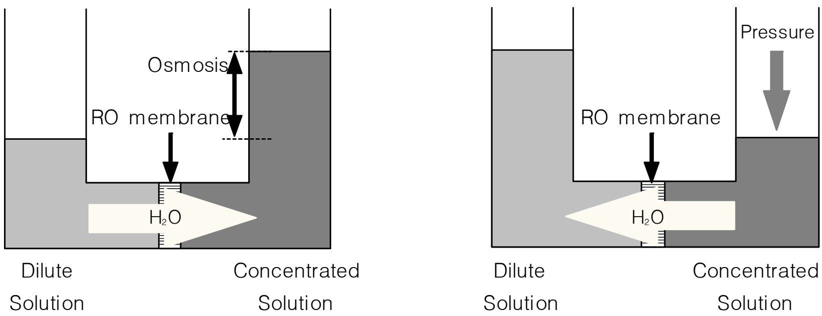
2-2. Theory of Reverse Osmosis Membrane

The phenomenon of osmosis is illustrated in the Figure below.

A semi-permeable membrane (RO membrane) is placed between two compartments. An RO membrane is consisted of a supporting layer with 50 μm in thickness and a barrier layer with about 0.2 μm in thickness. The phenomenon of osmosis occurs when pure water flows from a dilute saline solution in one compartment through the RO membrane into a higher concentrated saline solution in the other causing a rise in the height of the salt solution in the compartment of the higher concentrated solution.

The water flow will stop when the pressure of the column of the salt solution equals to the difference in chemical potential between the two aqueous solutions. The equilibrium point of the water column height in terms of water pressure against the membrane is called osmotic pressure.

If a force is applied to this column of water, the direction of water flow through the membrane can be reversed. This phenomenon is called reverse osmosis. This reversed flow produces pure water from the salt solution, since the membrane is not permeable to salt



2-3. Types of Reverse Osmosis Membrane

2-3-1. Asymmetric Membrane --- Cellulose Acetate(CA) Membrane

Historically, the asymmetric membrane is formed by casting a thin film acetone-based solution of cellulose acetate(CA) polymer, which was developed by Loeb and Sourirajan in 1962 and the first commercially viable RO membrane.

The resulting CA membrane has an asymmetric structure with a dense surface layer of about 0.1 - 0.2 μm which is responsible for the salt rejection property. The rest of the membrane, which is 100-200 μm thick and supports the thin surface layer mechanically, is spongy and porous, and has high water permeability. Salt rejection and water flux of a CA membrane can be controlled by variations in temperature and duration of the annealing step.

2-3-2. Thin Film Composite Membrane --- Polyamide(PA) Membrane

Thin film composite (TFC) polyamide membranes are consisted of a porous support layer and a thin film dense layer which is a cross linked membrane skin and is formed in situ on the porous support layer, usually made of polysulfone. The thin film dense layer is a cross-linked aromatic polyamide made from interfacial polymerization reaction of a polyfunctional amine such as m-phenylenediamine with a polyfunctional acid chloride such as tri-mesoyl chloride. This TFC manufacturing procedure enables independent optimization of the distinct properties of the support and salt rejecting skin. The TFC membrane is characterized by higher specific water flux and higher salt rejection than cellulose acetate membranes.

2-3-3. Comparison of Polyamide TFC Membranes with Cellulose Acetate(CA) Membranes

As mentioned above, the TFC membranes exhibit higher water flux and higher salt rejection than CA membranes which had been used widely until the commercial introduction of TFC membranes in 1981. TFC membranes are stable over a wider pH range and operable at lower pressure than CA membranes. Detailed comparisons between the two types of membranes are shown in the table below.

3. Types of Reverse Osmosis Membrane

Parameters		PA Membrane	CA Membrane
Operating pH range		2~12	4~6
Operating Pressure (Kg/cm^2)		15	30
Salt Rejection (%)	TDS	99+	98
	Silica(SiO_2)	99+	< 95
Salt Rejection Change after 3years		99%→98.7%	98%→96%
Chlorine Tolerance		<0.1 ppm	1 ppm
Membrane Fouling		High	Low