- at the end of each working day, the suction system should be cleaned with detergent solution and afterwards with the diluent solution;
- the aperture of the glass cuvette must always be kept immersed in diluent solution to avoid obstruction.

Further maintenance procedures (e.g., cleaning of mercury, etc.), must be carried out according to the manufacturer's instructions.

Centrifuges

Basic principles

A centrifuge is a machine that applies a sustained centrifugal force (i.e., a force due to rotation) to impel matter outwards from the centre of rotation. This principle is used to separate out particles in a liquid medium by sedimentation. The physical basis of the separation is the action of a centrifugal force on the rotating particles, which increases with the radius of the rotational field and the velocity of the rotation. The rate of sedimentation is determined by the density of the particles. Dense particles sediment first, followed by lighter particles. Depending on the conditions, very light particles may even remain in suspension.

The relative centrifugal force is related to the number of revolutions of the rotor per minute according to the formula:

$$\mathrm{RCF} = 1.118 \times 10^{-6} \times r \times n^2$$

where RCF = relative centrifugal force (g)

r = radius in millimetres from the centrifuge spindle to point of tube,

and

n = no. of revolutions per minute.

The relative centrifugal force can easily be calculated from a nomogram (Fig. 2.13), where the radius is measured from the centre of the rotor to the middle of the tube placed in the radially oriented rotor bucket; e.g., if the radius is 75 mm, the speed of rotation must be 2500 revolutions per minute to develop a centrifugal force of 520 g. It is important that the temperature in the centrifuge does not exceed 37 °C, otherwise degradation of some constituents of the specimen may occur.

There are two main types of centrifuge: preparative and analytical.

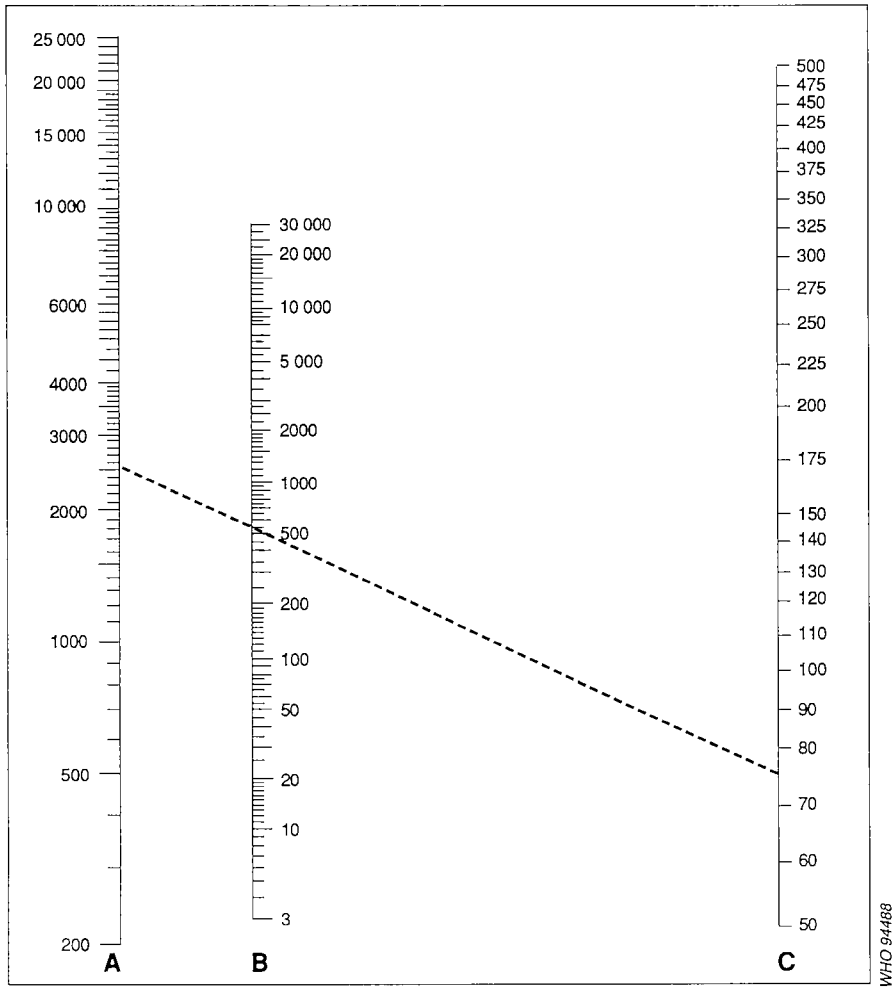
Preparative centrifuges are used to separate the solids suspended in biological samples from the supporting fluid. This is the most common type of centrifuge, and they are fitted with swing-out, or fixed-angle, heads.

Preparative centrifuges vary in their sample capacity and size, from floor-standing to small capacity centrifuges that can be sited on a bench. Some are fitted with internal wind shields to protect the operator from contamination by any aerosols that may be formed. This is now a mandatory safety requirement in many countries.

Two types of preparative centrifuge are currently used—mechanical and electrical —although the majority are electrical centrifuges.

Analytical centrifuges may be used to quantify one or more solid components in a mixed suspension. The only centrifuge of this type used in medical laboratories is the microhaematocrit centrifuge.

Fig. 2.13. Nomogram for determination of the relative centrifugal force.



A Speed of centrifuge spindle in rpm.
B Relative centrifugal force (x g).
C Radius in mm from centre of centrifuge spindle to point along tube or flask.

Unpacking, siting, installation, and electrical requirements

Follow the manufacturer's instructions, if these are available. Remove all packing and any transit fixings that may have been used.

Check that the equipment voltage is the same as the local supply, and that the fuse rating is correct. A correct fuse should protect the equipment from serious electrical damage.

Both bench and floor-standing centrifuges must be sited on a rigid surface, away from laboratory balances. Bench centrifuges should be at least 20 cm from the edge of the bench. If the sample breaks during rotation, considerable "out of balance" forces are generated, and the centrifuge may move about unpredictably.

Good working practices

Preparative centrifuges

- The centrifuge must be positioned exactly horizontally to avoid movement if the instrument is out of balance during operation.
- It is critically important that the centrifuge load is balanced at all times. Therefore, tubes should be loaded in matched buckets fitted with rubber cushions, and should be arranged so that like loads are opposite. A "dummy", i.e., a tube containing the appropriate volume of water, must be included when an odd number of specimens are to be centrifuged. Final balancing should be carried out by placing paired loads on the two pans of a reasonably sensitive balance, and balancing by adding water from a bottle or Pasteur pipette; if possible, add water to the lighter of the two samples, so that it balances the heavier load. Biological samples should be capped during centrifugation. The centrifuge should be stopped immediately if it develops an abnormal noise, indicating that it is not properly balanced.
- After use the buckets should be inverted to drain dry.
- After any sample spillage, always clean up the buckets and the centrifuge and disinfect with 70% (700 ml/l) alcohol immediately.
- Clean and disinfect the centrifuge often, because it is one of the most frequently used instruments.
- Check mountings and replace if necessary.
- Check motor brushes and replace if necessary.
- Check for corrosion and clean if necessary.
- Never operate a centrifuge with the lid open.
- Do not use the centrifuge at higher speeds than necessary.

Haematocrit centrifuges

Haematocrit centrifuges need not be balanced before use. As the samples are small capillary tubes, and the forces relatively low, it is only necessary to load the samples symmetrically. Never run the centrifuge with the lid open. Capillaries should be plugged at one end with the recommended sealing compound. The plugged end should always be placed against the sealing gasket. Even with the above precautions, it is possible that blood may leak from the bottom of the capillary. After any spillage, the centrifuge chamber must be disinfected and cleaned immediately with soap solution, and then with 70% (700 ml/l) alcohol.

Hazards/safety

Because centrifuges are regularly used to prepare blood and urine samples, it is recommended that the rotor bowl, centrifuge head, buckets and trunnion rings be disinfected before any servicing is carried out.

Tools

A general tool kit is satisfactory.

Spares

Suppression capacitor (interference filter)
Carbon brushes
Rubber feet (bench models)

Rubber cushions (for preparative centrifuges)
Sealing gasket (for haematocrit centrifuges)

Maintenance

1. Check lid lock.
2. Inspect trunnion rings and buckets for metal fatigue.
3. Check hinges, control knobs, rubber feet.
4. Check the weight of the buckets and replace them in their holders. The rubber cushions in the buckets may be lost or taken out for cleaning and misplaced, so that uneven loads occur. Even small weight differences can cause rapid wear and degradation of the motor bearings.

Service

1. Inspect brakes for proper operation.
2. Adjust lid lock to ensure proper operation of the electrical interlock.
3. Check for loose connections.
4. Check carbon brushes for wear, or lack of spring tension.
5. Check timer (if fitted).
6. Grease motor bearings.

Calibration

This is not generally required on preparative centrifuges. Haematocrit centrifuges may be checked with a tachometer, if one is available.

Electrode equipment

Electrodes are used for measuring the electrical potential that develops when a strip of metal is immersed in a dilute solution of a gas or salts. A transfer of gases or ions between the metal and the solution occurs, establishing the electrical potential (see also "Batteries" p. 13). The magnitude of the potential varies with the concentration of ions in the solution. If two electrodes are dipped into a solution, the difference between the electrical potentials of the two electrodes can be measured (Fig. 2.14). If one of the electrodes has a stable potential (i.e., a reference electrode), measurement of the potential difference can be used to determine the gas or ion concentration in the solution.

Fig. 2.14. Potentiometric chain.