketing & Strategy with honors from NMIMS Institute. He is also conferred with a Fellowship by Indian Plastics Institute in 2007.

Ajay Popat has more than 30 years of experience in Strategy, Business & Organisation Development with leading organisations like Ion Exchange (India) Limited, Pidilite and RPL. He has been associated with Ion Exchange since 1994 and has spearheaded company's several initiatives in developing and successfully commercialising proprietary, advanced & sustainable technologies for purification & separation in water, wastewater treatment and more recently in areas of renewable energy in compliance with legal, environmental, economic and social requirement of our country.

Ajay Popat is active in promoting the cause of water industry through active participation with the Water and Environment Council in CII, FICCI, Bombay Chambers of Commerce, Indian Environmental Association, Water Quality Association – India Task Force and other trade bodies. He has chaired and delivered more than 100 papers on the subject of Sustainable Environment Management practices. He continues to play an active role to facilitate the industry & its associated initiatives to achieve efficiency and excellence in water management practices benefiting all stakeholders.

Weblink: http://www.indiainfoline.com/article/news-sector-information-technology/zero-b-kitchen-mate-now-with-revolutionary-ess-technology-116033000238_1.html

Zero B Kitchen Mate now with revolutionary ESS technology

India Infoline News Service | Mumbai | March 30, 2016 15:06 IST

Zero B Kitchen Mate is safe as voltage cuts off if the current and voltage increase from the specified limit.

Ion Exchange (India) Limited, India's largest water management company under its flagship brand **ZERO B** introduces **Kitchen Mate**, a phenomenal breakthrough world over in the reverse osmosis based home water purification with ESS (Electrolytic System Sanitizer) technology first of its kind that protect storage tank water from slime formation 24 x7. This 7 stage RO water purifier helps to remove heavy metals, chemical impurities, micro-organisms and other contaminants from the water and gives crystal clear pure drinking water. Kitchen mate is a perfect choice for designer kitchens as it fits under the sink thereby saving valuable kitchen space.

Zero B Kitchen Mate is safe as voltage cuts off if the current and voltage increase from the specified limit. With this launch Ion Exchange reiterates its commitment towards its customers by understanding and catering to their specific needs through innovation in technology.

Speaking at the launch **Rajesh Sharma, Chairman and Managing Director, Ion Exchange (India) Limited said,** "Increasing awareness about health and primary concern about purity of water has triggered the demand for clean and safe drinking water. Keeping this in mind, we designed the stylish range of Kitchen Mate RO water purifiers for Indian homes. The product ensures pure and healthy drinking water irrespective of the harsh water conditions in different regions. All water purifiers by Ion Exchange are equipped with latest technologies not just for the convenience of our customers' health but also for a greener and sustainable society."

Zero B Kitchen Mate RO removes all dissolved solids like calcium, magnesium, sodium, bicarbonates, chlorides, sulfates, etc. present in water by 90% and thus converts saline water into clear natural tasting water. It also removes harmful minerals like arsenic, fluoride and lead. The product comes with a high capacity cartridge that disinfects water to eliminate bacteria and viruses. The elegant stainless steel finish body is perfectfor modular kitchens. Another noteworthy feature of the product is its auto-flush timer that periodically flushes the membrane to remove the salts deposited on the membrane therefore enhances the life of membrane.

At Ion Exchange, we know the importance water plays in achieving and maintaining a healthy lifestyle for you and the ones you care for. We have made it our goal to provide you with an adequate amount of life-sustaining safe and fresh-tasting water every day.

Apart from India's first technology in water purifier ESS that will protect tank water 24 x 7 by preventing bacteria formation this has loaded with more features for customer benefits such as Intelligent Auto Fill which will ensure that the RO purifier never runs out of pure & safe drinking water. This has been

equipped with Double Safety which provides additional safety by offering 100% germicidal protection. TLC value, ensures pump cut off whenever the tanks fill up, Pressure booster pump provides constant water pressure to the system. Dry Run Protection* avoids unnecessary wastage of power and shuts off when there is no water.

Kitchen mate comes with Hydropneumatic Tank, with storage capacity of 8 ltrs, provides pressurized water at a very high flow rate from the faucet.

Product output water is certified by USEPA drinking water standard and IS 10500