Impact Factor (SJIF): 3.632

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444

Volume 4, Issue 2, February-2017

A Review of Zero Liquid Discharge in Chemical Industry

Urvij Dave[1], Kinjal Patel[2], Rushabh Aghera[3], Dharmen Mistry[4], Ekta Jasrotia[5]

[1]*Department of Environment science and technology Shroff SR Rotary Institute of Chemical Technology, Vataria*
[2]*Department of Environment science and technology Shroff SR Rotary Institute of Chemical Technology, Vataria*
[3]*Department of Environment science and technology Shroff SR Rotary Institute of Chemical Technology, Vataria*
[4]*Department of Environment science and technology Shroff SR Rotary Institute of Chemical Technology, Vataria*
[5]*Department of Environment science and technology Shroff SR Rotary Institute of Chemical Technology, Vataria*

Abstract — *Zero Liquid Discharge (ZLD) is an ideal situation of complete closed loop cycle, where discharge of any liquid effluent is eliminated; it is a remarkable effort of every industry who implements it to meet with the environmental regulation in a challenging way.For achieving ZLD system for the industry, certain steps are needed to be taken. These steps include: Analysis of major characteristics of all influent streams entering into ETP, Identification of potentially recyclable streams and highly polluted stream, Segregation of streams on the basis of their characteristics and applicability of 4R (Reduce, Reuse, Recycle and Recover) principle in particular plant. Optimization of Effluent Treatment Plant (ETP), RO Plant and Multi Effect Evaporator (MEE) plant. The industry, for which we are working on ZLD, is basically a chemical industry discharging around 370 m3/day. By achieving ZLD, this huge discharge can be eliminated and daily water consumption of industry can be reduced significantly.*

***Keywords** - Multi effect evaporator (MEE), Zero Liquid Discharge (ZLD), Reverse osmosis(RO),Effluent, Environmental*

I. INTRODUCTION

Everyone needs water. Supplies of water are vital for agriculture, industry, recreation and human consumption. One problem that the water industry faces is disposal of concentrate from advanced water treatment processes. This report discusses Zero Liquid Discharge (ZLD) systems, one possible solution to concentrate disposal. ZLD disposal is the only option currently available in many inland regions where surface water, sewer, and deep well injection disposal are prohibited. A ZLD-system can produce a clean stream from industrial wastewater suitable for reuse in the plant and a concentrate stream that can be disposed, or further reduced to a solid. Furthermore, the prevalent technologies used for ZLD-systems and different types of components in a ZLD-system are being described in this review paper.

II. OPTIONS FOR ACHIEVING ZLD

ZLD can be achieved by the conventional primary, secondary and tertiary effluent treatment modified by the combinations of facilities such as:

- Reverse osmosis (RO)
- Lime Softening (LS)
- Thermal Brine Concentrator (BC)
- Crystallizer (Cryst)
- Spray Dryer (SD, used only for low-volume flow)
- Evaporation Pond (EP)
- Landfill (LF)

We can either select any one or combination of techniques given above depends upon the feasibility of reuse of treated waste water or recovered waste, as well as type of the industry.

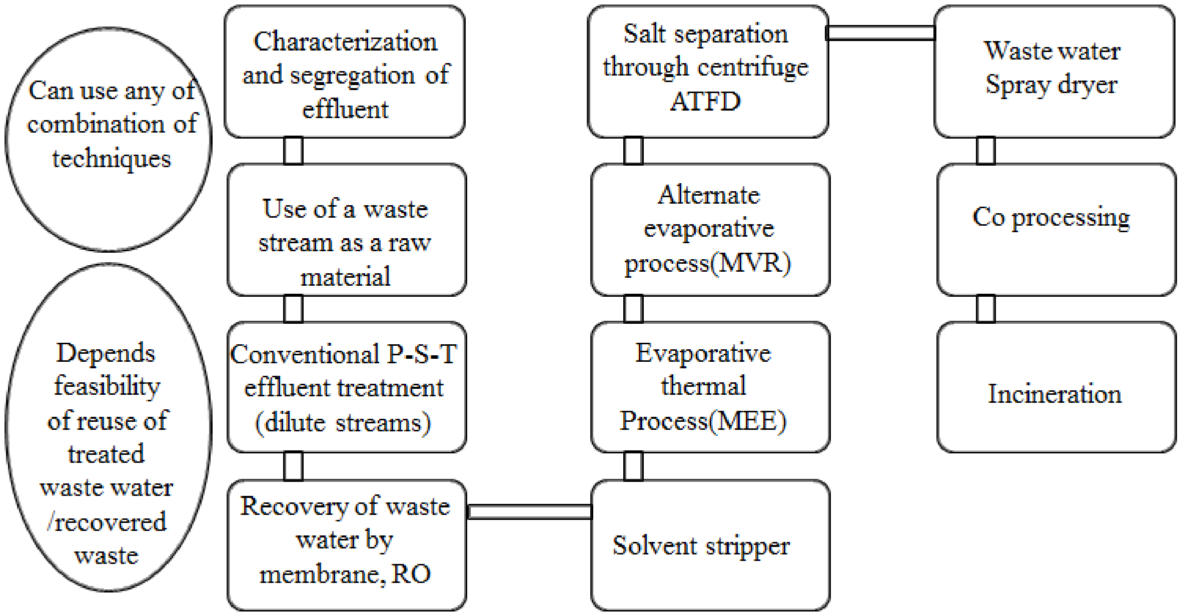

Figure : 1.options for achieving ZLD

2.1 RO

Reverse osmosis is a water purification technology that uses a semi permeable membrane to remove ions, molecules, and larger particles from drinking water. Reverse osmosis can remove many types of dissolved and suspended species from water, including bacteria and is used in both industrial processes and production of potable water. The result is that the solute is retained in the pressurized side of the membrane and the pure solvent is allowed to pass through the other side .The advantage of RO over evaporation is that the life cycle costs of RO are about half those of evaporators.Reverse osmosis is a process where water is pressurized so that it passes through a semi-permeable membrane, leaving dissolved inorganic salts and silica behind. As a rough guide to performance, RO can produce a concentrate containing 30000 ppm total dissolved solids (TDS). Two problems with RO are that organics will seriously foul RO systems and that RO requires a feed stream that is free of suspended solids. Because of this it is advisable to remove organics from wastewater before it enters the RO, so extensive front-end filtration equipment is required. Some membranes are pH and temperature sensitive, so pH control and feed equalization may be necessary. RO is also quite energy-intensive. The advantage of RO over evaporation is that the life cycle costs of RO are about half those of evaporators.

2.2 EDR

Electrodialysis reversal (EDR) is a membrane process in which electrolytes migrate across charge-selective membranes in response to an electrical field. In EDR, the polarity of the electrodes is reversed several times an hour and the fresh water and the concentrated wastewater are exchanged within the membrane stack to remove fouling and scaling. EDR differs from RO in that the ions are removed and the water is left behind, whereas in RO, the water is removed and the ions are left behind. Because of this, silica and dissolved organics are not removed with an EDR process, which is an important aspect to remember when the clean stream is reused. Like RO, EDR requires solids and organics removal from the feed for reliable operation.

2.3 EVAPORATOR

An Evaporator is a device used to turn the liquid form of a chemical into its gaseous form. The liquids is evaporated or vaporized into a gas. An Evaporator is used in air conditioning system to allow a compressed cooling chemical such as R-22(Freon) or R-410A, to evaporate from liquid to gas while absorbing heat in the process. It can also be used to remove water or other liquids from mixtures. The most prevalent type is the falling film evaporator, also called brine concentrator. This evaporator can treat RO or EDR concentrates to a total solids (TS) concentration of 300 000 ppm. At this value the boiling point rise of the brine results in either an excessively large heat-transfer area (large capital cost) or an excessively large temperature difference (large operating cost). Values higher than this makes the combination of a crystallizer and an evaporator more economical than an evaporator alone.

2.4 CRYSTALLIZER

The crystallizer reduces highly saturated wastewater to dry solids for disposal. High purity water is recovered from the crystallizer for recycling. A crystallizer may also recover specific salts from a mixed salt waste stream. The crystallizer is a forced circulation evaporator which uses a mechanical vapor compressor or plant steam as the energy source.

2.5 SPRAY DRYER

Crystallization is a chemical solid-liquid separation technique, in which mass transfer of a solute from a liquid solution to a pure solid crystalline phase occurs. In Chemical engg crystallization occurs in a crystallizers. Crystallizers are used in industry to achieve liquid solid separation. They are an important piece of chemical processing equipment because they are capable of generating high purity products with a relative low energy input. The crystallizer reduces highly saturated wastewater to dry solids for disposal. High purity water is recovered from the crystallizer for recycling. A crystallizer may also recover specific salts from a mixed salt waste stream. The crystallizer is a forced circulation evaporator which uses a mechanical vapour compressor or plant steam as the energy source.

2.6 AGITATED NUTSCHE FILTER DRYER (ANFD)

Agitated Filter is a closed vessel designed to separate solid and liquid by filtration under pressure or vacuum. The closed operation ensures odorless, contamination free and nonpolluting working conditions maintaining product purity and hygiene. The advanced technology of agitation and hydraulics used in the equipment makes it versatile and user friendly. The resulting wet cake can be reslurried and washed thoroughly with water or solvents unlike in" NUTSCHE" type filters or centrifuges. Wash liquid quantity can be controlled and recycled, reducing effluent load. The discharge of wet cake is automatic. If the process demands filtration in chilled or hot condition, it is also possible. Drying of wet cake is also possible when drying features are incorporated. The equipment is functionally safe and easy to operate. It can carry out various phase of process operations, viz: Crystallization, filtration, extraction, Discoloration, Washing and drying. The numbers of conventional machines employed for filtration process are also reduced. It has multi- functional utility, saves on power, labor, floor space, material wastage and time. The filter/filter dryer has wide field of applications in chemical, pharmaceutical, Agro chemicals, fine chemicals, and food industries. Sterilizable pharma versions are available for aseptic requirements.

The movements of agitator are:

1. Clock wise rotation: For smoothing cake surface and compacting it during filtration.
2. Antilock wise rotation: F or stirring near filter media to keep it clear of sedimentation, reslurring while washing and atomized discharging.
3. Upward movements: Operated by hydraulic cylinders at constant speed to assist mixing.
4. Down ward movement: Operated by hydraulic cylinders with variable speed to assist squeezing and discharge

III. APPLICATION OF TREATED WASTE WATER:

The potential application for the reuse of recycled water:

- In cooling towers, especially large scale industry
- Can be used in the gardening purpose for watering plants and lawns
- In toilet flush
- In water scrubber as scrubbing media
- For preparing lime slurry for ETP
- Different industrial washing operations
- Boiler feed water (particularly for generating steam for MEE)

IV. ADVANTAGES/ BENEFITS:

- Water Conservation
- ZLD systems employ the most advanced wastewater treatment technologies to purify and recycle virtually all of the wastewater produced.
- Reduces the wastewater discharge i.e. reduces water pollution
- Preferred option for industry where disposal of effluent is major bottleneck
- Prevents exploitation of hydraulic capacity of disposal system
- Separation of salts / residual solvents improve efficiency of ETP and CETP
- Separated solids valuable by-product which helps in reducing the payback period
- Mixed solvent separated in stripper can be reused or used as Co-processing
- Ease in getting environmental permissions
- More focus on production/ business rather than tracking after regulatory authorities
- Reduction in water demand from the Industry frees up water for Agriculture and Domestic demands.

Possibility of use of sewage for recovery of water, for Industrial and municipal use, using ZLD technologies.

CONLUSION

ZLD implementation is growing globally as an important wastewater management strategy to reduce water pollution and augment water supply.

ACKNOWLEDGMENT

The authors would like to thank Mr. Urvij Dave of department of Environmental Science and Technology, SRICT for support and guidance in this paper. We would also like to appreciate all the faculty of department of science and technology, SRICT.

REFERENCES

[1] Dr.Komal. Mehta "Design of Reverse Osmosis System for Reuse of Waste Water from Common effluent treatment Plant" (E-Issn: 2395 -0056)

[2] P. Kousi, E. Remoundaki, A. Hatzikioseyian, M. Tsezos "Sulphate –Reducing Bioreactors: Current Practices and Perspectives" (Iwabalkanyooung Water Professionals- 2015)

[3] J. Suschka And L. Przywara "Chemical And Biological Sulfates Removal" (University Of Bielsko- Biala 43-309 Bielsko- Biala, Ulwillowa 2, Poland)

[4] Michael mickey; "Survey of High –Recovery and Zero Liquid Discharge Technologies for Water Utility" (Water reuse Foundation)

[5] Amit Udgirkar, Sr. Manager; "Zero Liquid Discharge for the Industrial Sector"; Environmental Engineering, (Praj Industries Ltd)

[6] Viatcheslavf reger, Wolfson; "Zero Liquid Discharge (Zld) Concept, Evolution And Technology Options"; Israel Institute Of Technology, Haifa, Israel ("Zero Liquid Discharge" Workshop, Gandhinagar (January 27 - 28, 2014)

[7] I. Sajid Hussain, Chief Operating Officer,. "An Overview of Case Studies On Zero Liquid Discharge" Tamilnadu Water Investment Company Limited

[8] Guidelines on Techno – Economic Feasibility Of Implementation Of Zero Liquid Discharge (Zld) For Water Polluting Industries - Cpcb

[9] Mehta Komal P. And Patel A.S (Journal Of Environmental Research And Development) "Reverse Osmosis Design With Hydranautics Design Software For Industrial Waste Water Reuse"

[10] Overview of Industrial Pollution Management Policies In India And Context Of Zld – Hardik Shah, Member Secretary, Gpcb

[11] R.Sadik,R. Lahkale, N. Hssaine, M. Diouri And E. Sabbar "Sulfate Removal From Wastewater By Mixed Oxide";Euilibrium, Kinetic And Thermodynamic Studies; (Issn : 2028-2508)

[12] Huldeswanepoel "Sulphate Removal From Industrial Effluents Through Barium Sulphate Precipitation"(Dissertation Submitted In Fulfilment Of The Reuirments For The Degree Master Of Engineering In Chemical Engineering At The Potchefstroom Campus Of The North- West University)

[13] Achieving Compliance With Zero Liquid Discharge Norm; Sn. K. Srivastava, Adviser, Tata Strategic Management Group 3rd; annual Conference On "Balance Of Plant"-New Delhi22nd& 23rdmay 2013"

[14] J.P.Maree, I. Netshidaulu, G. Strobos, R. Nengovhela And A.J. Geldenhuys "Integrated Process For Biological Sulphate Removal And Sulphur Recovery"; (Division Of Water, Environment And Forestry Technology, Csir, Po Box 395, Pretoria, 0001, South Africa)

[15] Joe Bostjancic "Getting To Zero Discharge: How To Recycle That Last Bit Of Really Bad Waste Water" Rodiludlum, Resource Conservation Company (Rcc) (Ge's Water & Process Technologies)

[16] "Removal Of Pesticides From Water By NF And Ro membranes- By Chemical Process" Engineering Research Institute , Center For Research And Technology- Hellas, P.O. Box 60361, 6th Km Charilaou- Thermi Road, Thermi, Thessaloniki, Gr 57001, Greece)