now in the Gulf of California on a three-months scientific cruise. The trip is sponsored jointly by the University of California and the Geological Society of America. Its object is to study the sediments and geology of the bottom of the gulf. Four principal areas will be investigated in detail and soundings will be taken at other points. Dr. Francis P. Shepard is a member of the expedition.

THE American Association of Dental Editors, composed of the editorial staffs of non-proprietary dental journals, is considering a plan to develop means for the abstracting of all articles published in their respective journals. They propose that the editors of individual dental journals agree to furnish and pool abstracts of all articles which they publish. These will be offered to some large group, such as the American Dental Association, for publication.

ACCORDING to *Nature* the Geographical Department of the Northern Sea Route Administration (USSR) has sent out the icebreaker *Sedov* on a new expedition to the northeastern part of the Kara Sea. It will be remembered that the *Sedov* returned to Murmansk on January 29, 1940, after a remarkable drift in the Arctic of twenty-seven months duration. The head of the new expedition is V. I. Vorobyev. The purpose of the expedition is to study one of the most important parts of the Northern Sea Route in the Kara Sea—from Izvestia Tsik Islands to Russky Island. The total length of this part is about two hundred nautical miles. The expedition is to carry out hydrographic and hydrological research: it will make systematic soundings of the depths of the sea, study the currents, wind régime, ice conditions and will carry out magnetic observations.

DISCUSSION

ON THE THEORY OF THE SEPARATION OF ISOTOPES BY THERMAL OR CENTRIFUGAL METHODS

THE theory of the separation of the components of a fluid by the thermal process has been discussed in detail by Waldmann, Furry, Jones and Onsager and Debye.[1] The importance of the process has been greatly enhanced by the striking success of its use in the separation of the isotopes of the elements. With this success has come a demand for a more complete knowledge of the functioning of the apparatus for a greater variety of types of gas flow than vertical thermal convection; the calculations of the investigators, mentioned above, were limited to this case. With the realization that similar processes are applicable to the centrifugal method,[2] it seemed that the same general method which will be described in detail in this paper for the thermal case could be applied profitably to that very interesting problem. The results of the calculations for both these cases will be compared in this note. However, the conclusions will be restricted to those systems which have been in operation for a period of time sufficiently long that they have nearly reached a state of equilibrium. For simplicity, a two-dimensional system will be considered in which the mass motion in the fluid is in the direction of the z-axis, and in which the primary effect, either thermal diffusion resulting from a temperature gradient between the walls, is in the x-direction, or that diffusion resulting from a centrifugal field gradient, is radial in the r-direction. It will be convenient to consider a fluid composed of two components with masses m_1 and m_2 and with concentrations c_1 and c_2 respectively. For the thermal case the equation of equilibrium can be expressed, for example, for the first component in the form

$$-\rho v \frac{\partial c_1}{\partial z}+\rho D \frac{\partial^2 c_1}{\partial z^2}+\frac{\partial}{\partial x}\left[\rho D\left(\frac{\partial c_1}{\partial x}-\alpha \frac{c_1 c_2}{T} \frac{\partial T}{\partial x}\right)\right]=0 \quad (1)$$

in which the second term

$$\rho D \frac{\partial^2 c_1}{\partial z^2}$$

can be dropped if the total change in the concentration of the first component is small compared to its initial concentration. This equation is subject to the boundary condition that at $x=0$ and $x=d$,

$$\frac{\partial c_1}{\partial x}-\alpha \frac{c_1 c_2}{T} \frac{\partial T}{\partial x}=0$$

and that the net flow across any plane perpendicular to the z-axis is zero, *i.e.*,

$$\int_0^d (\rho v)\, dx=0, \text{ for all values of } z. \quad (2)$$

To complete the mathematical formulation of the problem the equation must be added which expresses the condition that across any plane perpendicular to the vertical axis the transport of component, one, resulting from diffusion and mass motion must be in equilibrium.

$$0=\int_0^d \rho\left(-D \frac{\partial c_1}{\partial z}+v c_1\right) dx$$

for all values of z. To the approximation that al changes in c_1 are small compared to its initial va this equation gives for a column of height, h,

$$\frac{\Delta c_1}{h} D \rho_0 d=-\int_0^d \int_0^x \rho v\, dx\left(\frac{\partial c_1}{\partial x}\right) dx$$

[1] Waldmann, *Zeits. f. Physik*, 114: 53, 1939; Furry, Jones and Onsager, *Phys. Rev.*, 55: 1083, 1939; Debye, *Ann. d. Physik*, 56: 284, 1939.

[2] Beams and Skarstrom, *Phys. Rev.*, 56: 266, 1939. U. S. Patent Application, ser. no. 263352, 1939.

where ρ_0 is the average density of the medium. Now the equation for thermal diffusion can be written to a first approximation as

$$\rho_0 D \frac{\partial c_1}{\partial x} = \rho_0 D \alpha \frac{c_1 c_2}{T\ av.} \frac{\Delta T}{d} - \frac{\Delta c_1}{h} \int_0^x (\rho v)\, dx \qquad (4)$$

where ΔT is the temperature difference between the walls and $T\ av.$ is the average temperature of the enclosure. The substitution of (4) in (3) gives for the thermal case

$$\frac{\Delta c_1}{h} = \frac{-\frac{\alpha c_1 (1-c_1)}{\rho_0 D d^2} \frac{\Delta T}{T\ av.} \int_0^d \int_0^x \rho v\, dx.\ dx}{1 + \frac{1}{\rho_0^2 D^2 d} \int_0^d ([\int_0^x \rho v\, dx]^2) dx}$$

as the equation for the determination of the total change in concentration Δc_1, along the column.

This equation has a number of simple properties: (1) For any given distribution of ρv consistent with equation (2) the value of Δc_1 can be determined by quadratures. (2) The total change in concentration varies directly as the height h of the column. (3) The change in concentration Δc_1 for a column of fixed height h has a maximum value for a definite value of d, the width of the column. For the case where the mass motion is that of thermal convection, *i.e.*,

$$\rho v = \rho_0 v_0 \frac{x}{d} (x - d/_2)\ (d - x)$$

the position of the maximum computed in this way agrees to within 3 per cent. with Waldmann's value. (4) The last two results are well known. The new and interesting conclusions concern the changes produced in these results by varying the character of the vertical mass motion such as may be accomplished by the appropriate use of baffles or other suitable mechanical means.[3] For the same transport of fluid across one half of the transverse section of the apparatus, the maximum in the value of Δc_1 as a function of d, occurs for certain velocity distributions at a smaller value of d—besides that the maximum value of Δc_1 is greater—the closer the maximum values of the velocity occur to the boundary $x=0$ and $x=d$. (5) Similar results to those stated above in (1), (2) and (3) can be calculated for a centrifuge operating at a frequency f with an appropriate mass motion of the fluid circulating in the direction of the axis of rotation of length h. The type of gas motion seems to be rather critical as these calculations show that not all types of circulation in the direction of the axis lead to an appreciable increase in the separation factor. Some idea of the relative optimum operation of the thermal and centrifugal separator respectively can be gained by com- ing the relative values of the maximum of $\Delta c_1/h$ as a function of the width d. As the width d of the centrifuge is defined the effective radius. For these two distinct types of apparatus the ratio of the maximum of $\Delta c_1/h$ is as the ratio of the static effects. By static effect is meant the change in concentration arising from either thermal diffusion or centrifugal diffusion without any accumulative effect from the circulation in the fluid. It is interesting to note, however, that the calculations predict that for the centrifugal case the transport of fluid across one half of the transverse section of the apparatus, such as may be produced by thermal means in a centrifuge of proper pitch, should be nearly the same per unit area as that of the thermal separator with the circulation produced by thermal convection when both apparatuses are operating under optimum conditions, with the same values for the pressure of the gas and the width of the apparatus.

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ewer and Bramley, *Jour. Chem. Phys.*, 7: 972, Oc- 1939; Bramley and Brewer, *Jour. Frank. Inst.*, 940 (Bartol Notes).

THE STANDARDIZATION OF OSMOTIC PRESSURE AS A TERM

IN physical chemistry osmotic pressure has a long-established meaning: a physico-chemical property of a solution. Any definitions of osmotic pressure should not conflict with this. Confining ourselves to aqueous solutions we may say that osmotic pressure measures the difference of the fugacity of water between that in pure water and that in water acting as the solvent in a solution. This difference in fugacity is more or less proportional to the solute concentration, so that this difference, and hence the osmotic pressure, increases with increasing solute concentration. Osmosis is diffusion of water. Water diffuses from regions of high water fugacity (pure water) to regions with lower water fugacity (solution). Hydrostatic pressure is enhanced in turgid cells; an increase in hydrostatic pressure increases the fugacity of water, *e.g.*, vacuolar water. Since this pressure increases water fugacity the difference between the fugacity of water in the solution under pressure and that of free pure water is diminished and the effective or actual osmotic pressure is also diminished. Cells in water equilibrium have no residual actual or effective osmotic pressure, although the same fluid under no excess pressure would have the osmotic pressure given by its composition. This view obviates the desire for such terms as suction pressure. Suction pressure is the residual effective osmotic pressure when the cell contents are under pressure insufficient for equilibrium.

The definition proposed by Eyster[1] seems to consider that some quantity parallel to fugacity of water should be termed osmotic pressure. He says, "The osmotic

[1] H. C. Eyster, SCIENCE, 92: 171, 1940.