CE 110
Diffusion in liquids and gases

Description

- **diffusive mass transport of substances in gases and aqueous solutions**
- **application of Fick's law**

Diffusion is the microscopic mass transport of particles such as atoms, molecules and ions due to differences in concentrations. It plays an important role in numerous processes. For example, diffusion can bring together the reactants in chemical reactions and, in some cases, it can be the rate-limiting step for the process.

CE 110 is equipped with two experimental units for investigating diffusion in liquids and gases. To investigate diffusion in liquids, a concentrated salt solution is used. The solution is contained in a U-tube, one end of which has a disc with several vertical capillaries. The U-tube is immersed into a tank containing demineralised water so that the disc with the capillaries is positioned below the surface of the water. The concentration gradient between water and the solution causes the salt ions to move out of the U-tube through the capillaries into the demineralised water.

The capillaries ensure that the ions move in one dimension. A stirrer in the tank prevents the salt concentration increasing near to the disc, thus preventing concentration differences in the tank. A conductivity meter measures the salt concentration in the tank.

To investigate diffusion in gases, a highly volatile solvent is used. The solvent is contained in a vertical tube which is immersed into a heated water bath. The thermal energy from the water bath causes the solvent to evaporate. A fan generates an air flow, which moves horizontally at the upper end of the tube. The gaseous solvent diffuses due to the concentration gradient from the surface of the liquid solvent upwards to the pure air flow. The air flow transports the solvent molecules away, thus ensuring a constant concentration at the upper end of the tube. The volume of liquid solvent in the tube decreases over time. A scale microscope enables the level to be determined. A heater with controller keeps the temperature in the water bath constant.

Learning objectives/experiments

- fundamentals of diffusion: Fick's law
- derivation of the calculation formula for the diffusion coefficients for the given experimental conditions
- determination of the diffusion coefficient for the mass transport in gas
- determination of the diffusion coefficient for the mass transport in liquid

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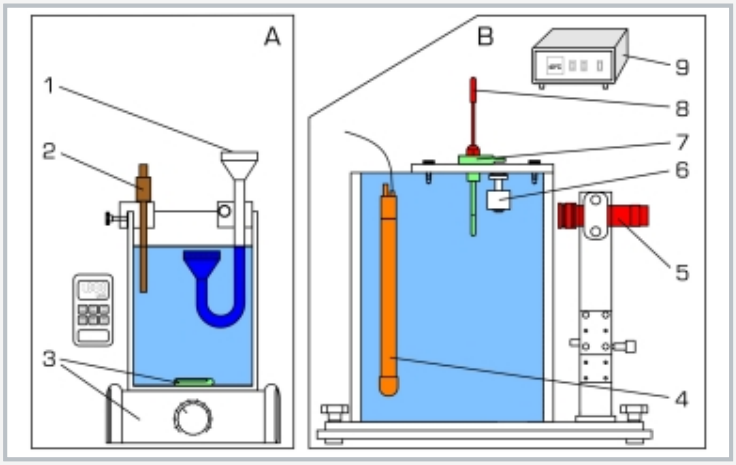
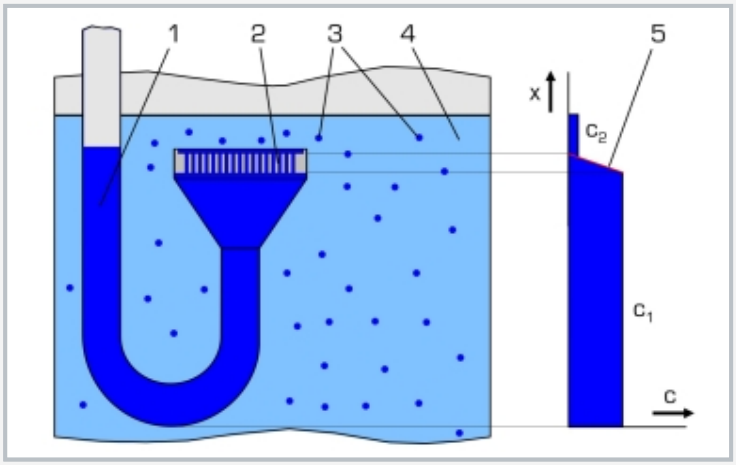
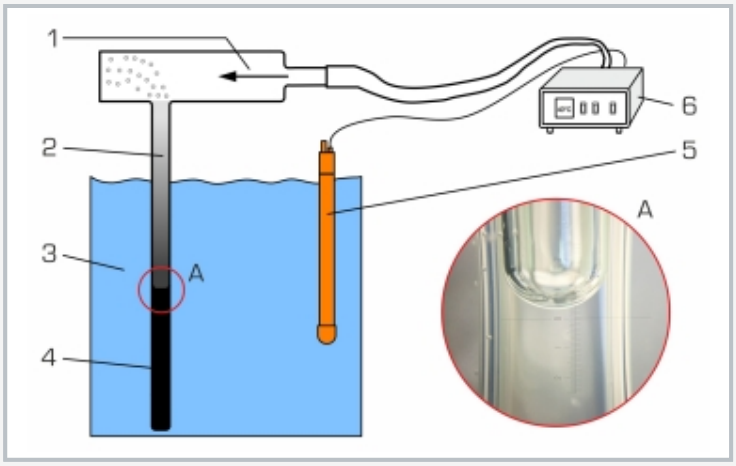


Units for diffusion in liquids (A) and in gases (B): 1 U-tube with capillaries, 2 conductivity sensor, 3 magnetic stirrer with magnetic stir bar, 4 heater in the water bath, 5 microscope, 6 float switch, 7 diffusion tube, 8 temperature sensor, 9 display and control unit



Diffusion in liquids: 1 concentrated salt solution, 2 capillaries, 3 salt ions, 4 water, 5 concentration gradient;
x path, c concentration, c_1 concentrated solution, c_2 diluted solution



Diffusion in gases: 1 air flow, 2 gaseous solvent, 3 water bath, 4 liquid solvent, 5 heater, 6 display and control unit; A meniscus in the microscope

Specification

[1] investigation of diffusion in liquids and gases
[2] transparent tank with magnetic stirrer, conductivity meter and U-tube with capillaries for investigating diffusion in aqueous solutions
[3] evaporation of a highly volatile solvent with a diffusion tube in a heated water bath for investigating diffusion in gases
[4] removal of gaseous solvent at the upper end of the diffusion tube with a fan
[5] heater with controller and sensor for adjusting the temperature in the water bath
[6] height-adjustable microscope for monitoring and determining the solvent volume in the diffusion tube
[7] separate display and control unit contains temperature display and fan

Technical data

Tank with stirrer: approx. 1500mL
Speed stirrer: 0...1500min^{-1}
253 capillaries made of stainless steel
- diameter: 1mm, length: 5mm

Water bath: approx. 2L
Diffusion tube for solvent
- diameter: 3,4mm, length: 85mm

Power output heater: approx. 125W
Fan: 120...320L/h
Microscope scale division: 0,1mm

Measuring ranges
- temperature: 0...100°C
- conductivity: 0...200mS/cm

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase
120V, 60Hz, 1 phase
UL/CSA optional
LxWxH: 210x210x280mm
(experimental unit for diffusion in liquids)
LxWxH: 220x290x450mm
(experimental unit for diffusion in gases)
LxWxH: 370x340x200mm
(conductivity meter)
Weight: approx. 16kg

Scope of delivery

1 experimental unit for diffusion in liquids
1 experimental unit for diffusion in gases
1 display and control unit
1 conductivity meter
1 magnetic stirrer with 2 magnetic stir bars
1 stopwatch
1 set of instructional material

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Optional accessories

WP 300.09	Laboratory trolley