Ultracentrifuge

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LETTERS TO THE EDITOR

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Ultracentrifuge

We have previously described[1] a simple ultracentrifuge with which very high centrifugal forces were obtained. The method of rotating the centrifuge was a modification of that used by Henriot and Huguenard[2] in which very great stability and flexibility could be secured. The rotor was both supported and driven by a series of air jets in such a way that the maximum speed was limited only by the velocity of the air jets and the strength of the rotor.[1] In this work the centrifuge was applied to the study of suspensions of particles sufficient in size and relative weight to be separated in a comparatively short time and, as a result, the simple centrifuge chambers there described were quite satisfactory. However, recent experiments in the sedimentation of particles of molecular dimensions which sometimes require several hours centrifuging have necessitated changes in design in order to eliminate a slow remixing caused by convection currents. Since a convection current in a liquid is essentially a buoyancy phenomenon, any convection action is greatly magnified in solutions subjected to high centrifugal forces, i.e., in solutions subjected to centrifugal forces of several hundred thousand times gravity, very small temperature differences within the fluid will produce large convection currents. In the case of the air driven centrifuge the bottom part of the rotor is kept cooler than the top part due to the expanding air jets below and the air friction, etc., above. It was, therefore, necessary to design a centrifuge chamber that would eliminate these troublesome temperature gradients. After some schemes, such as previously warming the air, etc., were found to be impractical, this was accomplished by some rather simple changes in the design of the rotor. The depth of the centrifuge chamber was reduced to about 0.6 mm and bounded at bottom and top by specially prepared strong glass disks[1] sealed around the periphery with soft DeKhotinsky. Just below the centrifuge chamber a deeper chamber was provided which could be filled with a liquid to act as a temperature equalizer. Liquids with high temperature coefficients such as turpentine are preferable for this purpose because of the temperature equalization by their own convection action, but usually some of the solution being centrifuged will serve the purpose. With this arrangement the trouble arising from convection currents has been eliminated so that the centrifuge may run for many hours without appreciable remixing, e.g., hemoglobin molecules have been separated from the clear fluid with the above arrangement utilizing centrifugal forces of only about 10^5 gravity. To increase the capacity of the centrifuge, several centrifuge chambers may be placed one above the other or a large chamber may be divided into a series of thin partially insulated layers.

In order to collect both the lighter and heavier portions of the substance being centrifuged, a slightly heavier nonmiscible liquid should be used to displace the lighter fractions in a way previously described.[1] In these methods it is preferable to provide means of conducting the displacing liquid to the periphery without its passing through the solution to be collected. The liquid should not be too heavy or introduced too rapidly as stirring will occur. Sugar solutions may be used for substances where the lighter fractions only are to be saved.

Another phase of the work has been the development of small centrifuges to give very high centrifugal forces. With a rotor 9 mm in diameter driven by four jets of hydrogen (pressure 160 lbs. per sq. in.) instead of air a rotational speed in excess of 20,000 r.p.s. was obtained. This rotational speed produces a centrifugal force of about seven million times that of gravity, on the periphery of the rotor. These small centrifuges should be especially suitable for the microscopic observation of small particles in intense centrifugal fields by methods similar to those of Harvey.[3] A simple way of measuring the rotational speed is to view a white dot near the periphery of the rotor in a rotating mirror above the stator, preferably by means of a telescope.

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[1] See Science **78**, 338 (1933) for details of construction and other references.

[2] Henriot and Huguenard, J. de Phys. et Rad. **8**, 443 (1927).

[3] Harvey, J. Frank. Inst. **214**, 1 (1932).

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