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Heterophase Fluctuations and Pretransition Phenomena

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LETTERS TO THE EDITOR

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The Effect of Baffles on the Thermal Separation of Gases

Various experiments have been carried out in this laboratory to determine the effect of chamber design on the efficiency of the thermal mechanism for the separation of gases and isotopes. A tube was used of the same general design as that described previously[1] except that it was equipped with a ground glass joint to permit the insertion of baffles. The chamber was made from concentric glass tubes 110 cm in length; the inner heated tube was 1 cm O. D. and the clearance between the hot and cold surfaces was 2 cm. The power input was 500 watts. Under these conditions a 50–50 ammonium-methane mixture gave a negligible separation. However, by the use of baffles it was possible to materially enhance the value of the separation factor.

One set of baffles was made by soldering 100 copper washers, 4 cm O. D. and 2 cm I. D. on three $\frac{1}{16}''$ brass rods with a clearance of 1 cm between washers. The unit was mounted symmetrically between the hot and cold surfaces. In this chamber the separation factor was 1.18. Another type of baffle was made from 1-inch brass washers machined to fit tightly on the inner heated tube; the clearance between washers was 2.2 cm. The separation factor in this case was 1.35, a greater separation than any previously obtained with a tube of similar length.

An idea of the movement of the gases within the tube was obtained by depositing a uniform film of ammonium chloride on the walls before admitting the ammonium-methane mixture. Fig. 1 shows the condition of the deposit after several hours of operation. The ammonium chloride is now deposited on the outer wall in clearly defined striations placed symmetrically with respect to the baffles. The position of the striations shows that the hot gas moves directly across the tube from the heated to the cold surface and then back in well-defined swirls. The net effect of these movements is that the tube is crossed by a series of streams of hot gas, each contiguous to cold streams moving in the opposite direction. The character of the deposits excludes the possibility of any general mass movement down along the cold wall. Similar striations were observed in some of the concentric glass tubes already tested but were not noted in a tube with a fine heated wire extending down the center. The results indicate that the separation factor is enhanced by the definition of the swirls. A detailed account of this mechanism will be presented shortly.

FIG. 1. Striated deposit of ammonium chloride on the cold wall.

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[1] Bramley and Brewer, J. Chem. Phys. 7, 553 (1939).

Heterophase Fluctuations and Pretransition Phenomena

In a recent paper[1] J. Frenkel proposes a theory of fluctuations in the neighborhood of the melting point and other transition points. The phenomenon of "premelting" of crystals is defined as to the formation of small nuclei of the second (liquid) phase below the melting point. The author states that "The appearance of small nuclei of a new phase within a practically homogeneous substance (liquid or gaseous) has been admitted hitherto only in the case of undercooling or overheating, i.e., a thermodynamically unstable state." I wish, however, to draw attention to the fact that I have discussed this question already in a paper in 1922.[2] In the papers quoted by Frenkel in a preliminary note[3] attempts were made to treat the question with kinetic methods. On account of the difficulty of such a treatment, I—like Frenkel—used a thermodynamical reasoning using Einstein's method for calculation of fluctuations. The result of my considerations (formulae 1 and 2) were similar to those expressed in Eqs. (7*b*) and (8*a*) of Frenkel. A further development of the problem by Frenkel was done by taking into account the surface energy of the nuclei.

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[1] J. Frenkel, J. Chem. Phys. 7, 538 (1939).
[2] E. Brody, Physik. Zeits. 23, 197 (1922).
[3] J. Frenkel, J. Chem. Phys. 7, 200 (1939).