TOTAL WATER MANAGEMENT FOR INDUSTRIAL WATER CONSERVATION

WELCOME TO WORKSHOP ON “WHAT CAN INDUSTRY DO TO CONSERVE WATER & REUSE” ORGANISED BY SAUDI ARABIAN WATER ENVIRONMENT ASSOCIATION (SAWEA)

AT HOTEL HOLIDAY INN, AL KHOBAR

ON 6TH DECEMBER, 2006

PRESELTOR: ION EXCHANGE (INDIA) LIMITED

LOCAL ASSOCIATES: H.K. GROUP OF CORPORATION
Incorporated in 1964 as a subsidiary of the UK-based Permutit which became a fully Indian owned company in 1985.

First Company in India to start manufacturing World-Class Ion Exchange Resins.

More than 40,000 installations in India and Abroad. Over 400 installations in Industries like Nuclear, Power, Fertilizer, Oil & Gas, Petrochemical, Pharma, Pulp & Paper, Chlor-Alkali.

All operating units are ISO 9000: 2000 certified; Resin & Chemical manufacturing units are ISO 14000 certified.
Total Solutions for Industry, Homes, Communities

Total Water Management

- Drinking Water Purification
- Water Treatment
- Post Treatment
- Waste Water Treatment
- Total Service Support
- Resins Membranes Chemicals
- Water Recycle
- Sullage/ Sewage Treatment

Pre-Treatment
THE WIDEST PRODUCT RANGE INTERNATIONALLY...

✓ INDUSTRIAL WATER & WASTE WATER TREATMENT PLANTS
✓ ION EXCHANGE RESINS
✓ WATER TREATMENT CHEMICALS
✓ HOUSEHOLD / INSTITUTIONAL WATER TREATMENT EQUIPMENT
Water Technology Development Chart

State of the Art
1970s/1980s
Early Systems

Pretreatment with UF system
Conventional Pretreatment
Conventional Pretreatment

Reverse Osmosis
Mixed-Bed
Cation / Anion

RO-EDI
Mixed-Bed
- **MICROFILTRATION** is a low pressure membrane process for separating suspended solids from a feed stream. Water, salts, and select macromolecules pass through a semi-permeable membrane, while suspended solids are retained and progressively concentrated.

- **ULTRAFILTRATION** is a low pressure membrane process for separating high molecular weight species from a feed stream. Water, salts, and low molecular weight species selectively pass through a semi-permeable membrane, while macromolecules and suspended solids are retained and progressively concentrated.

- **REVERSE OSMOSIS** is a high pressure membrane process for separating low molecular weight species from a feed stream. Water selectively passes through a semi-permeable membrane, while salts and macromolecules are retained and progressively concentrated.
# Membrane Filtration Spectrum

<table>
<thead>
<tr>
<th>Separation Process</th>
<th>Reverse Osmosis</th>
<th>Ultrafiltration</th>
<th>Particle Filtration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td>Nanofiltration</td>
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<td>Microfiltration</td>
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<table>
<thead>
<tr>
<th>Relative Size of Common Materials</th>
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<tbody>
<tr>
<td>Aqueous Salt</td>
</tr>
<tr>
<td>Carbon Black</td>
</tr>
<tr>
<td>Paint Pigment</td>
</tr>
<tr>
<td>Giardia Cyst</td>
</tr>
<tr>
<td>Human Hair</td>
</tr>
<tr>
<td>Metal ion</td>
</tr>
<tr>
<td>Virus</td>
</tr>
<tr>
<td>Bacteria</td>
</tr>
<tr>
<td>Beach Sand</td>
</tr>
<tr>
<td>Tobacco Smoke</td>
</tr>
<tr>
<td>Yeast Cell</td>
</tr>
<tr>
<td>Mist</td>
</tr>
<tr>
<td>Colloidal Silica</td>
</tr>
<tr>
<td>Coal Dust</td>
</tr>
<tr>
<td>Granular Activated Carbon</td>
</tr>
<tr>
<td>Sugar</td>
</tr>
<tr>
<td>Asbestos</td>
</tr>
<tr>
<td>Pollen</td>
</tr>
<tr>
<td>Milled Flour</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Micrometers</th>
<th>0.001</th>
<th>0.01</th>
<th>0.1</th>
<th>1.0</th>
<th>10</th>
<th>100</th>
<th>1000</th>
<th>5000</th>
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</thead>
<tbody>
<tr>
<td>Approximate Molecular Weight</td>
<td></td>
<td></td>
<td></td>
<td>100</td>
<td>200</td>
<td>1,000</td>
<td>10,000</td>
<td>100,000</td>
</tr>
</tbody>
</table>

Note: 1 micrometer (micron) = 4 x 10^-6 inches = 1 x 10^4 Angstrom units
What Can UF Remove?
- Silicates
- Colloids
- Particulate Matter
- Algae
- Bacteria
- Coliform
- Viruses
- Giardia
- Cryptosporidium
- Oils and Grease
- Proteins

What can UF reduce?
- Total Organic Carbon
- Color components

What can UF not remove?
- Salts
- Gasoline
- Sugars
- Alcohols
- Low Molecular Weight Molecules
Indion Ultrafiltration System

Feed

Hollow Fibers

Permeate

Permeate

Concentrate
REVERSE OSMOSIS SYSTEM
SCHEMATIC REPRESENTATION OF TYPICAL REVERSE OSMOSIS SYSTEM

- WATER SOLUTION
- HIGH PRESSURE PUMP
- RO MODULE
- PERMEATE
- REJECT
INDION DUO
RAPIDE
AUTOMATIC
DEMINERALIZER
Indion Duo Rapide

AIR SUPPLY

CLIENTS 415 V X 50 HZ
3 PH SUPPLY E

CONDUCTIVITY METER

FLOW METER CUM TOTALISER

FILTER WATER TANK

ACID MEASURING TANK

32% HCL

CAUSTIC DILUTION TANK

32% NaOH

TREATED WATER
Conventional DM Vs Indion Duo Rapide

- **Service** - Min 8 Hours
- **Regeneration Time** - 180 mins
- **Semi-Automatic**
- **10 to 30 ms/cm Conductivity**
- **Non neutral effluent**
- **Civil Work required**
- **Treated water tank size required for min 3 hours**

- **Service** - Min 3 Hours
- **Regeneration Time** - 35 mins
- **Fully Automatic**
- **Less than 5 or 1 ms/cm Conductivity**
- **Near neutral effluent**
- **Civil Work not required**
- **Reduction in tank size by 60%**
ION EXCHANGE LTD 17

- FRONT VIEW
- (WITH DISPLAY SCREEN)

- REAR VIEW
  (WITH CATION POLISHER)
INDION ELECTRODEIONISATION SYSTEM
EDI Technology

(+) Anode

(-) Cathode

Ultrapure Product

Cl-, Na+

Na+, Cl-

Na+, Cl-

H+, OH-

H+, OH-

Cl-, Na+

Conc

Conc

Feed Cl-, Na+

ION EXCHANGE (I) LTD
EMERGING TECHNOLOGIES IN DECENTRALISED WASTE WATER TREATMENT
Fluidised Media Reactor (FMR)

- COMPACT SINGLE TANK DESIGN
- Attached Growth
- Aeration tank with patented media
- Lamella Settler
- Chlorine Contact Tank
EMERGING TECHNOLOGIES IN DECENTRALISED WASTE WATER TREATMENT

MBR
(Submerged Membrane Bio-Reactors)
Separation by MBR
Conventional System V/s MBR

CONVENTIONAL SYSTEM
100%

MBR SYSTEM
25%
INDION
NEW GENERATION
PACKAGE SEWAGE TREATMENT PLANT
(NG PSTP)
Effluent Quality

**Influent**
- BOD - 300 ppm
- SS - 300 ppm

**Effluent**
- BOD - 30 ppm
- SS - 30 ppm

NG PSTP
Wastewater treatment scheme selection

- Disposal (Under Pollution Control Board norms)
- Water Scarcity (Need for Recycle)
- Zero Discharge Norms (Government Regulations)
- Common Effluent Treatment Plants
- Process products recovery
CASE STUDIES

• WATER CONSERVATION

• WATER RECYCLE

• WATER QUALITY IMPROVEMENT
PULP AND PAPER INDUSTRY

- Total treatment capacity - 11000 cu.m. Per day; water recovery 98% and fibre recovery 99%

- Influent suspended solids - 1400 ppm. Reduced to less than 5 ppm.

- A new process for recycling utilising the gravity settling principle using high rate solids contact clarifier and continuous sand filter

- Capital pay back in two years
White water recycle in Paper industry

FROM PAPER MACHINE

HOLDING TANK

SOLID CONTACT CLARIFIER

CLARIFIED WATER SUMP

CONT SAND FILTER

POLYMER DOSING

SLUDGE PIT

SUSPENDED SOLIDS 3-5 PPM

TO MIXING CHEST

SUSPENDED SOLIDS 20-50 PPM

TO PAPER MACHINE

SUSPENDED SOLIDS 150-1400 PPM

FROM PAPER MACHINE
A textile industry in southern India

Discharge of effluents, cost and availability of raw water was the problem

Discharges 500 Cu.M. Per day of waste water having dissolved solids of 3600 ppm.

Isolated wash water from total coloured effluent (dye)

75% of the waste water recovered and reused

Treatment incorporates reverse osmosis for reduction of dissolved solids

Treated effluent TDS < 200 ppm.
A fertiliser industry in northern India
Water conservation was the objective
Discharges 4200 cu.M. Per day of waste water having dissolved solids of 2600 ppm and silica of 120 ppm.
85% of the waste water recovered
Incorporates silica removal by physico chemical process followed by reverse osmosis system
Treated effluent TDS < 400 ppm.
WATER TREATMENT PLANT

REVERSE OSMOSIS PLANT
COOLING WATER BLOWDOWN RECYCLE

- Customer: Madras Fertilisers Ltd.,

- Problem: Repeated problems with the existing RO plant – frequent choking leading to cleaning and downtime

- Capacity: Treatment flow 160 m3/hr of Cooling Tower Blow down

- Solution: Effluent treated through Ultrafiltration for Feeding to the existing RO plant
COOLING WATER BLOWDOWN RECYCLE

- Collection Tank
  - Cl₂ dosing
  - Dolomite Polymer dosing
  - HCl dosing

- HRSCC

- Filter feed tank

- Sand filter
  - Ultra-filtration

- Reverse Osmosis (120m3/hr)
  - Cartridge filter
  - Pump
  - Antiscalant, SBS dosing

- UF Permeate tank
  - Pump

Flow rate: 160m³/hr
Recycled effluent to produce treated water for low end application & treated water having Resistivity > 10 meg. Ohm. Cm

Influent suspended solids - 1400 ppm. Reduced less than 5 ppm.

A complete reuse system with clarification, filtration, Ultrafiltration, Reverse Osmosis and De-ionizers installed successfully.
Recycling in Electronics Industry

- Equalisation
- Clarification
- pH Correction
- Pressure Sand Filter
- Sludge Drying Bed
- Thickener
- Outlet
- 100 m³/h
- 19 m³/h
- 14 m³/h
- 17 m³/h
- 13 m³/h
- Pit
- Low end use
- Mixed Bed Unit 2
- Mixed Bed Unit 1
- RO System
- UF system

Cake for disposal
A heavy engg. Industry
Discharge of oily waste effluents was the problem
Combined effl. COD - 10000 TO 20000 ppm. Emul. Oil - 5000 to 20000 PPM. TDS - 5000 to 10000 ppm.

Treatment incorporates membrane processes - Ultrafiltration and Reverse Osmosis

Emulsified oil concentrated from 0.5% TO 40% BY UF AND COD REDUCED IN PERMEATE TO 100 ppm. Volume 2% of influent qty.

UF permeate treated by Reverse Osmosis for reduction of dissolved solids.

Treated effluent TDS < 500 ppm.
Oily Waste Water Recycle

- Equilisation tank
- UF process tank
- Ultra filtration system
- Acid cracking tank
- Free oil collection tank
- Reverse Osmosis System
- Cartridge filter
- Softener
- Activated carbon filter
- Solar pond
- Oily waste
- Oil skimmer
- High Pressure pump
- RO feed tank
- Solar pond
- Activated carbon filter
- Pump
Zero Discharge in Engineering Industry

- A multinational compressor manufacturer in northern India
- Zero discharge is the objective
- Incorporates state of art membrane separation technologies in the scheme
- Oily effluent treated by UF
- UF permeate + non oily effluent + cooling tower blowdown recycled by RO system to produce water for process
- Reject from RO used for treatment of raw water + reject from RO used for effluent treatment is recycled through sea water RO
- Overall recovery of RO plants is 93%
Severe problem of water scarcity and discharge of complex effluent

- Discharged 30 m$^3$/hr effluent of TDS - 20000 ppm, COD - 50 ppm

- Treatment incorporates high rate solid contact clarifier & membrane processes like Ultrafiltration and Reverse Osmosis

- 40 - 50 % of effluent recovered with recycle system of 15 m$^3$/hr

- Treated effluent TDS < 500 ppm, SDI < 1
Recycling in Chemical Industry

- CT: Feed
- Lime
- Soda Ash
- Poly
- UF feed Tank
- Ultra filtration system
- Reverse Osmosis System
- Acid Antiscalent SBS
- RO feed Tank
- Sludge disposal

Feed Process:
- Q = 30 m³/hr
- TDS > 20,000 ppm
- TH > 7,500 ppm
- Fe = 0.8 ppm

Reverse Osmosis System Process:
- Q = 15 m³/hr
- TDS > 500 ppm
FATTY ACID MANUFACTURING INDUSTRY

- **Customer**: Leading Fatty acids/Soap manufacturer in Mumbai

- **Problem**: Severe space constraint to treat and discharge complex soap effluents.

- **Solution**: INDION Membrane Bio-Reactor (MBR) for treatment of process effluents and Utility effluent streams.

- **Quantitative**: This will be the 1st company in India to install INDION Membrane Bio-Reactor (MBR) system to overcome the above problem and to treat
• **1) PROCESS EFFLUENT STREAMS**
  • Treatment capacity - 295 m3/day

  • Treatment scheme - Free oil removal using Tilted Plate Interceptor
    • and removal of emulsified oil by DAF →
    • Biological treatment in Bio Tower →
    • *INDION MBR* with enhanced oxidation using
    • PAC for COD reduction (< 100 ppm)

• **TREATED EFFLUENT QUALITY**

  • TSS - < 2 ppm, O& G – Nil, BOD - < 20 ppm, COD - < 100 ppm,
  • TDS - 425 ppm
• Customer : Chennai Petroleum Corporation Limited (CPCL)

• Problem : Acute water scarcity in the region which led to shutdown of refinery few years back.

• Quantitative : Zero discharge 200 m3/hr capacity Effluent treatment & recycling plant

• Inlet TDS : 1860 ppm, BOD : 20 ppm, COD : 250 ppm,

• Solution : Zero effluent discharge effluent treatment plant was designed with 252 m3/hr capacity UF plant followed by 220 m3/hr RO plant.

• Outlet Quality : TDS < 40 ppm, BOD : Below detectable limit

• COD : Below detectable limit
ZERO EFFLUENT DISCHARGE IN REFINERY INDUSTRY

INLET ANALYSIS (Typical)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.0 - 8.5</td>
</tr>
<tr>
<td>O&amp;G (ppm)</td>
<td>10</td>
</tr>
<tr>
<td>TSS (ppm)</td>
<td>50</td>
</tr>
<tr>
<td>Turb (NTU)</td>
<td>20</td>
</tr>
<tr>
<td>BOD</td>
<td>20</td>
</tr>
<tr>
<td>COD</td>
<td>250</td>
</tr>
<tr>
<td>TDS</td>
<td>1860</td>
</tr>
<tr>
<td>Cl (ppm)</td>
<td>850</td>
</tr>
<tr>
<td>Ca (ppm)</td>
<td>130</td>
</tr>
<tr>
<td>Mg (ppm)</td>
<td>70</td>
</tr>
<tr>
<td>M Alk (ppm)</td>
<td>62</td>
</tr>
<tr>
<td>Nitrates (ppm)</td>
<td>20</td>
</tr>
<tr>
<td>Phosphates (ppm)</td>
<td>5</td>
</tr>
<tr>
<td>Si (ppm)</td>
<td>15</td>
</tr>
<tr>
<td>Coll Si</td>
<td>7.2</td>
</tr>
<tr>
<td>Fe (ppm)</td>
<td>3</td>
</tr>
<tr>
<td>SO4 (ppm)</td>
<td>300</td>
</tr>
<tr>
<td>Phenols (ppm)</td>
<td>1</td>
</tr>
<tr>
<td>SDI</td>
<td>&gt; 6</td>
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</tbody>
</table>
AUTOMOBILE INDUSTRY

- Customer : Hyundai Motors Limited, Chennai

- Problem : Water scarcity, Customer was buying tanker water. Reject TDS could not be more than 2100 ppm to meet disposal norms.

- Quantitative : 22 m3/hr capacity Sewage Recycle Plant
- analysis Permeate TDS < 50 ppm
- Recycle TDS < 2100 ppm for disposal

- Solution : Two sewage recycle plants each with ultra-filtration as pretreatment to RO to ensure RO feed with SDI < 1.0, Nil - Organics and Turbidity < 0.1 NTU. Under abnormal water scarcity situation customer to get treated sewage in tankers to be recycled in the UF-RO system.
AUTOMOBILE INDUSTRY

Feed System

Q = 22 m³/hr
TDS = 1100 ppm
COD = 100 ppm
BOD = 15 ppm
Turbidity = 15 NTU

UF 1 System

MGF1

NaOCl

SHMP Antiscalent
SBS Acid

RO 1 System

Q = 18 m³/hr
TDS = 1100 ppm
COD = 100 ppm
BOD = 15 ppm
Turbidity = 15 NTU

Abnormal Feed System

UF 2 System

MGF2

SHMP Antiscalent
SBS Acid

RO 2 System

Degasser

TDS < 150 ppm

NaOH

Q = 22 m³/hr
TDS = 1100 ppm
COD = 100 ppm
BOD = 15 ppm
Turbidity = 15 NTU

AUTOMOBILE INDUSTRY

ION EXCHANGE (I) LTD
Multinational manufacturer of organic pigments

High cost of raw water & disposal cost to CETP

Discharged 50 m³/hr effluent of TDS - 10000 ppm, COD - 500 ppm, silica - 25 ppm

Treatment incorporates state of the art membrane processes like Ultrafiltration and Reverse osmosis

Total treatment capacity - 18 m³/hr capacity recycle system

Treated effluent TDS < 200 ppm
Recycling in Chemical Industry

<table>
<thead>
<tr>
<th>Process</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed</td>
<td>Q = 18m³/hr TDS: 10,000 ppm COD: 500ppm Hardness: 200ppm SS: 50 ppm</td>
</tr>
<tr>
<td>CT</td>
<td></td>
</tr>
<tr>
<td>MGF</td>
<td></td>
</tr>
<tr>
<td>RO Feed Tank</td>
<td>SDI &lt; 1 Turbidity &lt; 0.1NTU</td>
</tr>
<tr>
<td>Ultra filtration system</td>
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<tr>
<td>Reverse Osmosis System</td>
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</tr>
<tr>
<td>Permeate</td>
<td>Q = 12 m³/hr TDS &lt; 200 ppm</td>
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<tr>
<td>Reject</td>
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<tr>
<td>Antiscalent SBS Acid</td>
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</table>
Water scarcity was a problem and zero discharge of effluent was the objective

Discharged 530 m3/day effluent from cooling tower blowdown and DM waste of TDS - 3200 ppm, Silica - 130 ppm.

Treatment incorporates TDS & silica removal by physico-chemical process followed by Ultra-filtration & Reverse Osmosis

90 % recovery having TDS < 350 ppm, SDI < 1, turbidity - < 0.1 NTU
Recycling in Cement Industry

Feed

Q = 23m³/hr
TDS = 3200 ppm
Silica = 133 ppm

NaoCl

CT

Lime, dolomite, Soda Ash, Poly

Ultra filtration system

SDI < 1.0
Turbidity < 0.1 NTU
Silica < 20 ppm
Bio-Organics - Nil

Centrifuge

Sludge Disposal

Reverse Osmosis 1 System

Permeate
TDS < 350 ppm

Final Reject 1.8m³/hr

Evaporator
Recycling in Carwash industry

- Strict discharge norms from PCB
- Scarcity of bore well water
- Cost of raw water is high
SEWAGE RECYCLE IN RESIDENTIAL COMPLEXES

1. Raw water tank
2. Softener
3. Bathrooms/Laundrette
4. Sullage Collection Tank
5. Kitchens/Drinking/Cooking
6. Sullage Treatment & Recycle System
7. Ultra Filtration/Riverse Osmosis
8. Treated Sewage For Gardening
9. Sewage Treatment & Recycle System
10. Sewage
11. Treated Sullage For Toilet Flushing

Gardening

100 Micron Stainer
We have installed Reverse Osmosis (RO) plant after MBR during our pilot studies to make quality of water equivalent to drinking quality. During the visit to our pilot plant, Chief Minister of Delhi, Ms. Sheila Dixit drank the treated water after RO plant in the presence of large gathering of Indian & Overseas delegates. This is a great testimony to the quality of water that we can produce using MBR.