DOW™ Reverse Osmosis Membranes

Quick Reference Guide – Reverse Osmosis

What is reverse osmosis?

Reverse osmosis (RO) is the finest level of filtration currently available. RO is a pressure-driven membrane process that separates purified water from a feed stream. RO is so-called because it is the opposite of the natural process known as osmosis.

What is the DOW™ FILMTEC™ FT30 membrane?

FT30 is a thin-film composite, semi-permeable membrane with a pore size in the angstrom range. FT30 exhibits high water throughput, or flux, while acting as a barrier to dissolved salts and organic materials. Typical solute rejections are listed in Table 1. Thin-film composite describes the multi-component composition of the membrane, allowing optimization of each layer.

Why use DOW™ RO membranes?

Dow has offered leading reverse osmosis technology for more than 20 years. DOW™ FILMTEC™ FT30 membrane chemistry is globally recognized as state-of-the-art.

Some specific application examples for DOW™FILMTEC™ RO elements include:

- Product concentration
- Evaporator condensate polishing
- RO permeate polishing
- Water recovery/reuse
- Energy recovery
- Pretreatment of plant or process make-up water
- Wastewater treatment
- Water removal prior to evaporation; pre-concentration
- UF/MF permeate processing

Dow food processing elements have been optimized to offer increased active membrane area on a consistent basis through automated glueline placement and element fabrication. DOW elements are designed for, and used in, a wide range of applications, from process streams to water purification. Our goal is to offer customers the best value in membranes through performance and customer support. Dow reverse osmosis products for food and dairy are listed in Table 2.

Do Dow membranes meet government standards?

Dow elements designed for food and dairy applications are based on the needs of food and dairy processors. All components of Dow food processing elements are compliant with U.S. Food and Drug Administration indirect food contact guidelines.

Table 1 - Solute Rejection (Approximate)

Solute	MW	Rejection	Solute	MW	Rejection
Sodium chloride	58	99%	Ethanol	46	70%
Sodium nitrate	85	93%	Isopropanol	60	90%
Magnesium chloride	95	99%	Lactic acid (pH 2)	90	94%
Calcium chloride	111	99+%	Lactic acid (pH 5)	90	99%
Magnesium sulfate	120	99+%	Lactose	342	99+%
Dissolved reactive silica	60	98%	Sucrose	342	99+%

2000 ppm Solute, 225 psi (15 bar), 77°F (25°C), pH 7.0, 15% recovery (unless otherwise noted)

Examples of Conditions Where Membrane Systems Could be Economically Advantageous

1. Evaporator Limitations

Reverse osmosis technology is widely used by processors who require increased capacity without the purchase of a new evaporator. RO pre-concentrates a stream by removing water, allowing more solids to be processed. Scenarios for pre-concentration with RO are found in Figures 1 and 3.

By pre-concentrating a stream by 2-4 times, an RO system results in less load on the downstream evaporator. It allows a plant to process additional product with minimal capital investment.

2. Wastewater Recovery/Reuse

Water going down the drain not only leads to disposal costs, it is a lost resource. Membrane systems can often treat wastewater streams to minimize disposal costs and to recover water for reuse. In some cases, the concentrated waste stream also becomes a saleable product.

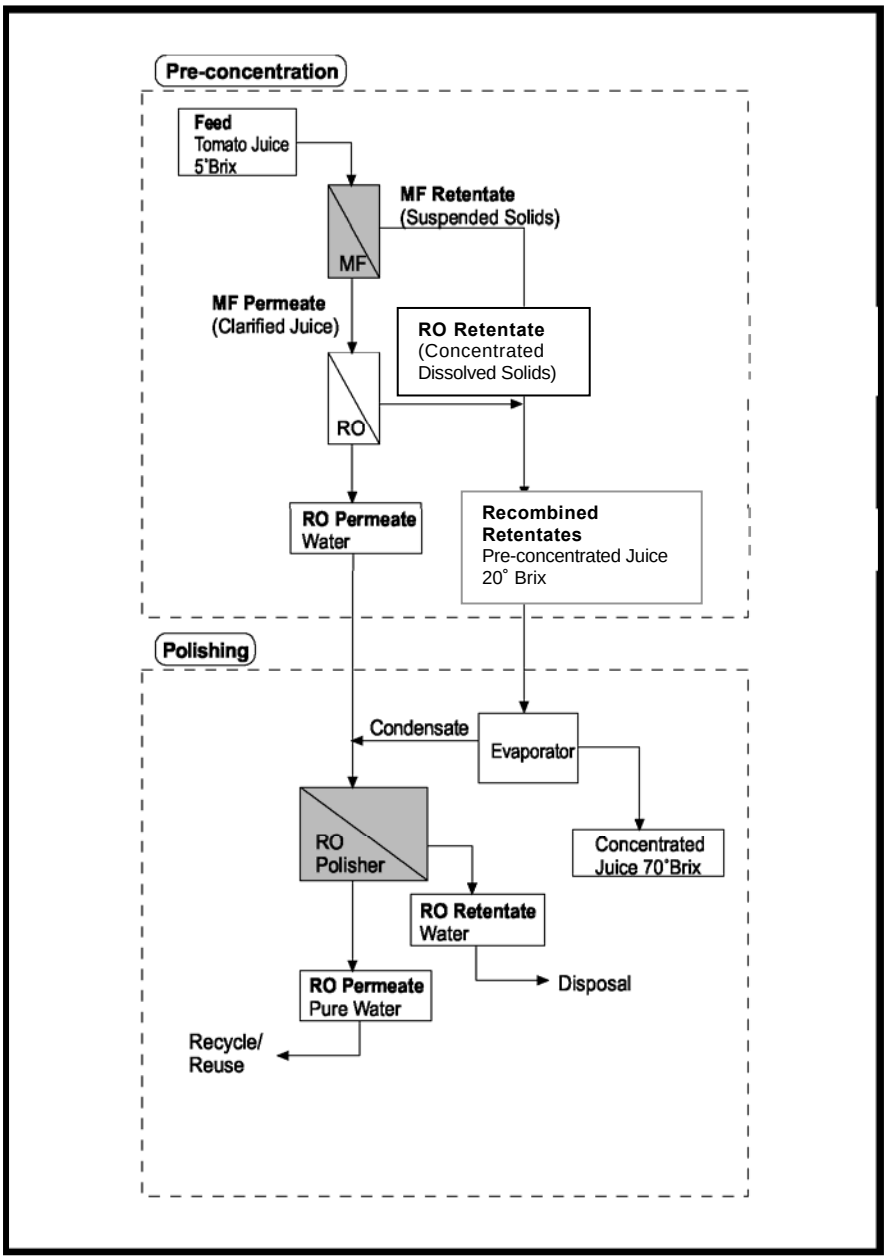
Reverse osmosis is generally the final operation of a treatment process that often includes other membrane types.

3. Evaporator Condensate Stream

Evaporator condensate polishing has become a very common reverse osmosis application during the past several years. Polishing condensate through RO offers a source of clean water that may be reused. The energy from this stream may also be recovered through heat exchange.

RO membranes typically reduce the BOD content of condensate streams to less than 10 ppm. Similarly, an RO polishing system is often used to further reduce BOD from an RO process stream.
Examples of polishing systems are illustrated in Figures 1 and 2.

Figure 1 – Pre-concentration and Polishing of a Process Stream



4. Treatment of Process Water

Reverse osmosis is often used to purify the water being used in an entire plant or for a specific process. Improved water quality can have a positive effect on finished product quality and consistency. It can also ensure consistency for products processed in different locations.

Downstream treatment concerns such as silica, hardness, scale, or mineral content can often be addressed more economically by using RO to purify a plant's fresh make-up water.

Figure 2 – Evaporator Condensate Polishing

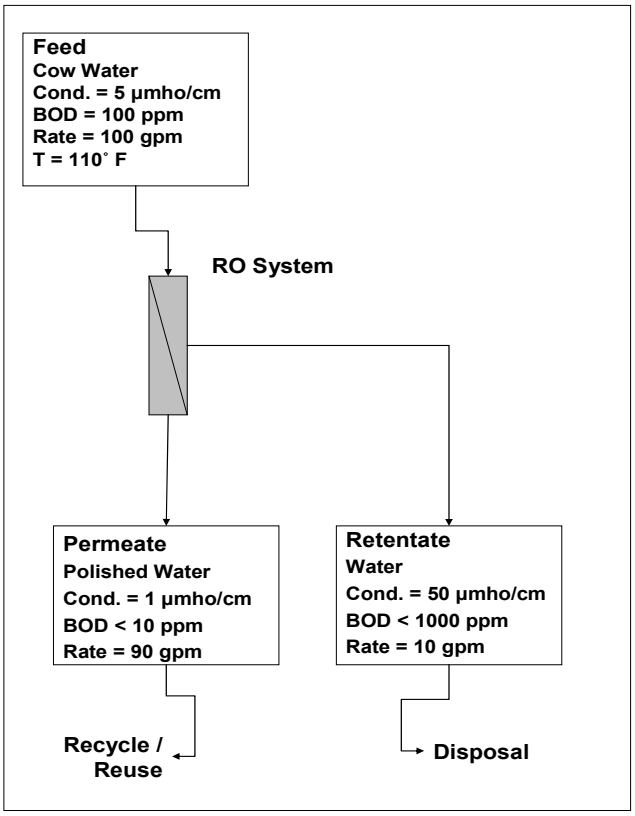


Figure 3 – Reverse Osmosis of Whole Whey

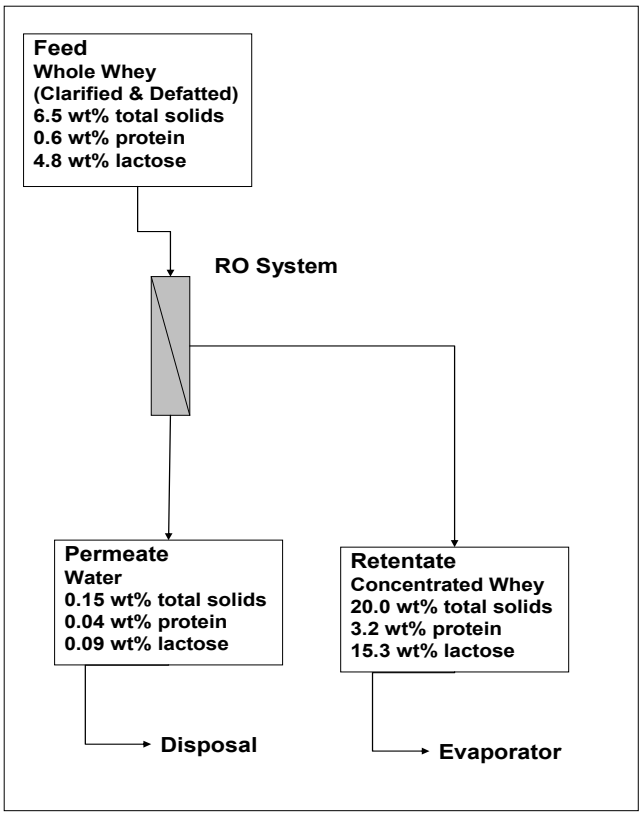


Table 2 – DOW™ Reverse Osmosis Products for Food & Dairy Applications

Product	Part number	Design active area – ft2 (m2)	Outer Casing
DOW™ Food and Dairy RO-8038	302219 / (302218)	370 (34.4)	Outer shell
DOW™ RO-390-FF	116314 / (100608)	390 (36.2)	Mesh wrap
DOW™ RO-3840 / 30-FF	196310 / (108664)	81 (7.5)	Mesh wrap
DOW™ RO-3838 / 30-FF	80588 / (80589)	79 (7.4)	Mesh wrap
DOW™ RO-3938 / 30-FF	(117259)	85 (7.8)	Mesh wrap

Part numbers in brackets are wet elements.

Note: 3838 and 3840 elements are designed for use in 14-gauge sanitary tubing.

8040 elements are designed for use in Schedule 40 pressure vessels.

Table 3 – Design Guidelines

Product	Max. recirculation cross-flow – gpm (m3/h)	Max. element ΔP† – psi (bar)
DOW™ Food and Dairy RO-8038	80 (18.2)	13 (0.9)
DOW™ RO-390-FF	80 (18.2)	13 (0.9)
DOW™ RO-3840 / 30-FF	30 (6.8)	15 (1.0)
DOW™ RO-3838 / 30-FF	30 (6.8)	15 (1.0)
DOW™ RO-3938 / 30-FF	30 (6.8)	15 (1.0)

**Maximum pressure drop across entire vessel is 60 psi (4.1 bar).

What Reverse Osmosis Cannot Do

1. "Dead-End" Filtration

In ordinary filtration, one commonly filters the total feed stream through a medium with a perpendicular flow through the filter. With RO, the semi-permeable membrane will not allow the passage of organics or salts, so dead-end filtration will result in plugging or fouling.

To avoid a build-up at the membrane surface, a sweeping flow must be used on the feed side. This design is known as cross-flow filtration; and because of this requirement, RO always splits a feed into two exit streams: a "retentate" stream with concentrated solute and a purified water stream.

2. Extreme Concentrations

The natural process of osmosis causes water to pass through a semi-permeable membrane toward a region of higher solute concentration to equalize solution strength. The equilibrium point in terms of water pressure against the membrane is called osmotic pressure.

A stream's osmotic pressure is dependent on solute type and concentration. As a feed is concentrated, it has more osmotic pressure to overcome, and thus, higher feed pressure is required to permeate water through a membrane. As a result of the pressure limitations on RO elements, each solution has a maximum practical concentration.

3. Excessive Suspended Matter

Streams with high quantities of suspended (non-dissolved) matter will quickly foul an RO membrane. Pretreatment is needed to optimize processing a stream of this type. Ultrafiltration or microfiltration are often used prior to RO.

4. Complete Separation

Even though RO is the finest filtration available and it can separate even the smallest solutes, the "perfect" RO membrane cannot be manufactured. Solute rejection depends on the individual material; although rejections as high as 99.99percent can be achieved, it has not been demonstrated that a perfect 100percent separation is possible.

DOW™ Food and Dairy Membranes
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Form No. 609-00132-1209
CH 172-140-E-800R