Gaseous diffusion coefficient essay sample

Environment, Water

Introduction

The knowledge of physical and chemical properties of certain materials is important because very often process engineering deal with the transformation and distribution of these materials in bulk. One such property is diffusivity.

Theory

When a concentration gradient exists within a fluid consisting of two or more components, there is a tendency for each constituent to flow in such a direction as to reduce the concentration gradient. This is called mass transfer.

Description

The experiment to determine the diffusivity of gaseous is based on the Winkelmann’s method. In this method, the volatile liquid is allowed to evaporate in a vertical glass tube over the top of which a stream of vapour-free gas is passed. A water bath is provided for maintaining a steady temperature so that there is no eddy current in the vertical tube and mass transfer takes place from the surface by molecular diffusion alone. By monitoring the evaporation rate, which is the rate of fall of liquid surface, and with the knowledge of concentration gradient, the diffusivity can be calculated

The rate of mass transfer is given by:

(1)

Where, D= diffusivity [m2/s]

CA= saturation concentration at interface [kmol/m3]

L= effective distance of mass transfer [m]

CT= total molar concentration [kmol/m3]

CBm= logarithmic mean value of CB [kmol/m3]

Considering the evaporation of the liquid:

(2)

Where, ρL= density of liquid [kg/m3]

M= molecular weight [kg/kmol]

From Equation (1) and (2), the diffusivity of acetone, D can be calculated as:

Where, s is the slope of the plot against

Procedure

1. Fill the water bath with distilled water to approximately 20 mm from the top 2. Switch on the main power on the control panel

3. Adjust the set-point value on the temperature controller to 50oC (Warning!! Do not set the temperature controller beyond 70oC) 4. Switch on the heater. Observe the water temperature heats up to 50oC and remains constant 5. Partially fill the capillary tube with acetone to a depth of about 15 mm 6. Carefully insert the capillary tube through the fitting on top of the water bath cover 7. Observe the initial level of acetone through the telescope. Record the level of acetone. 8. Connect the flexible tubing from the air pump line to one end of the capillary tube. Switch on the air pump.

Observe and record the level of acetone for every 15 minutes in the following table.

Time, t (s)	Level of acetone, L (mm)	L – Lo, dL (mm)	L + Lo (mm)	t / (L + Lo) (s/mm)
900				
1800				
2700				
3600				
4500				
5400				
6300				
7200				
8100				

Results and discussions

1. Plot against . Determine gas diffusivity, from the obtained slope, s.

2. Compare the experimental value with the theoretical value that can be predicted from empirical equations.

3. What will be the diffusivity if you increase the heating temperature? Explain.