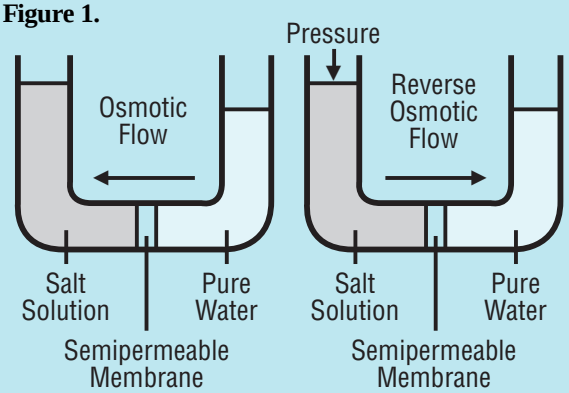
How Reverse Osmosis Works

Reverse osmosis (often referred to as "RO") is the most refined level of liquid filtration available. While a conventional liquid filter uses a porous material such as a screen to capture solid particles from a liquid stream, an RO element employs a semi-permeable membrane that separates molecular-sized particles out of the liquid.

In water treatment, for example, the membrane is permeable to water molecules (i.e., water molecules can pass through), but is not permeable to molecules of dissolved solids such as salt. If such a membrane were to be placed between two compartments in a container, as shown in Figure 1, and a salt solution is placed on one side of the membrane and pure water placed on the other side, water can pass through the membrane while the dissolved salt cannot.

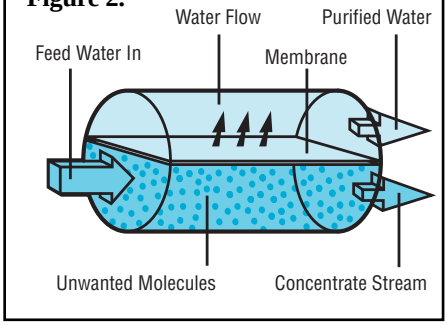
Figure 1.



An important scientific principle now comes into play in this example: two dissimilar liquids separated by a semi-permeable membrane will try to reach the same concentration of dissolved solids on both sides of the membrane. The only way for this to happen, however, is for the pure water to pass through the membrane in an attempt to dilute the salt solution. This flow of water through the membrane, in an attempt to reach equilibrium, is called osmosis.

But if the goal of purification is to remove the salt from the water, it is necessary to reverse the natural osmotic flow through the membrane by forcing the salt water through the membrane in the reverse direction. This can be accomplished by applying pressure to the salt water side of the container, creating a condition known as reverse osmosis, again see Figure 1.

Figure 2.



While the principle of reverse osmosis is simple, a practical RO process cannot continue indefinitely unless steps are take to ensure that the membrane does not become clogged by precipitated salts and other impurities forced against it by the pressurized stream of feed water. Since RO systems operate on what is known *as cross flow filtration* (see Figure 2), purified water permeates through the membrane while the concentrate containing rejected salts flows parallel to the membrane, sweeping impurities away from the membrane surface and discharging them with the concentrate stream.

In the early days of reverse osmosis technology—the late 1950s and early 1960s—RO membranes were made of cellulose acetate. The FilmTec Corporation was established in 1977 with the introduction of the first commercially viable thin-film composite polyamide membrane. The most important advantages of the new technology, which is still fundamental to today's FILMTEC® RO elements, is better rejection of

dissolved solids, increased productivity at lower operating pressures, greater structural stability, and the ability to produce two to three times more purified water per unit of membrane area than elements made of cellulose acetate.

In addition to removing from 95% to more than 99% of dissolved salts, RO membranes also reduce bacteria passage as well as the passage of bacterial byproducts by 99.5% or better. RO also removes silica and total organic carbon (TOC) from incoming water. These are often important additional considerations in many water treatment applications and/or total water treatment system designs.

The FilmTec Corporation was acquired by The Dow Chemical Company in 1985. Since that time, the company has introduced new high-surface-area elements that provide up to 21% greater active surface area and 20% to 40% greater productivity than even conventional thin-film composite RO elements. Among other recent improvements in RO technology has been the introduction of low energy elements. These operate effectively at a lower pressure than conventional elements, saving as much as 40% in electrical energy pumping costs.