Demonstration Experiments

to the presentation

"Chemical Potential in Focus – Flow of Substances and its Consequences"

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International Conference on Chemical Thermodynamics
August 5-10, 2012, Búzios / Brazil

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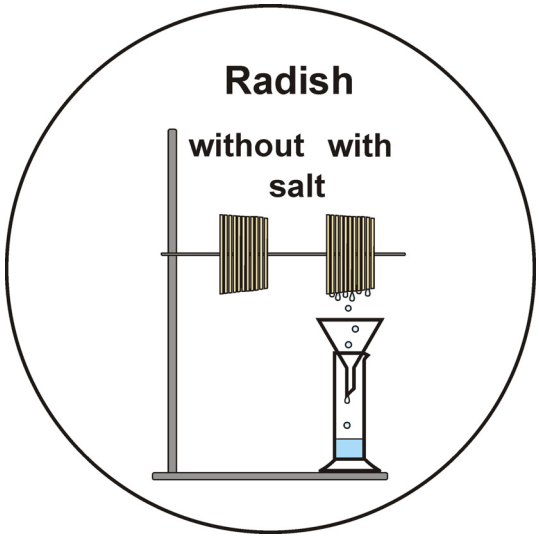
Juice “Extraction” from Slices of Salted Radish

– “Radish´s tears” –



Equipment:

wire or meat skewer (preferably stainless steel, diameter: 1 mm, length: 200 mm)
50 mL-measuring cylinder
funnel
fupport stand, clamp holder
falt shaker
futting board or plate

“Chemicals”:

white radish
table salt (NaCl)

Procedure:

Preparation: The white radish is marked on the outside with a longitudinal line with a permanent felt marker (so that the slices can be stacked correctly later on). The radish is cut into slices having a thickness of approx. 2 mm. The slices are piled in the original order in two stacks with a height of approx. 5 cm each and placed on a plate.
Procedure: The slices of one of the stacks are picked up in turn and salted very well with the shaker so that the salt grains form a relatively dense layer. Subsequently, the slices are piled on top of each other in the former sequence. Both stacks are speared on the skewer and the skewer is attached to the ring stand. The measuring cylinder together with the funnel is put under the salted slices.

Observation:

Immediately, juice begins to drip out of the stack with the salted slices. The measuring cylinder contains approx. 20 to 30 ml juice after 10 to 15 minutes.

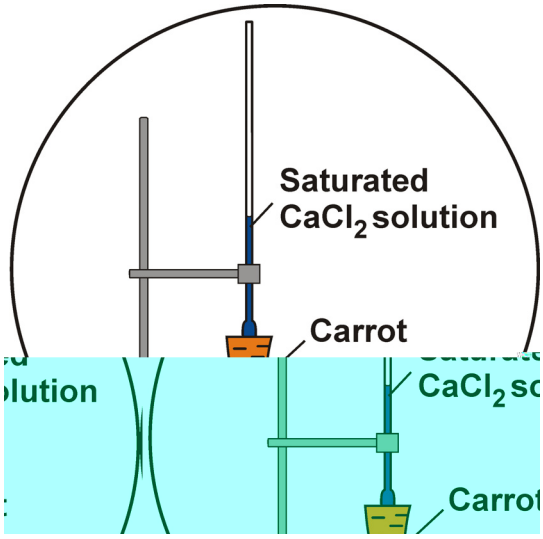
Explanation:

The solvent water migrates from the more diluted solution within the cells of the radish through the semipermeable cell membrane into the concentrated, therefore water-poor, salt solution on the outside. The process is explained in terms of the chemical potential of the solvent which is lower in the more concentrated solution because of the lower concentration of solvent in this solution.

Disposal:

The radish can be disposed of with the regular household garbage.

Osmotic Cell



Equipment:

riser pipe with a funnel shaped end
possibly ground-in glass stopper
cork borer with adequate diameter
beaker
support stand, clamp holder, extension clamp
strip of white cardboard

"Chemicals":

carrot
saturated calcium chloride solution
methylene blue solution

Safety:

calcium chloride ($CaCl_2$):

H319
P305 + P351 + P338

methylene blue solution ($C_{16}H_{18}ClN_3S$) (in ethanol):

H302, H315, H319, H335
P261, P305 + P351 + P338

It is highly recommended to wear safety glasses and protective gloves.

Procedure:

The inside of the carrot is hollowed out in a cylindrical form with the aid of a cork borer. Alternatively, one can drill totally through the carrot and close the bore hole on one side with the ground-in glass stopper. Subsequently, the calcium chloride solution colored with methylene blue is filled into the cavity. Then the funnel shaped end of the riser pipe is pressed into the hole without causing air bubbles. The meniscus of the solution should be just visible at the lower end of the riser pipe. The osmotic cell is then held on the stand by a clamp.

Observation:

After a short time, one observes a continuous rise of the solution in the riser pipe. With the white cardboard placed behind the pipe, the phenomenon is made more easily visible.

Explanation:

The solution in the cavity is more strongly concentrated and the solvent therefore more diluted than in the cells of the carrot. Because of the corresponding potential drop solvent flows through the semipermeable cell mebrane into the salt solution. As result the liquid begins to rise in the riser pipe, but the hydrostatic pressure of the column of solution