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## Application of Membrane Technology in Waste Handling

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Dr. A.V.R. Reddy is a Senior Scientist & Head, Reverse Osmosis Membrane Discipline, CSMCRI, Bhavnagar with about 29 years of research experience in the field of synthetic polymers and membrane technology. He has experience in the development of TFC RO membranes and fouling resistant ultrafiltration for desalination & water purification, solvent-resistant polyimide membranes for the recovery of organic solvents and acid resistant membranes for the treatment of dye effluents. He is presently involved in the development of hollow fiber membranes and submersible membrane systems, etc., for water reclamation applications. He has 48 publications in various international journals, guided and supervised 3 Ph.D. candidates, 6 M.Phil. students and 10 M.Sc./M.Tech project students.



### ABSTRACT

Treatment of industrial effluents or process water is essential for protecting the environment & reducing pollution, besides augmenting water for reuse in production processes. Membrane separation processes such as reverse osmosis (RO), nanofiltration (NF) and ultrafiltration (UF), which were originally developed for desalination of brackish and sea water and for water refining to obtain safe drinking water, have received great importance in recent years for the treatment of industrial effluents for water reclamation for industrial use, and for product recovery & pollution control in the chemical, electronic, food and biotechnology industries. In general, they require minimal temperature changes and chemical addition, operate in either continuous or batch modes, use significantly less energy than traditional separation processes, do not alter the chemical structure of the processed materials, and are easy to integrate into existing processes due to their modular nature and compact size. Different membrane types are filling niches in specific applications in treating different industrial effluents, often as replacements for older technologies, as they offer an effective and economic tool to provide solutions to various commercial, social, and environmental needs. CSMCRI has developed different type of membranes which can find applications in desalination, for water reuse and recycling of contaminated water, for the separation of organic solvent mixtures, etc. as follows.

- Developed polyamide thin film composite (TFC) reverse osmosis membrane (1m wide x 100m long in a batch) according to phase inversion & interfacial polymerization processes. TFC membrane is suitable for desalination of brackish water and sea water, water reclamation, water purification and other separation applications. Using the indigenous TFC membrane, several brackish water and desalination plants (500-5000 LPH) and a 1 MLD capacity water purification plant have been installed in the country. Further, recovery of water/acetic acid from the effluent containing water-acetic acid- aromatic carboxylic acids was carried out on a pilot scale RO unit and reusable water/acetic acid could be obtained.
- Developed low fouling flat sheet acid resistant UF/NF membranes and hollow fiber UF membranes which are suitable for water reclamation from industrial effluents, for the recovery of acid/water from acid effluents having low molecular weight organic solutes like naphthalene sulphonic acid, for the treatment of dye effluents, etc. The membranes were evaluated for the treatment of textile dye solutions containing solute sizes in the range of 600-1000 Da in order to mitigate the environmental pollution associated with the effluent discharges. The water fluxes of the membranes are in the range of 3560 l/m<sup>2</sup>-h at the operating pressure of 3 kg/cm<sup>2</sup>. Textile dye solutions could be treated up to 80-90% volume concentration using ultra-nanofiltration membranes having solute exclusion groups and the concentrate was evaporated to obtain solids containing dye and salts. The membranes have shown rejections of >99% for dye solutes, which results in the production of reusable water with zero discharge.
- Developed polyimide based solvent resistant membranes for low temperature (-10 to -15°C) separation of toluene & methyl ethyl ketone from lube oil mixture and for the separation of hexane from vegetable oil mixture. Solvent separation of about 95% could be obtained from the mixture containing equal amounts of toluene & methyl ethyl ketone and lube oil at -15°C, which is used in lube oil processing.