

POREX FILTRATION

CASE STUDY | ZERO LIQUID DISCHARGE

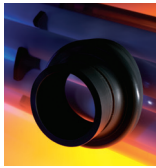
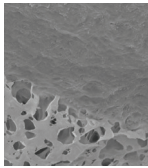
POREX® Tubular Membrane Filter (TMF™) Applied in a ZLD System as Critical Solid/Liquid Separation Process

Abstract Introduction



Beijing Shougang Biomass Energy Technology Co., Ltd, a branch company of SHOUGANG GROUP, was established in August, 2010 with ¥400 million registered capital. Located in Tanzhe Temple Town, Mentougou District, Beijing, this company focuses on minimizing and recycling of municipal trash, and renewable energy power generation. Treatment capacity is 3,000 tons per day, or one million tons annually. Domestic garbage, after collection, separation and selection is sent to 4 incinerators. Thermal energy of incineration is used to produce electricity with two 30-megawatt generator units.

An ultrapure water treatment system was built to produce demineralized water for these generator units. Properly treated local municipal water is introduced into this DI water system as the water source. The DI water system consists of a UF (ultrafiltration) unit, 2 pass RO (reverse osmosis) unit and an EDI (Electro deionization) unit. When producing the demineralized water, the RO's also generate a certain amount of reject water (brine water) that contains dissolved solids (positive ions, negative ions). Typically the ratio of RO permeate to RO reject is 3:1, which means 25 m³/hr reject water is generated when 75 m³/hr RO permeate water is produced and sent to subsequent treatment processes.



POREX FILTRATION

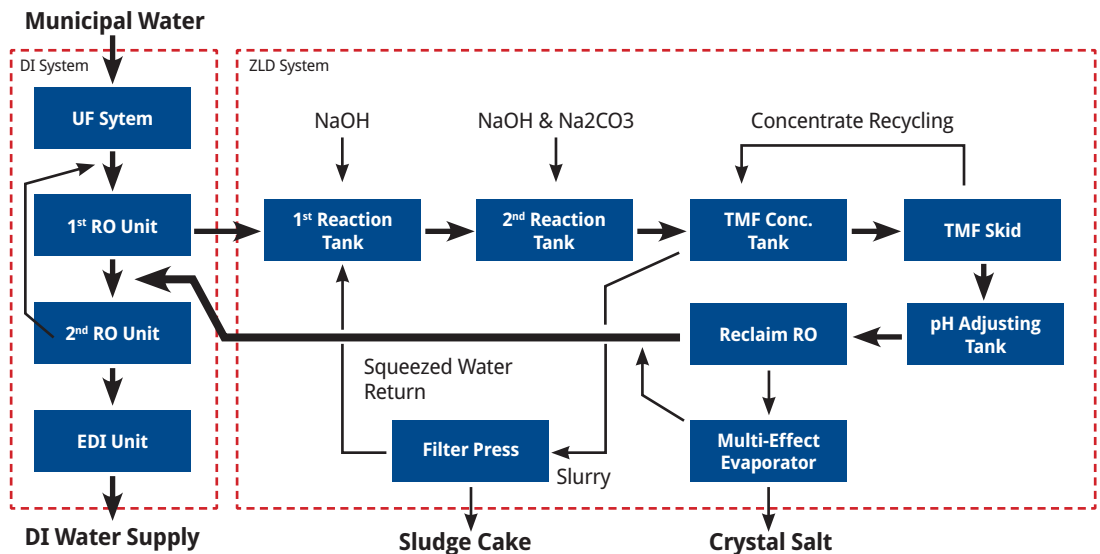
CASE STUDY | ZERO LIQUID DISCHARGE

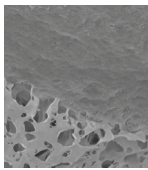
Abstract Introduction Continued

Normally in this kind of DI water system, RO brine is discharged directly into sewage pipe network or storm sewer system as it contains high hardness and high TDS. But for this power plant, and according to relevant regulations of local government, no wastewater is allowed for emission. Consequently, a water treatment company was assigned to design and construct a Zero Liquid Discharge (ZLD) system to treat this water stream.

In this ZLD wastewater treatment system, there is a chemical precipitation unit (converts hardness ions to relevant insoluble matter), followed by a POREX® Tubular Membrane Filter™ (TMF) system for highly efficient solid/liquid separation producing clean, soft water to subsequent reclaim RO. Final brine water of reclaim RO, containing very high dissolved solids, is sent to a multi-effect evaporator for crystallization.

Process Schematic





POREX FILTRATION

CASE STUDY | ZERO LIQUID DISCHARGE

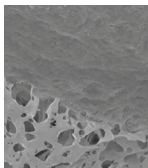
Process Description

Reject water from the 1st RO of DI water system is collected and sent to the 1st reaction tank; caustic soda is added to raise pH to more than 11.0 so that Magnesium ions convert to relevant insoluble matter (Magnesium Hydroxide). Silica can also be precipitated by means of adsorption and reaction with Magnesium Hydroxide. Precipitated water overflows to the 2nd reaction tank in which more caustic soda and sodium carbonate is added. pH is maintained at about 10.5, which is beneficial for Calcium converting to insoluble Calcium Carbonate. After two stage chemical precipitation, the solid-liquid mixture overflows to the TMF concentration tank (also called a recirculation tank). A circulation pump (also called process pump) sends water into tubular membrane filter modules (connected in series) for solid/liquid separation. In a cross flow mode, most of the feed stream will recycle between TMF modules and circulation tank; suspended solids return to the circulation tank from the membrane tubes.

Filtrated water (flow rate equal to system capacity) is sent to a pH adjusting tank for neutralization and then flows to a separate filtrate tank for short term storage before it is sent to reclaim RO system for desalination. This volume is the amount of reclaimed water, which is sent back to DI water system for reuse. Meanwhile, an amount of final brine is discharged from the reclaim RO and is sent to the evaporator for crystallization. Condensate from this evaporator is also sent back to the main DI water system for reuse while crystal salt is carried out of the factory for resale.

During the filtration process, suspended solids are concentrated in the recirculation tank. To control the solids, a portion of concentrated water is sent to the filter press system for dewatering. Sludge cake produced from the filter press is also carried out of the factory, while squeezed water is returned to the 1st reaction tank.

In zero liquid discharge filtration, the most important concern is to reduce water volume as much as possible so that a smaller evaporator can be utilized — because evaporation is a costly approach, it can result in higher construction and operating costs. This unique pre-RO treatment system (chemical softening reaction+ TMF separation) can effectively remove hardness ions and silica so that reclaim RO can operate at a very high recovery rate. Therefore, only a small-scale evaporator is required and may be selected for final crystallization.

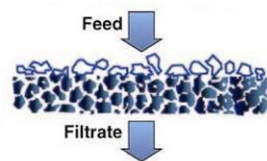


About Microfiltration

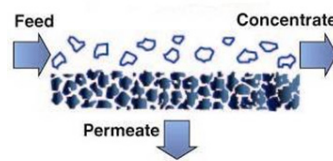
Microfiltration is a cross flow, pressure-driven membrane separation technology designed to remove submicron (and larger) suspended solids from water supplies. It differs from conventional (“dead-end”) filtration in that in a conventional process the entire water supply passes through the filter medium, whereas in the crossflow process, a portion passes through the membrane, becoming “permeate,” while the remainder exits the system as “concentrate,” carrying away almost all of the suspended solids.

The following illustration compares these two processes.

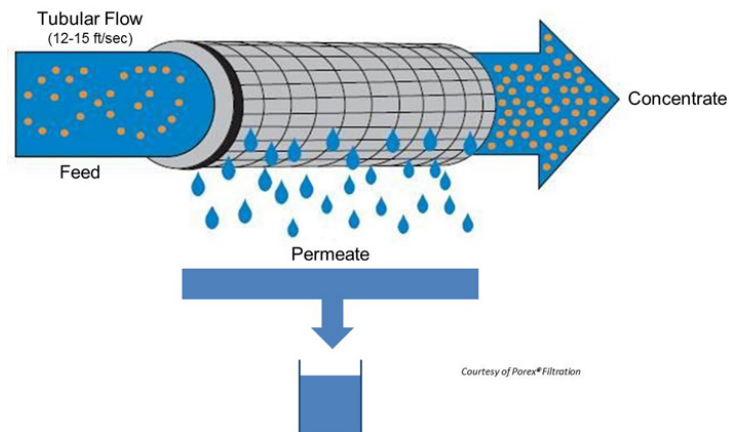
Conventional Filtration

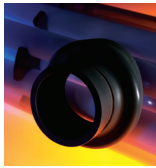
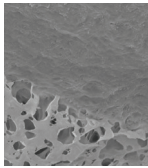


Crossflow Filtration



The mechanism of microfiltration is depicted below.

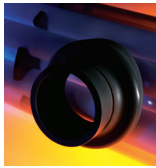
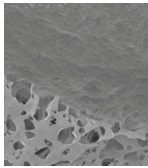




TMF Characteristics and Advantages

The initial purpose of developing tubular membrane filter, and the broadest application up to now, is as a replacement of conventional solid/liquid separation process, i.e. clarifier. There are several advantages of Porex TMF compared with a traditional clarifier process that include:

1. The Porex TMF filtrate water quality is much better than clarifier-treated water. Due to the presence of the filtration membrane, all particles larger than the nominal pore size will be rejected. Treated water quality is equal to UF product water.
2. Due to the excellent filtrate water quality, the Porex TMF product water can be fed directly into an RO system without any other treatment. In comparison, when the water comes from a clarifier, then a multimedia filter, activated carbon filter or ultrafiltration process is typically needed prior to sending through RO.
3. Coagulant (PAC, FeCl_3 , FeCl_2 , FeSO_4 , etc.) is either not necessary in a TMF system, or the dosage is greatly reduced. Flocculent (PAM) is also not required in a TMF system. Only caustic soda is required. Eliminating coagulant results in much less sludge cake volume and reduced treated water TDS compared to a conventional clarifier system.
4. The unique design of the cross flow Porex TMF system can easily handle a 2~5% suspended solids concentration. This produces less remaining slurry and results in better performance of the filter press.
5. The Porex TMF system can be designed for automatic operation and can be placed into service mode from standby mode at any time. This ensures for easier maintenance.
6. Compared with a traditional clarifier, the TMF skid frame requires much less space. Also, the TMF skid is available for expansion meaning that the water capacity can be enlarged by simply adding more skids and TMF modules.



POREX FILTRATION

CASE STUDY | ZERO LIQUID DISCHARGE

System Information

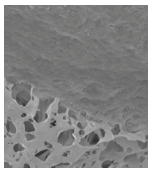
There are two RO units in the main DI water system. Either of them produces 75 m³/hr RO permeate water and generate 25 m³/hr RO brine at the same time. So, capacity of the ZLD system is designed as 50 m³/hr. The following table lists the feed and permeate rates for the RO systems along with the resulting recovery calculations (permeate rate/feed rate) for each. For the whole system, total recovery rate is 95% and the evaporator treats 10 m³/hr brine water vs a system capacity of 200 m³/hr.

Parameter	Membrane System Flow and Recovery		
	Main System RO	Reclaim RO	Total
Feed (m ³ /hr)	200	50	200
Permeate (m ³ /hr)	150	40	190
Reject (m ³ /hr)	50	10	10
Recovery (%)	75%	80%	95%



Reaction tanks and concentration tank (underground)

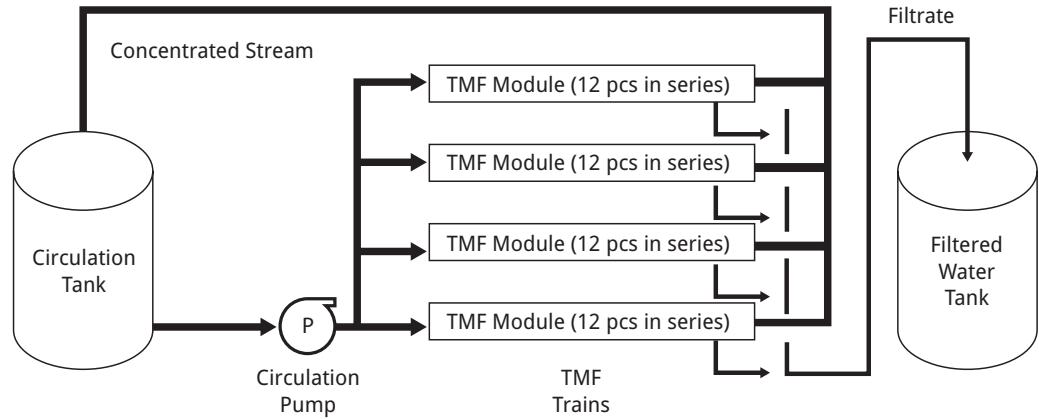
TMF Capacity: 50 m³/hr
Module Spec: Porex Tubular Membrane Filters (TMF) used; Specification of module is 37 tubes per module, PVC housing, membrane tube diameter is 1/2 inch, and tube pore size is 0.1 micron. Filtration area is 2.58 m² per module.



POREX FILTRATION

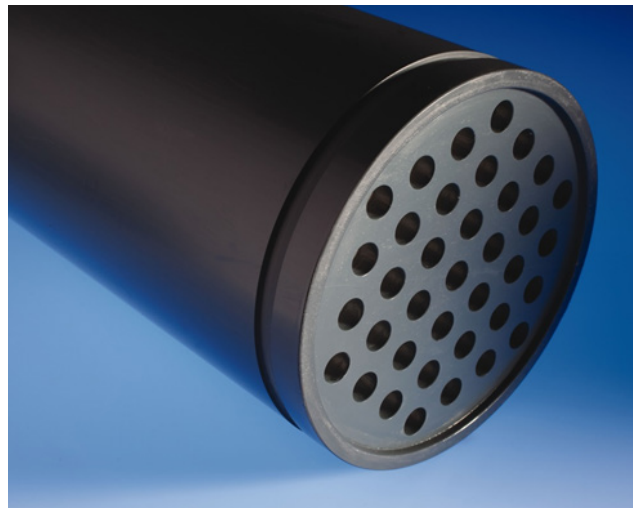
CASE STUDY | ZERO LIQUID DISCHARGE

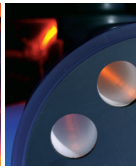
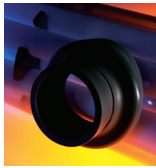
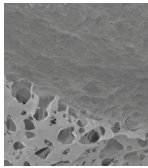
TMF System Specifications



This system contains 4 trains total installed in one skid. Each train contains 12 modules connected in series for a system total of 48 modules. Included in the system are a common circulation pump (process pump), filtered flow meter, back pulse unit and a set of isolation valves. A common CIP unit (including 3 tanks and 1 air diaphragm pump) is set for all 4 trains in the skid. The system is designed to be available for cleaning of each train, or cleaning for whole system.

The membrane modules applied in this system are illustrated below.





POREX FILTRATION

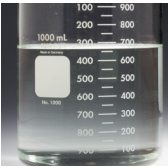
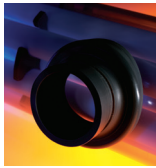
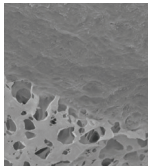
CASE STUDY | ZERO LIQUID DISCHARGE

TMF System Specifications Continued

Each module consists of 37, 72" long tubes enclosed in PVC housing. Specifications of modules and tubes are as follows:

Modules	
Housing Diameter	6"
Permeate Port (Qty 2)	2.875" x 1.89" L pipe stub
Concentrate Ports	6" pipe Anvile Gruvlok groove
Mounting Required	Horizontal; 2 point
Module Length	72"
Tubes	
Number of Tubes	37
Nominal ID	1/2"
Nominal OD	0.79"
Total Active Surface Area	27.75 ft ² (2.58 m ²)
Internal Liquid Volume	
Permeate Volume	3.07 gallons
Concentrate Volume	2.26 gallons
Total Volume	5.33 gallons
Materials of Construction	
Potting	Solvent Cement
Internal Supports	Polypropylene
Gasket Material	None
Preservative (Shipping)	Propylene Glycol
Membrane	PVDF

The feed flow is down the center of the tube (lumen feed) with the permeate passing through the tubular wall and collected from the area around the outside of the tubes inside the housing. A total of 48 Porex modules are in this TMF system.



POREX FILTRATION

CASE STUDY | ZERO LIQUID DISCHARGE

Operation Status

System construction work was finished in July of 2013 and commissioning work started subsequently. System performance has met all design specifications:

- Filtrate flow rate ranges from 45 to 60 m³/hr, with average flow rate greater than 50 m³/hr.
- TMF filtrate turbidity is less than 0.5 NTU. So, frequent replacement of guard filter cartridges (i.e., before reclaim RO) will not be required.

Most hardness ions (Ca, Mg, Sr, Ba) and silica have been removed from the influent water, which eliminates the risk of RO scaling making it possible to run each RO at a very high recovery rate (80%).

Summary

In China, this was the first Porex TMF system installed for softening. RO reject water contains very high hardness ions (Ca, Mg, Ba, Sr) and silica, which becomes a serious limiting factor for reclaim RO recovery rate improvement. After chemical softening reaction, these ions convert into relevant insoluble matters. Tubular membrane filters act as very high-performance solid/liquid separation units; all suspended solids have been removed and permeate turbidity is low enough for direct RO treatment with no further filtration required.

Since all scale related matters have been turned into insoluble type and retained by TMF, RO is available to run at a very high recovery, which means that a small evaporator is now suitable. Both construction and running costs are greatly reduced, as well. In this zero liquid discharge filtration system, tubular membrane filters (Porex TMF) function as a connecting link between the upstream chemical softening stage and the downstream reverse osmosis desalination unit. TMF modules handle challenging, high concentration solid-liquid mixtures while producing clean, low hardness water that is suitable for RO treatment.



500 Bohannon Road
Fairburn, GA 30213
USA

T +1 770.515.7700
F +1 770.515.7799

US Toll Free 866.515.7783

www.porexfiltration.com

info@porexfiltration.com