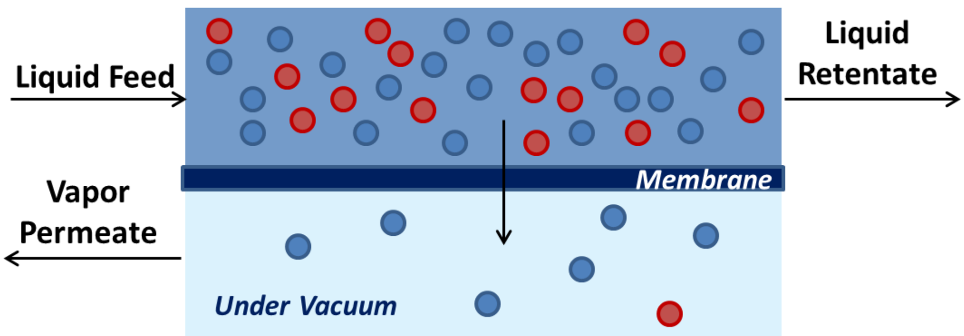
Pervaporation Background Theory

CMS membranes remove water by the pervaporation mechanism. Briefly stated pervaporation involves dissolved or dispersed water adsorbing to the membrane surface, evaporating, and finally permeating through the selective membrane layer. Permeation is made possible by establishing a driving force for water transport. A simple graphic of this mechanism is shown below where water is shown by the blue circles and solvent as the red:



Water removal (or water flux) is defined as the amount of water that permeates a given membrane area over a certain amount of time. In equation form, this looks like:

$$Q_w \left(\frac{mol}{h-m^2}\right) = \pi_w (x_w \gamma_w P_w^{sat} - y_w P)$$

- Q_w is the water flux (units of mol/h/m^2)
- π_w is the membrane permeance to water
- x_w is the mole fraction of water in the feed mixture
- γ_W is the water activity coefficient (function of x_w)
- P_w^{SAT} is the water vapor pressure at the temperature of the feed
- y_w is the vapor concentration of water on the permeate side
- P is the vacuum pressure

Examining this formula one can see that water removal rates are highest:

1. **At low vacuum pressures**. The pilot rig has a vacuum pump that achieves vacuum levels between 0.3-3.0 psia
2. **At high temperatures**. The higher the temperature, the higher the vapor pressure of water
3. **At high water loadings**. More water in the feed creates a higher driving force
4. **At high water activity coefficients**. Put another way, when water does not want to be in a mixture with the process solvent. This activity coefficient will be high in nonpolar or slightly polar organics like hexane or xylene and low for polar species like acetone.

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