5.7 VAPOR PRESSURE

Vapor pressure, or equilibrium vapor pressure or saturation vapor pressure is the pressure of the vapor phase in equilibrium with liquid or solid phase of the same substance. Sometimes vapors of multiple substances are mixed together, then the vapor pressure of a substance is also called the **partial pressure**. For a pure substance vapor pressure is equal to the total pressure, but for a mixture, the vapor pressure from any one type of molecule is only a fraction of the total pressure.

A high vapor pressure implies that the substance at that temperature has a high concentration of molecules in vapor. That would be the case if the substance is volatile at that temperature. A low vapor pressure will mean the opposite. For instance, at room temperature, the pressure in a closed container containing water is less than a similar container containing acetone which is more volatile.

Kinetic theory is helpful in understanding vapor pressure. The molecules in a liquid have a range of kinetic energies. The molecules near the surface with enough kinetic energy to leave the surface exit the liquid and become vapor borne. Similarly some molecules in the vapor strike the liquid surface and are trapped. At a particular temperature the two processes reach an equilibrium resulting in the equilibrium vapor concentration. The pressure of the gas above the liquid when the equilibrium is reached is called the **saturated vapor pressure**.

The saturated vapor pressure depends on the temperature and volume of the liquid/vapor system. Suppose you place some liquid in an enclosed rigid container to keep the net volume of the liquid and vapor fixed. Also suppose that the container is only partially filled with the liquid and the rest of the space is filled with the vapor. Now, if you raise the temperature of the liquid/vapor system, more molecules will be in the vapor phase. This would increase the vapor pressure. The change in the vapor pressure with temperature for a fixed volume follows the liquid-gas coexistence line in the phase diagram between the triple point and the critical point shown in Fig. 5.10.

If the container is not closed, then the equilibrium between the liquid and vapor phases is not reached since the molecules in the vapor phase migrate away from the container. The migrated molecules are replaced by molecules from the liquid phase which is essentially the drying process. If the vapor pressure in the environment is higher

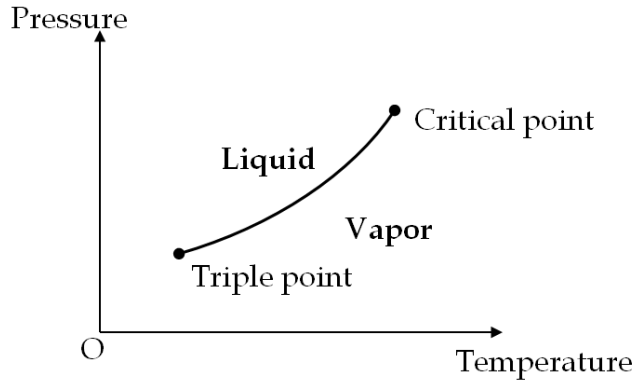

Figure 5.10: Saturated vapor line between triple point and critical point.

than the saturated vapor pressure under the given conditions of temperature pressure, the vapors will condense rather than evaporate off. This is the reason why clothes dry faster in air when humidity is low than on highly humid days.