PROPERTIES OF ETHYLENE GLYCOL

Physical Properties

Ethylene glycol is a clear, colorless, odorless, liquid with a sweet taste. It is hygroscopic and completely miscible with many polar solvents such as water, alcohols, glycol ethers, and acetone. Its solubility is low however, in nonpolar solvents, such as benzene, toluene, dichloroethane, and chloroform. Following are some of the physical properties of ethylene glycol

Boiling point at 101.3 kPa	197.60 °C
Freezing point	-13.00 °C
Density at 20°C	1.1135 g/cm^3
Refractive index, n_D^{20}	1.4318
Heat of vaporization at 101.3 kPa	52.24 kJ/mol
Heat of combustion	19.07 MJ/kg
Critical temperature	372 °C
Critical pressure	6515.73 kPa
Critical volume	0.186 L/mol
Flash point	111 °C
Ignition temperature	410 °C
Lower explosive limit	3.20 vol%
Upper explosive limit	53 vol%
Viscosity at 20 °C	19.83 mPa.s
Cubic expansion coefficient at 20 °C	0.62×10^{-3} K^{-1}

Table 2.1 Physical Properties of Ethylene Glycol

Ethylene glycol is difficult to crystallize; when cooled, it forms a highly viscous, super-cooled mass that finally solidifies to produce a glasslike substance.

The widespread use of ethylene glycol as antifreeze is based on its ability to lower the freezing point when mixed water. The physical properties of ethylene glycol- water mixtures are, therefore, extremely important in this regard. The relevant plots are shown in Fig 2.1

1. Chemical Properties

The ethylene glycols (commonly called diols) are dihydirc alcohols that have an aliphatic carbon chain. The two hydroxyl groups result in high water solubility and hygroscopicity and provide reactive sites. The heavier glycols exhibit some of the properties of ethers because of the ether linkage in their molecular structure.

The reaction of the ethylene glycols are similar to those of the monohydric alcohols in which the hydrogen group is replaced by halogens, is esterified of forms ethers, etc. Typical reactions, which are of industrial importance, are as follows:

Esters

Organic acids react with ethylene glycol to produce mono- and diesters, the relative yields of which are dependent on the molar ratio of the acid to the glycol.

$$(CH_2OH)_2 + RCOOH \rightarrow RCOOCH_2\text{-}CH_2OH + H_2O$$

$$(CH_2OH)_2 + 2RCOOH \rightarrow RCOOCH_2\text{-}CH_2OOCR + H_2O$$

Polyesters are formed by the reaction of ethylene glycol with polybasic acids or their derivatives, Bishydroxyethyl terephthalate, which is used to produce polyethylene

terephthalate, is made from the condensation of ethylene glycol with dimethyl terephthalate or terephthalic acid.

Ethers

Ethylene glycol can form mono- or diethers because of its two hydroxyl groups. The monoalkyl ether can be prepared by the reaction of dialkyl sulfates with ethylene glycol. The reaction of ethylene glycol with ethylene oxide produces higher glycols or ether glycols.

Oxidation Derivatives

The oxidation of ethylene glycol with nitric acid or in the vapro phase using oxygen produces glyoxal.

$$(CH_2OH)_2 + O_2 \rightarrow (CHO)_2 + 2H_2O$$

The two adjacent hydroxyll groups also allow cyclization, and polycondensation; one or more of these functional groups may, of course, also react with other derivatives. Examples of reactions coming under this classification are the formation of 1,3-Dioxolane, 1,4-Dioxane, etc.