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USSR B. F. Pokhil

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NEW METHOD FOR DETERMINING THE RATE OF DIFFUSION (MOBILITY) OF SURFACE ACTIVE MOLECULES ON A SOLID -- GAS BOUNDARY SURFACE

B. F. Pokhil
Lab of Surface Phenomena,
Inst for Phys and Chem Investigations,
Leningrad

We have developed a new method for determining the rate of diffusion of surface-active substances on the boundary surface between a solid substance and a gas. This method yields reproducible results. The principle of the method is described below.

If a platinum plate which had been previously heated on a flame in order to clean it is brought into contact at one end with a surface of water poured into an [N. K.] Adam balance while a surface-active compound (for instance, oleic acid) is introduced onto the other end of the plate (the one which is surrounded by air), the surface-active compound begins to evaporate into the two-dimensional space formed by the solid -- gas boundary. The rate of this evaporation depends principally on the nature of the underlying surface and the temperature of the surrounding medium. When the molecules of the surface-active compound reach the opposite end of the plate (the one which is in contact with water), they naturally begin to spread rapidly over the water surface, indicating this fact by the two-dimensional pressure created by them. This pressure is registered directly by the Adam balance. Before each experiment the Adam balance is brought into an operating condition; then one end of the metal plate is brought into contact with the water surface, the surface-active substance is introduced at the other end, and the number of molecules transferred from the plate onto the water surface is determined as a function of time by means of the Adam balance. In cases when the diffusion of a substance which develops a considerable pressure in the gas phase of the film formed by it is studied, this pressure can be used directly for determining the concentration of the substance in the film, i.e., the number

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of molecules transferred from the plate to the surface of the water within any given period of time. In order to do this, it is only necessary to plot the π/σ curve, where π is the two-dimensional pressure exerted by the film, and σ the area per 1 mol $Å^2$ [per 1 molecule in angstroms square?], or use published data.

By relating two-dimensional pressures found in the investigation of the diffusion rate to pressures from π/σ curves, we can determine directly the values in which we are interested. The best results, as far as reproducibility is concerned, are obtained at low two-dimensional pressures corresponding to a gaseous state or one near to it.

In the case of substances the gaseous film phase of which exhibits very low two-dimensional pressures (pressures which practically cannot be determined), it is necessary to remove the metal plate after keeping it for some definite time in contact with the water surface, and then compress the film until the latter begins to break. If the total area occupied by all molecules of the film at the time when the film begins to break up is known, and the limiting area corresponding to one molecule of the substance in question is also known (for instance, this area corresponds to 20.5 angstroms square in the case of myristic acid), the number of molecules transferred from the surface of the plate to the surface of the water during the time when the plate was in contact with the water can be calculated. The point at which the film begins to break up is clearly noticeable, so that any error which may occur due to the determination of this point is insignificant. This permitted us to utilize the phenomenon of film breakage not only in the investigation described above, but also for the study of adsorption of surface-active compounds by solid adsorbents. The latter investigation has not yet been published.

In studying the rate of diffusion in the boundary solid-gas of molecules of crystalline (solid) surface-active substances (for instance, myristic acid) it is necessary to have a temperature of the surrounding medium which is higher than the critical temperature of the substance; otherwise the

substance cannot evaporate into the two-dimensional space. A small crystal of the substance under investigation is fused to the end of the metal plate removed from the water. Subsequently the experiment is carried out as described above. The results of an investigation of this type will be published by us in the future.

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