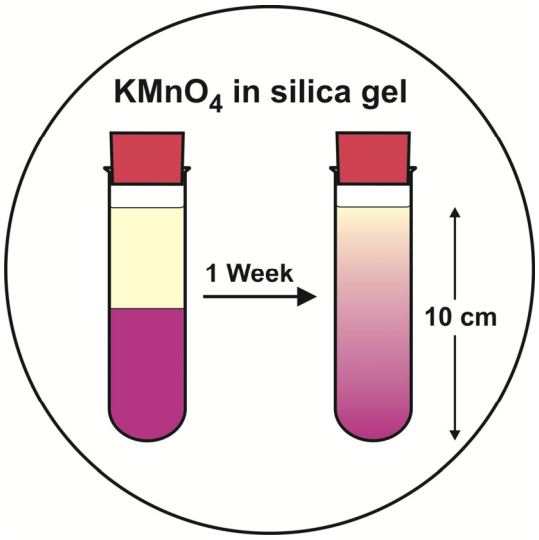
Diffusion of Permanganate in Silica Gel



Equipment:

beaker
large test tube

Chemicals:

sodium silicate
nitric acid (2 kmol m^{-3})
potassium permanganate solution (0.02 kmol m^{-3})
deionized water

Safety:

nitric acid (HNO_3) (2 kmol m^{-3}):

H290, H314, H332
P260, P280, P303 + P361 + P353, P305 + P351 + P338, P310

The acid can cause skin burns and eye damage. Inhalation of nitric acid fume and its decomposition gases such as nitrogen dioxide poses a very serious health risk. Wearing protective gloves and safety goggles is obligatory. In addition, the experiment has to be carried out in a fume hood.

Procedure:

Commercially available pure sodium silicate is diluted eightfold with deionized water; subsequently, the NaOH content is neutralized with nitric acid [example: starting mixture: about 5 g of sodium silicate and 35 g of water, addition of 6.7 mL of nitric acid (2 kmol m^{-3})]. After a few minutes, the color changes to yellowish. After coloring the gel purple by a little of the potassium permanganate solution, the large test tube is half filled with it. Immediately afterwards, a second portion of the gel is prepared and the upper half of the test tube is filled with it.

Obervation:

After a week, the MnO_4^- ions have already covered a distance of a few centimeters. This process can be followed easily using the violet color of the ions as indicator.

Explanation:

The diffusion of the MnO_4^- ions from one place to another can be considered as a reaction,

$$MnO_4^-|_{\text{position 1}} \rightarrow MnO_4^-|_{\text{position 2}},$$

and it is thus also determined by the chemical potential. The transport of substances always takes place in the direction of a potential gradient; this means that a substance migrates spontaneously only in a direction in which the μ value at the starting point is greater than at the destination. The chemical potential of a substance falls with its increasing dilution; the substance therefore migrates from areas of higher concentration (μ value large) to areas of lower concentration (μ value small).

Disposal:

The gel is added to the heavy metal waste.