CERAMIC MEMBRANE

NETWORK PROJECTS

Industrial waste minimization and clean up

Waste water treatment for reuse and recycling purpose is gaining importance due to the enactment of strict environmental pollution control measures and shrinking availability of fresh water. Use of ceramic membranes have gained currency in the waste water treatment. It has several advantages such as stability towards high temperature, high pressure, abrasion, chemical attack and pH resistance. Cross flow microfiltration with ceramic membranes is known for waste water treatment from distilleries, breweries, fermentation industry, etc.

Treatment of waste water from textile industry

Laboratory studies were conducted on cross flow microfiltration system for treatment of waste water from the textile industry.

Two types of effluent samples: hot boiling water and chlorine treated water were collected from a fabric sizing unit at Kolkata. These samples were treated by cross flow micro-filtration (CMF). The raw effluent, permeate and retentate were characterized for particle size distribution, turbidity, pH, TDS, DO etc. Lab scale studies showed that turbidity (TSS) reduction was possible up to < 1 NTU from the feed turbidity of 150-200 NTU in the textile waste water. The process may be used as pretreatment for TSS removal.

Effluent from textile dye house having various reactive dyes was characterized in terms of turbidity, pH, color, TDS, conductivity etc. Two types of dye house effluent samples were collected from a local dye house (a) Bi-colored effluent having a mixture of two reactive dyes viz. reactive red and reactive black and (b) composite effluent sample containing several reactive dyes.

For treatment of effluents, three approaches were followed: (a) Hybrid cross-flow micro-filtration (HCMF) where adsorption media was added in situ (b) Pretreatment of effluent using coagulants followed by cross-flow micro-filtration and (c) Pretreatment of effluent using coagulants followed by hybrid cross flow micro-filtration. In the hybrid process, >99% dye removal was obtained in the bi-colored effluent (initial dye concentration of 77 mg/l for red and 252 mg/l for black dye respectively).

The possibility of reusing the ceramic membrane treated effluent was explored in collaboration with the industry. The permeate from HCMF of bi-colored effluent was used in the dyeing of 100% cotton knits wear with addition of the associated chemicals in the normal dose. The sample of cotton fabric dyed using treated water was compared with that dyed using fresh water. Further studies with regard to the addition of the associated chemicals in the make-up charge during dyeing of cotton fabric using membrane treated effluent is in progress.

Environment friendly leather processing technology

The objective of this project is to develop prototypes using emerging technologies based on ceramic microfiltration membrane for improved pretreatment system for RO (Reverse Osmosis), removal of faecal coliform from municipal wastewater. The major work done were: characterization of raw effluent collected from four different stages of beam house from a local tannery unit and bench scale studies using ceramic micro-filtration membrane module for treatment of tannery wastewater and determination of physical parameters of the permeate system using sectional and composite samples. Permeability studies with respect to flux and turbidity removal was undertaken after cleaning of the membrane surface following three different routes viz. chemical cleaning, incineration of the membrane element at 1000°C and a combination of incineration and chemical cleaning.

The salient outcomes of the study were: (a) The possibility of cleaning and regeneration of the membrane layer by incineration of the organics present in the fouling layer were explored by thermal analysis and the study of the effect of incineration temperature on the permeability characteristics were carried out after heating the fouling membrane element at different temperature (800 – 1000°C). Chemical cleaning after incineration resulted in the decrease of permeated turbidity < 1 NTU without improvement in throughput capacity.

![Composite Tannery Effluent (CTE/T28/2.1K) vs Supernatant of Composite Tannery Effluent (SCTE/T28/2.1K)]

Effect of feed conditions on turbidity removal through alumina coated (KM/B11/M2A37) ceramic element at 1.2 kgcm⁻² TMP
(b) The temperature range used for incineration of organics were found to cause irreversible changes in the membrane layer and feed pretreatment followed by chemical cleaning exhibited better performance. (c) Protein removal of 50% and 85% could be obtained using CMF and HCMF techniques respectively. The spectrophotometric analysis revealed considerable color removal.

**EXTERNALLY FUNDED PROJECTS**

**Installation of arsenic removal unit using ceramic membrane module.**

Designing a hybrid system consisting of suspended adsorbent media and cross flow micro-filtration technique is a novel approach for removal of arsenic and iron from ground water and to cater to the need of safe drinking water for community use. The basic components of this hybrid system are (i) absorption of arsenic by colloidal media particles suspended in water and (ii) application of membrane based separation technique for solid-liquid separation using ceramic micro-filtration membrane module. The salient features of the technology are:

- Simultaneous removal of arsenic and iron from highly contaminated ground water below the limits recommended by WHO
- Modular design with flexible production capacity
- Semi-automatic user friendly operating procedure can be operated by female community members
- Low sludge volume

At the instance of Public Health Engineering Department (PHED), Govt. of West Bengal, four number of community models of Arsenic Removal Plants (2500 LPD capacity) were installed during March-April, 2003. Monitoring of the performance of the plants were carried out during 2004-06. All the plants were running successfully with minimum of maintenance. The Institute extended support towards periodical cleaning of sludge, fresh charge of media and quality control of the filtered water. A documentary film was produced on "Taming Arsenic" highlighting the health benefits experienced by the community after using the quality drinking water produced at these arsenic and iron removal plants. Field visits, awareness programmes, lectures to demonstrate the sustainability of the technology through community participation towards lowering the operation and maintenance cost of the plant attracted the private entrepreneurs and financial organizations to take up projects for setting up these plants under SSI Sector with marginal investment for production of safe drinking water for community use. Three private entrepreneurs took the license for procurement and installation of 3 plants. The West Bengal based entrepreneurs were Antique Aqua (Bashirhat), Spandan (Shyamnagar) and Atraye Aqua (Balurghat).

**Development of ceramic cartridge filter for pre-treatment of sea water**

Reverse Osmosis (RO) membrane technology has been accepted as a promising technology for desalination of brackish water and sea water for future solution of drinking water needs on a large scale. A pre-requisite for successful operation of a RO plant is feed pretreatment for removal of suspended solids and other particulate matter, which would otherwise would lead to fouling of the RO membrane. RO feed water requires a Silt Density Index (SDI) of <3 which implies bringing down the suspended solids level to < 1 ppm. The conventional feed pretreatment technique for Sea Water Reverse Osmosis (SRWO) includes use of flocculation-coagulation process, lamella clarifier, sand filter, activated carbon treatment and disposable type polymeric cartridges which usually have a life of 3-6 months. Since ceramic membranes have longer life span due to better chemical and mechanical stability, and can accommodate highly turbid feed water with periodical cleaning by back flushing/pulsing, a feed pretreatment unit based on ceramic membranes can be a viable alternative to the existing pretreatment system.

This project sponsored by BRNS, was aimed at evaluating suitability of the low cost porous ceramic elements developed by CGCRI for removal of iron and arsenic from ground water for pretreatment of sea water. A pretreatment unit consisting of two modules, a high flow pump and a frame for fitting 3 modules was fabricated and installed at SWRO pilot plant of Desalination Division, BARC, Mumbai and put on trial to test its efficiency using service water and partially treated sea water using sand filter. A detailed laboratory evaluation was carried out using highly turbid feed water to compare the results of pilot scale studies. The results of the bench level studies are as follows:

(a) Ceramic elements are suitable for treatment of turbid water (100-115 NTU) with turbidity removal of > 99% producing turbidity level of < 0.1 NTU irrespective of the nature of feed water (Ground water and River water).
(b) Higher turbidity removal in case of ground water and river water may be attributed to the formation of a cake layer of the particulate matter present in the feed stream at the particular cross flow velocity. Further studies are in progress.

**Pilot scale demonstration of ceramic membrane based iron removal plants in North Eastern states**

North Eastern States of India account for a large storehouse of replenishing freshwater, but the people of the hill region often lack the access to safe and adequate drinking water and sanitation for agriculture and livestock. Mainly iron and sometimes arsenic and fluoride are the contaminants which mar the quality of water in this region. Under a DST sponsored project, two iron removal plants (5000 LPD capacity) in each of the eight states are planned to be installed in the north-eastern region. One plant each was installed in Assam (Guwahati) and Tripura (Udaipur). Two plants were installed in Nagaland (Dimapur – one in Walford Colony and the other in Chakhessang Colony). The two plants in Nagaland were inaugurated on February 11, 2006.

Iron removal plant based on CGCRI technology installed at Dimapur, Nagaland. (Inset) Mr. Imkong M. Imchen, Minister of Science & Technology, Government of Nagaland seen with Dr. H. S. Maiti, and other dignitaries after inauguration of the plant.