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A CONVENIENT APPARATUS FOR MEASURING THE DIFFUSION OF GASES AND VAPORS THROUGH MEMBRANES

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In measuring the rate of diffusion of vapors or gases through solids, a standard method is to place a membrane of the solid between two chambers, in one of which the diffusing substance is placed, and to measure the rate at which the substance passes from the one chamber to the other. In such an apparatus it is necessary to have a leak-proof seal at the joint between the two chambers and the membrane.

In many types of diffusion apparatus described in the literature, waxes, tars, cements and similar substances form the seal around the test membrane. These materials usually cause trouble, however, either by gradual crystallizing and leaking, permitting diffusion through them, giving off gas, often failing to adhere to the apparatus, slowly flowing at room temperature or being otherwise mechanically defective. The apparatus described in this paper is a combination of a mechanical clamp and a mercury seal. Although it was developed for experiments involving the diffusion of water through rubber, it should also be suitable for other experiments involving the diffusion of gases or vapors through substances such as leather, plastics and certain types of paper.

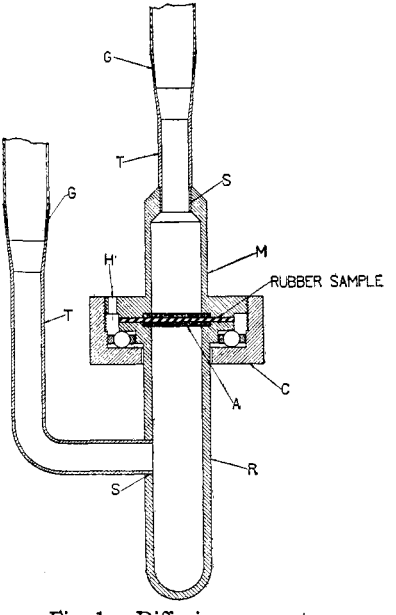

Fig. 1.—Diffusion apparatus.

Fig. 1 shows a detailed, cross-sectional view of the assembled apparatus. It consists essentially of three assembled parts, R, M and C, of which the main pieces are machined from nickel or stainless steel rod. The tubes T,T are made by spinning and shaping copper tubes and they are joined to R and M at S,S. The joints are copper-plated to enable them to be made air-tight by soldering. The joints G,G are copper-glass seals of the type described by W. G. Housekeeper.[1] Glass tubes leading to the diffusion-measuring device and to the evacuating system are sealed to G,G. The hole H gives access to the space around the membrane. Dimensions are not given in

[1] Housekeeper, *J. Am. Inst. Elec. Eng.*, [5] **42**, 954 (1923).

Fig. 1, because the apparatus can be made any size. A membrane area of 5.0 sq. cm. is convenient.

The screw clamp C is provided with ball bearings so that there is no appreciable torsion on the sample when it is clamped between R and M. Rigid porous disks, A,A, are placed on each side of the test sample as supports against unequal pressures resulting from unequal evacuation of the two parts of the apparatus, from the presence of diffusing material, the evolution of gas from the test membrane, or the opening or re-evacuating of one side of the apparatus. For this purpose any material, such as metal or glass screening or alundum filter disks, may be used, so long as it does not introduce an indeterminable absorption error.

The apparatus has been successfully used to determine the rate of diffusion of water through a rubber sheet. The sheet was cut into a disk of a diameter that would just slightly overlap the edge of the bearing flange of R. With Part C lowered and alundum filter disks fitted in place, the sections R and M were placed together, with the rubber disk between them, and centered by hand. Clamp C was then brought up and screwed into place, thus holding the rubber and the two brass pieces tightly together. The space between Part C and the body of Part R was then filled with a non-hardening putty to retain mercury, which was poured through the hole H until the space around the ball bearings and the rubber membrane was filled. A measuring device was sealed on the M side of the apparatus and a capsule of distilled water was placed in the R side. Both parts of the apparatus were then evacuated to about 0.01 mm. and the glass ends sealed off.

The water capsule was broken mechanically and the rate of passage of water into Chamber M was measured either by a mercury manometer observed through a micrometer microscope or gravimetrically by observing the extension of a calibrated quartz fiber spring[2] to which was attached a light quartz basket containing phosphorus pentoxide.

Conclusions

An efficient diffusion-measuring apparatus, embodying a mechanical clamp and a mercury seal, has been designed. This apparatus should find a variety of uses, such as the measurement of the rate of diffusion of gases and vapors through rubbers, waxes, leathers, certain types of paper and similar materials.

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[2] McBain and Bakr, THIS JOURNAL, **48**, 690 (1926).