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APPLICATIONS AND USES OF INDUSTRIAL CENTRIFUGES

A centrifuge is a piece of equipment that puts an object in rotation around a fixed axis, applying a force perpendicular to the axis of spin that can be very strong. The centrifuge works using the sedimentation principle, where the centrifugal acceleration causes denser substances and particles to move outward in the radial direction. At the same time, objects that are less dense are displaced and move to the center. There are three types of centrifuge designed for different applications.

Industrial scale centrifuges are commonly used in manufacturing and waste processing to sediment suspended solids, or to separate immiscible liquids. An example is the cream separator found in dairies. Very high speed centrifuges and ultracentrifuges able to provide very high accelerations can separate fine particles down to the nano-scale, and molecules of different masses.

Large centrifuges are used to simulate high gravity or acceleration environments. Medium-sized centrifuges are used in washing machines and at some swimming pools to wring water out of fabrics [1].

English military engineer Benjamin Robins (1707–1751) invented a whirling arm apparatus to determine drag. In 1864, Antonin Prandtl proposed the idea of a dairy centrifuge to separate cream from milk. The idea was subsequently put into practice by his brother, Alexander Prandtl, who made improvements to his brother's design, and exhibited a working butterfat extraction machine in 1875 [2].

By the nature of the processes occurring at centrifugation, the centrifuges are distributed to the filtering and precipitating. Centrifuges are equipped with perforated rotors of conical configuration, located horizontally or vertically. In the process of filtration centrifugation distinguishes three periods: the formation of sediment, its consolidation and mechanical drying. The sediment is unloaded by rotor vibration or by screw. In the screw sediment centrifuge, after the deposition of the axle parts, the auger is transported along the rotor and simultaneously dewatered. Fugate flows along the spiral screw channel in the deposition zone. In centrifuge with a screw deployment, the axial velocity of the movement of eyepieces is determined relative to the rotational speed of the shank, the average diameter of the rotor, the length of the screw. In a vibration scan centrifuge, the average speed of movement across the pole is from the frequency and amplitude of its oscillation, diameter, angle of inclination, frequency of rotation, as well as the density and coefficient of external choice of output and anhydrous products.

The spiny part of the centrifuge is called a rotor. Rotors have a finite lifetime. They undergo tremendous forces. Being made of metal, they can suffer from fatigue over time, causing the rotor to suddenly fly apart. The more slowly the rotor spins, the more inherently safe it is. Rotor failure at very high speeds can be deadly [1].

Depending on the particular application, centrifuges differ in their overall design and size. There are five major types of centrifuges. They are: 1) small bench centrifuges; 2) large capacity refrigerated centrifuges; 3) high speed refrigerated

centrifuges; 4) ultracentrifuges (preparative ultracentrifuge and analytical ultracentrifuge).

The «speed» of a centrifuge is measured in revolutions per minute, or rpm. Centrifuges are generally divided into 3 categories based on their maximum attainable speed: 1) «Low-speed»: to maximum of ~ 5 x 103 rpm; 2) «High-speed»: to maximum of ~2 x 104 rpm; 3) «Ultracentrifuges»: to maximum of ~105 rpm.

Centrifuges are either refrigerated or not refrigerated. Refrigerated centrifuges have a built-in refrigeration unit surrounding the rotor, with a temperature sensor and thermostat permitting selection of a particular temperature or a permissible temperature range that is maintained during centrifugation. Many biological samples are temperature sensitive, and centrifugation in the cold (1-4^{o}C) is frequently required.

Centrifuges that are not refrigerated are normally used at whatever temperature the room they are in happens to be. This is typically described in research reports as «room temperature» or «ambient temperature», which sounds somewhat scientific. In fact, such terminology means that the temperature was probably somewhere above 20^{o}C but is actually unknown. For purposes of repeatability, it is a good idea to measure «room temperature» in your room with a thermometer. It should be noted, however, that such measurement will provide only an estimate, because the spinning of the centrifuge itself can generate heat that warms up the centrifuge and any samples contained within. If samples must be kept cold and a refrigerated centrifuge is not available, a non-refrigerated centrifuge is frequently pre-cooled and run in a temperature controlled room («cold-room»).

Centrifuges can be used for a multitude of applications, because there are many different types available in today's market. Some common applications for centrifuges are: 1) separation of mixtures with close densities; 2) separate immiscible liquids; 3) sediment suspended solids; 4) separation of blood; 5) separation insoluble particles (e.g. insoluble proteins in a protein solution); 6) isotope separation; 7) gravity simulation environments for astronauts; 8) separating creams; 9) washing machine spin function; 10) separation of wastewater sludge; 11) material synthesis in a high gravity environment [3].

Today, centrifuges are controlled by microprocessors. Some can be used under high pressure or super cooled.

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