



Tubular Membrane Filtration and Their Applications

GIW Test Facility Tishomingo OK.

- THE TREATMENT TRAIN COMPONENTS
- GIW has developed and utilized a variety of produced water treatment technologies over the past decade. Using this knowledge and experience GIW has identified the most effective systems and has designed a proprietary treatment train comprising:
 - Coalescor
 - Media filter
 - Green chemical (000 rated)
 - UF (in/out) UF (out/in)
 - Reverse Osmosis
 - Nano engineered contaminant absorbents
 - Deoxygenating

Purpose of the Study

- This project will address the following questions: What constituents present in produced water prohibit the use of this water for beneficial uses such as stream flow augmentation, irrigation, livestock watering, and municipal and industrial use? Can a produced water treatment train using green technology be developed to create a cost-efficient method of reclaiming produced water for stream flow augmentation, irrigation, livestock watering, and municipal and industrial use?
- How practical would an appropriately sized treatment train be in a real time application?
- Would the cost of the treatment train produce significant savings when compared to the costs of PWRI, evaporative ponds, chemical treatment or dilution/blending?

Testing and Results

- Sample ports have been installed at the inlets and outlets of each system enabling the operators to record pressures, temperatures and flow rates. The in-house monitoring equipment is also capable of measuring:
 - Total Dissolved Solids
 - Total Suspended Solids
 - Dissolved Oxygen
 - Iron
 - Hydrogen Sulfide
 - Chlorides
 - In line monitor for particle and oil droplet sizing
 - Bacteria
 - Chloride
 - Sodium
 - Sulfate
 - Alkaline earth metals including Magnesium, Calcium, Strontium and Barium
- Texas A&M verified and took part in the study.

GIW TUBULAR MEMBRANES AND MODULES



- **Tubular membranes**
 - **20+ types, RO to MF**
 - **Robust / high solids capability**
- **Tubular modules**
 - **Stainless steel and ABS plastic**
 - **Supported / unsupported**

A19 MODULE



- **37 x 1/2" diameter unsupported tubes**
- **12 ft versions – 54 ft² area**
- **UF/MF membranes (20k MWCO to 0.5 micron)**
- **Operating limits: up to 140°F & 100 psi**
- **Replaceable core**

Benefits

Tubular Polymeric Membranes, with possible operating pressure to cover the range of MF to RO separations, are cost effective solutions for applications where one or more of the following are true:

- Suspended solids and colloidal materials are present.
- Fats, oils and other organic foulants are present.
- Fluids have high viscosity.
- Foam ball cleaning is effective in removing foulants, reducing the need for chemical cleaning compounds and their disposal.
- Pretreatment required to enable use of other membrane configurations is expensive or not practical.

Benefits (Continued)

- Temperatures are higher than can be tolerated by other polymeric membrane configurations
- Solutions are abrasive that might otherwise damage inert membrane materials (ceramics and stainless steel).
- When high cross-flows are needed to maximize flux and minimize channel blockage.

There are some novel applications within biofuels.

Algae separation and concentration has special concerns because of the large amount of water removal required.

Tubular UF, MF and RO can concentrate whole algae, with choice of membrane determined by the final process desired.

The Problem

*Produced water with oil
Content above overboard
Discharge levels and high
TSS making it unsuitable
For reinjection or reuse*



The GIW Solution

Something only a Coalescor, 10micron filter and tubular membranes can provide . . .



Tubular Membranes

Foam Balls

The Coalescor removes oil to a level below 25ppm and the solids filter removes solids down to 10 micron in size.

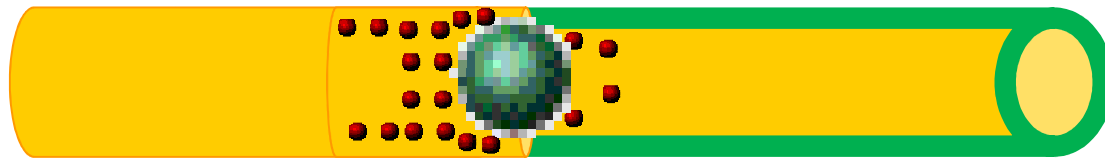
Tubular NF membranes are used to remove organic materials thus eliminating bacteria.

Then, instead of using cleaning chemicals small, soft balls made of sponge are sent into the membrane tubes.



Foam Ball Cleaning

As the foam balls move through the membrane tube they wipe off fouling compounds coating the interior of the membrane.



Final Cleaning Step

The fouling material then becomes debris that the normal flow of water can flush out of the tubes.



Periodic Cleans Without Chemicals

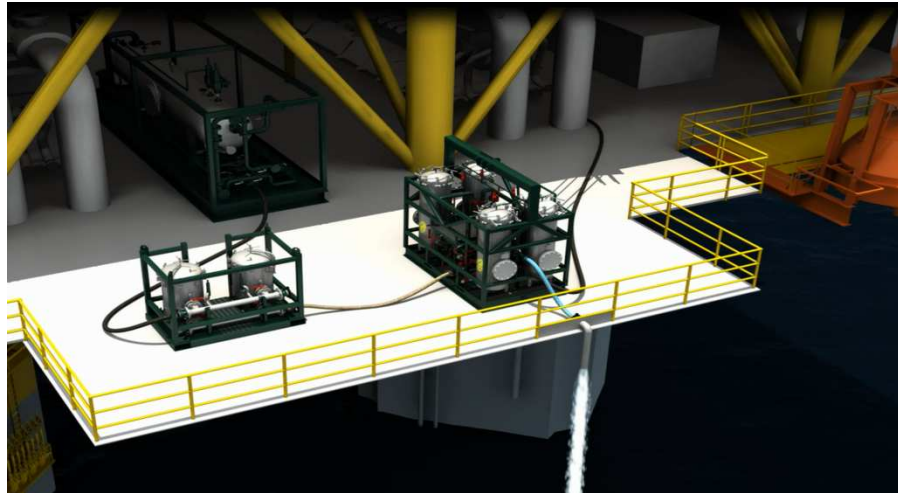
This process can be repeated by reversing flow and sending foam balls back through again.

Chemical cleaning can then be postponed for several days or weeks.



Tubular Membranes

Typical Installation Filter, Coalescor and Tubular membrane



Container Unit



Bleach Effluent, Pulp and Paper Plant

Stora Nymolla, Sweden

- 2 process lines on softwood & hardwood, 300 m³/hr capacity
- Tubular UF membranes, 4-6000 MWCO
- 98% reduction in effluent volume
- 50% reduction in total discharged COD
- Operated since 1995



A19 + Spiral Polisher

Repsol Quimica, Spain

- 2 stage membrane treatment plant
- Ultrafiltration
 - removal of susp. solids
 - A5 tubular membranes
- Reverse osmosis
 - concentration of COD
 - filtrate for reuse
 - spiral wound membranes
- Mixed retentate is incinerated at 20 x reduced volume
- Permeate with low COD can be reused as low-grade water





GIW Services Offered to the Oil and Gas Industry Off or On-shore.

- Water Treatment (Produced Water & Flow Back Fluid)
- Sulphate Removal
- Deoxygenating for Well Flooding
- Well Testing
- Pipeline
- Rentals
- On Site Nitrogen Services Well Lifting, Recirc. Units
- Industrial Wastewater Treatment Products
- Valves including Specialized Pig Valves