

**Table 14.1** Conventional separation technologies.<sup>10</sup>

Technology	Separation principle	Disadvantages
<i>Removal of low solute concentrations</i>		
Solvent extraction	A selective solute from the aqueous phase is separated out by dissolving in an additional solvent	Additional chemicals Re-separation requirements
Reverse osmosis	The solution is pressurized against a selective membrane, which only allows the pure solvent to pass	Sensitive to fouling and scaling
Ion exchange/adsorption	To remove dissolved ions from solution and replace them with other similarly charged ions/to adhere the dissolved solute to a surface of the adsorbent.	Fouling from iron and/or calcium sulfate Organic contamination from the resin Thermal/design problems of adsorbent
<i>Removal of high solute concentrations</i>		
Evaporative crystallization	Solutes are crystallized by evaporating the solvent until the required supersaturation is reached	High energy consumption Operation at high working temperature
Cooling crystallization	Solutes are crystallized by cooling the solution below its saturation temperature	A positive and steep solubility-temperature line Limited yield
Anti-solvent crystallization	An anti-solvent that reduces the salt solubility is added to the solvent and thus crystallization occurs	Extra chemicals Recovery of anti-solvent
Precipitation	A reagent that will form a sparingly soluble product is added to the existing solution and thus precipitation is effected.	Extra chemicals Formation of unexpected solid phase
Membrane crystallization	The solvent is removed from the solution by a membrane which creates or enhances the generation of crystals	Scale formation on the membrane surface
<i>Removal of both low and high solute concentrations</i>		
Freeze crystallization	Water is removed by ice formation	Not suitable for eutectic systems

A continuous EFC process is required in order to cost effectively treat large volumes of brines, since it has the capability to generate products of a consistent quality and is cheaper in terms of equipment.

### 14.1.3 Theoretical Basis – Binary Phase Diagrams

EFC achieves simultaneous recovery of salts and highly pure water from brine solutions by operating at the eutectic point of the salt-water system in consideration. The eutectic point is defined as the composition and temperature below which both solvent and solute crystallize out of solution. Different salt-water systems have different eutectic compositions and temperatures.