Answer on Question #70028 - Chemistry - General Chemistry

Question: Determine the required concentration (in percent by mass) for an aqueous ethylene glycol ($C_2H_6O_2$) solution to have a boiling point of 104.0°C.

Solution

Ethylene glycol is much less volatile than water, so we can assume it is a non-volatile substance. Also it does not dissociate when dissolved in water, so the van't Hoff factor (*i*) is equal to 1. So, we can solve this problem using classic equations of ebullioscopy.

1) Write the equation for the boiling temperature increase relative to pure solvent:

$$\Delta T_{boil} = i * K_b * C_m,$$

where K_b is the ebullioscopic constant (0.512 for water), C_m is the molality of the solution (number of moles of solute per 1 kg of a solvent), and $i = 1$ as we mentioned above.

2) Find the molality of the ethylene glycol solution:

$$C_m = \frac{\Delta T_{boil}}{K_b} = \frac{4}{0.512} = 7.8125 \frac{mol}{kg\ H_2O}.$$

3) Find the mass of ethylene glycol:

$$m(C_2H_6O_2) = n(C_2H_6O_2) * M(C_2H_6O_2) = 7.8125 * 62 = 484.375\ g.$$

So, the required solution contains 484.375 grams of ethylene glycol per 1 kg of water. The mass of the solution is

$$m(solution) = m(water) + m(C_2H_6O_2) = 484.375\ + 1000 = 1484.375\ g.$$

And the mass percentage of ethylene glycol will be

$$\omega(C_2H_6O_2) = \frac{m(C_2H_6O_2)}{m(solution)} * 100\% = \frac{484.375}{1484.375} * 100\% \approx 32.63\%.$$

Answer: the concentration of an ethylene glycol solution is 32.63%.