Optimization of Sorption of Porous Materials

Shenkova, Anastasia (School: The Advanced Education Science Center Kolmogorov Boarding School of the Moscow State University)

Liquid transport in porous materials is used in many industries: in everyday life, medicine, liquid filtration. These processes are of great practical importance: for example, they help to eliminate an ecological disaster. The problem of oil spills in the world ocean is now urgent because the existing solutions are not applicable on an industrial scale: they are expensive. The purpose of my report is to study liquid transfer and filtration. The absorption of liquid occurs due to the action of surface tension forces. It includes two modes: capillary effect in micro and macropores. During the experiment, the sponge swells. Previous works do not explain well the lifting mechanism at large time intervals. Here I used Darcy's law model with gravity influence and took into account the change in porosity and permeability during the experiment. Using a dye and video tracing, the dependence of the height of liquid rise on time and the liquid distribution were found. In the experiment, the absorbed mass dependence on time was investigated. The conditions for maximum absorption were found: a sponge should be slightly moistened, the contact area with the liquid should be maximized, the sponge should be completely immersed in the liquid, the contact angle should be minimized. The maximum mass ratio (mass of the absorbed liquid to the mass of a dry sponge) was 54 for phenol-formaldehyde foam. Filtration is carried out based on the hydrophobicity of the material: it allows oil to pass through, but not water. Previous studies have also examined the filtration of immiscible liquids and I did a comparison between some hydrophobic coating like paraffin, fat, and others. Cellulose sponges can filtrate at about 200 cm^3 of oil per hour, so such filters can be used to clean up oil spills.