

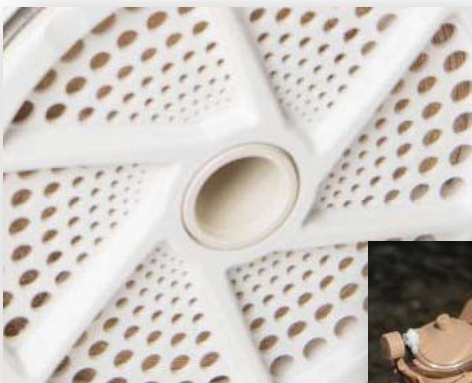
# Proven Solutions for the Most Challenging Wastewaters



**Fluid Technology Solutions, Inc.**

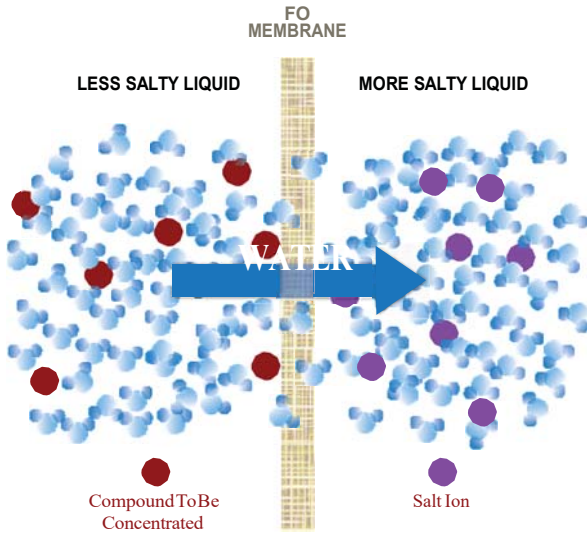


**Fluid Technology Solutions (FTS)** is a global leader in water treatment technology, providing innovative and proven solutions for the most challenging wastewaters. We focus on Forward Osmosis (FO) and High Brine Concentration Recovery (HBCR) membrane research and development, manufacturing, and membrane system engineering and design to provide innovative solutions to meet the needs of corporate, industrial, and municipal customers around the world. FTS provides total water treatment solutions that utilize FO and HBCR with complimentary wastewater filtration (OsmoBC™) and energy-efficient crystallization technologies to achieve Zero Liquid Discharge (OsmoZLD™).



# Forward Osmosis Technology

Forward Osmosis is a “green” technology that uses a semi-permeable membrane to separate water from dissolved solids. In nature, plants and trees draw water into their roots by osmosis. FO is powered by natural osmosis, as the solvents in the water seek the area of higher solute concentration on the other side of the membrane (diagram 1).

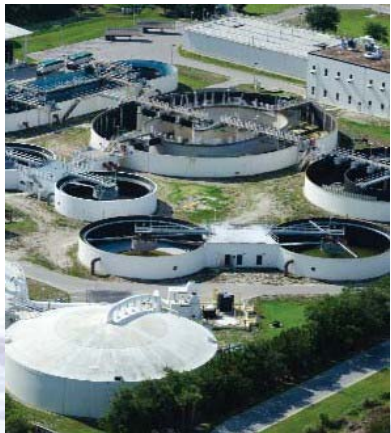


PRINCIPAL OF FORWARD OSMOSIS

Unlike the high-pressure-driven Reverse Osmosis (RO) process, Forward Osmosis pulls water molecules through the membrane via osmotic pressure differences, and does not require the external pump or hydraulic pressure that RO does. For this reason, FO systems are better suited for filtering high-fouling feed streams, enabling FO to be used as a complementary pretreatment process to pressure-driven membrane filtration.

Forward Osmosis is ideal for industrial applications where wastewaters and other feed streams containing a high level of suspended solids and high salinity need to be filtered or concentrated. These challenges typically cannot be resolved with a single filtration process.

Forward Osmosis, through the process of natural osmosis, can dewater waste streams that typically require extensive pretreatment. Since numerous pretreatment steps are avoided, CAPEX and OPEX are reduced. FO membrane is highly anti-fouling for lasting service life and lowering OPEX. When fouling occurs, simple backwashing and flushing removes foulants and restores membrane performance.





# Products and Services

## Commercial Products

FTS offers a complete line of membrane filtration products and services centered on Forward Osmosis and High Brine Concentration Recovery. This includes custom system design and engineering, membrane manufacturing, membrane system integration and operations, and full-scale system implementation.

Forward Osmosis membranes are manufactured by FTS on flat sheet 40-inch casting equipment, and feature

membrane elements that are fabricated in a spiral element configuration and other configurations as needed. The cellulose-based membranes have high resistance to fouling and abrasion, making them ideal for treating dirty waste streams and concentrating recovered valuable products. The spiral elements are manufactured in industry standard configurations and dimensions with feed spacer options to allow treatment of virtually any level of contamination in any stream.

**FTS has the following commercial product lines:**

### OsmoF<sub>2</sub>O™ Forward Osmosis Industrial

The FTS FO industrial product line utilizes low-fouling cellulose membranes. They are easy-to-clean with high flux recovery over many cleaning cycles, providing long membrane life. The 8040 and 4040 series are available in sizes to fit a wide range of conventional membrane module housings.

<b>FO-CTA-8040-85</b>	For treating high-fouling wastewaters (such as landfill leachate).
<b>FO-CTA-8040-45</b>	For treating moderate-fouling wastewaters (including dirty seawater and other contaminated brine streams).
<b>FO-CTA-8040-31</b>	For treating low-fouling wastewaters (such as clean brines).
<b>FO-CTA-4040</b>	These elements are identical to the 8040 series, but feature a smaller 4-inch diameter (102 mm) to accommodate smaller volumes and specialty applications (such as pharmaceuticals).

### OsmoF<sub>2</sub>O™ Forward Osmosis Sanitary

FTS's sanitary "Full Fit" Forward Osmosis membrane elements are specifically designed for use in sanitary, food and beverage, and medical applications. The full-fit configuration minimizes stagnant areas and is an ideal choice for applications requiring a sanitary design. The sanitary product line has the same solids handling options as the industrial line, with increased membrane area per element, reducing cost and system footprint.

<b>FO-CTA-8040-45-S</b>	For processing moderate-fouling liquids under sanitary conditions (such as concentrating nonfat milk).
<b>FO-CTA-8040-31-S</b>	For processing low-fouling liquids under sanitary conditions (such as clarified juices).
<b>FO-CTA-4040</b>	Sanitary elements with all the features of the 8040-S series, but with a smaller 4-inch (102 mm) diameter to accommodate smaller volumes and specialty applications.



OsmoBC™ System



## HBCR™ High Brine Concentration Recovery Spiral Elements

HBCR™ High Brine Concentration and Recovery membrane element is available as a stand-alone product or in combination with Forward Osmosis. When used within a stand-alone process, an HBCR train is capable of generating up to 200,000 TDS at 1000 psi (70 bar).

In combination with more passes of HBCR, less than 500 TDS permeate is generated while still reaching 200,000 TDS concentrate, and thereby minimizing ZLD costs. The most common application is the re-concentration of draw solution in Forward Osmosis membrane system, generating above 140,000 TDS concentrate.

### HBR-TFC-8040 High Brine Concentration

### HBR-TFC-4040 High Brine Concentration

## SeaWaterReverseOsmosis(SWRO)

Spiral elements designed specifically for OsmoF<sub>2</sub>O and HBCR applications, providing better solvent resistance than conventional SWRO.

### SWRO - 8040 Sea Water Reverse Osmosis

### SWRO - 4040 Sea Water Reverse Osmosis

## UF<sub>2</sub>O™ Ultrafiltration Spiral Elements

FTS's modified cellulose membrane is used for emulsified oil / water separations with ultrafiltration rejection characteristics.

**UF-CTA-8040-85** For processing high-fouling wastewaters (such as oil and gas produced water and flowback waters).

**UF-CTA-8040-45** For processing moderate-fouling waste waters (such as clarified cooling fluids).

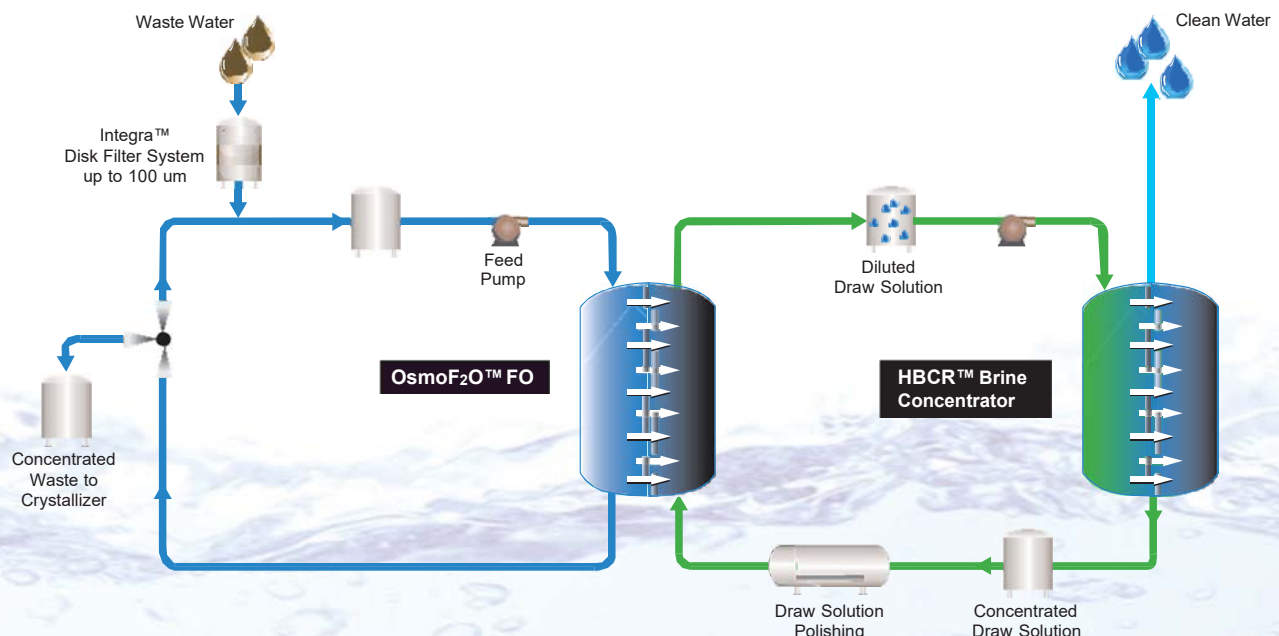
## Automatic Disk Filtration System, Low Temperature Evaporative Crystallization

FTS offers complimentary treatment technologies to Forward Osmosis membrane systems to realize the most economical Total Zero Liquid Discharge (OsmoZLD™) solutions to the most challenged wastewaters.

**Integra™ Disc Filtration System** Removes suspended solids from 200 microns to as small as 5 microns in a wide array of industrial applications

**LTEC™ Low Temperature Evaporative Crystallization** Proven in the field concentration and Zero Liquid Discharge for the Oil & Gas and Electric Power industries

## The OsmoBC™ Treatment Process



## Personal Hydration Products

FTS offers a product line of portable, personal FO membrane water filters. These revolutionary forward osmosis emergency water filters and emergency seawater desalinators deliver clean water in an enriched nutrient drink. These products require no energy or chemical additives and are able to filter from very dirty sources.

Outdoor enthusiast and humanitarian organizations will benefit from these products when water supplies are compromised to keep them healthy and hydrated.

Under direction from senior US Military survival and logistical personnel, the products are designed to meet the rugged mission critical needs of expeditionary and mobile forces.

### WaterDropF<sub>2</sub>O™

An emergency forward osmosis product that draws clean water through a high-purity membrane, creating a low-cost nutrient beverage for personal hydration.

### Mariner F<sub>2</sub>O™

A lightweight easy-to-use, seawater filter designed for ocean survival and used by the US Coast Guard. This desalinator rejects 97% of salt while generating a half-liter of high-calorie survival drink.

### HighSeas F<sub>2</sub>O™

All the features of the Mariner F<sub>2</sub>O desalinator, but is reusable up to eight times, generating a total of four liters of high-calorie survival drink.

### RangerF<sub>2</sub>O™

A hydration backpack that filters on the go, designed to military specifications for extended missions where water resupply is problematic. Nearly one liter per hour of safe hydration from virtually any water source.

### TaprootF<sub>2</sub>O™

Designed as a small group osmotic filtration system for remote survival, this product produces up to two liters per hour (35 liters/day) with no energy or chemical input, from virtually any dirty water source.

RangerF<sub>2</sub>O™



Mariner F<sub>2</sub>O™



FO-CTA-8040-31



## Markets

**Industrial and Municipality:** Oil & Gas, chemical and petrochemical, refinery, mining, power generation, food & beverage, landfill leachate, desalination.

**Hydration Products:** Military, disaster relief, humanitarian, and retail markets for sports and nutrient drinks.





# Benefits

## Benefits of OsmoF2O™ Forward Osmosis

- **Low CAPEX and OPEX** — OsmoF2O™ FO can treat extremely challenging wastewaters like landfill leachate, oily wastewater, produced water, and injection water without pretreatment compared to traditional MF/UF + RO/DTRO membrane treatment systems.
- **Very High Antifouling Characteristics** — OsmoF2O™ FO membrane has highly hydrophilic characteristics, easily pulling water molecules through the membrane to produce purified water or drinks from even the most challenged wastewater and highly polluted and high salinity waters.
- **Energy Saving** — OsmoF2O™ FO requires very low pressure (about 2.5 - 3.5 bar), achieving the results of MF/UF + RO while saving energy.
- **Brine Concentration** — OsmoF2O™ FO and HBCR™ can treat high-TDS wastewater and concentrate the

TDS up to 200,000 ppm to minimize the amount of thermal evaporation and crystallization, saving CAPEX and OPEX.

- **Preserves Flavors and Nutrients** — OsmoF2O™ FO concentrates food and juices with low heat, preserve flavors vs. thermal dewatering.
- **Low Maintenance Costs** — OsmoF2O™ FO and HBCR™ are proven commercialized membrane technologies for many challenged waters and fluids, featuring FTS' innovative patented membrane configuration, system engineering, and design.
- **Treats Sensitive Materials** — OsmoF2O™ FO operates at low pressures and can concentrate pressure-sensitive materials such as pharmaceuticals and biotech feed streams.

## Benefits of HBCR™ Reverse Osmosis

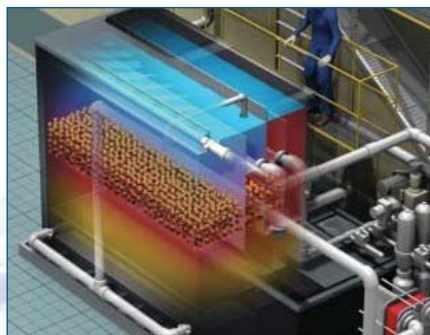
- **Energy Saving with Low Pressure and High Brine Concentration** — Achieves up to 200,000 TDS NaCl concentration with 70 bar pressure.
- **Easy-to-Use and Maintain** — The HBCR™ system uses conventional SWRO equipment (pumps, housings, components) for high brine recovery.
- **Low CAPEX and OPEX** — Extremely economical compared to thermal or vacuum pressure concentrators to realize Zero Liquid Discharge.

- **FO and UF Compatible** — Works well with Forward Osmosis or Ultrafiltration to treat challenging wastewaters.
- **Compact Design** — The HBCR™ system has a modular design and is skid-mounted, making it easy to install and maintain.

HBR-TFC-8040



LTEC™



Integra™



# Services

FTS provides project-focused services including:

- Application assessment
- Laboratory testing
- Piloting
- Systems engineering
- Project management
- Technical planning
- Procurement
- Systems manufacturing supervision
- Commissioning
- Systems engineering integration
- Customer training & operations
- Troubleshooting



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