

Heat of Vaporization

An evaporating liquid absorbs energy. This energy is used to do the work of overcoming the attractive forces among the molecules of the liquid so that they can enter the vapor phase. Although this absorption of energy increases the potential energy of the molecules, it does not change their average kinetic energy. Therefore, the temperature of the vapor does not change. The energy absorbed during evaporation may be taken from the immediate surroundings of the liquid. This lowers the temperature of the surroundings. The energy also may come directly from the kinetic energy of the molecules of the liquid, thus lowering the temperature of the liquid. In either case, evaporation of a liquid has a cooling effect. This effect is quite noticeable when alcohol, for example, evaporates after being applied to the skin or when you step out of water after bathing or swimming.

The quantity of energy needed to vaporize a unit mass of a liquid at constant temperature is called its heat of vaporization. The heat of vaporization usually decreases as the temperature increases. At higher temperatures, the molecules in a liquid are farther apart and require less energy for their vaporization than at lower temperatures. The heat of vaporization of water at 70°C is 2.33×10^3 joules per gram, whereas at 100°C it is 2.26×10^3 joules per gram.

Heats of vaporization usually are indicated for the normal boiling point temperature of the liquid. The value for alcohol is 8.6×10^2 joules per gram. This is much less than for water. You therefore can conclude that the intermolecular forces of attraction in alcohol are weaker than those in water. The value for chloroform is lower still: 2.5×10^2 joules per gram.

When a vapor condenses to a liquid at the boiling point, the process of vaporization is reversed, and energy is released. This energy is called the heat of condensation. The amount of energy given up is equal to the heat of vaporization. When steam condenses, it gives up 2.26×10^3 joules per gram without changing temperature. That is why a burn caused by steam at 100°C often is worse than one caused by an equal mass of liquid water at the same temperature.

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