Centrifuges

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Centrifuges used in laboratories will vary from small bench top devices to large, high capacity, high speed floor standing machines. Typical centrifuge operating speed classifications are:

- Low speed < 8000 rpm
- Medium speed 8000 ~ 30000 rpm
- High speed 30000 ~ 80000 rpm
- Ultracentrifuge > 80000 rpm

The main hazards associated with the use of centrifuges

- Ejected parts arising from rotor or rotor accessory failure
- Release of potentially harmful, infectious materials being processed
- Entrapment or contact with a spinning rotor
- Manual handling injury associated with the mounting and demounting of centrifuge rotors.

The main elements of safe centrifuge operation

- Operation by competent staff
- Risk management measures
- Maintenance and inspection
- Effective rotor management

Operation by competent staff and students

- Centrifuges should only be operated by suitably trained & competent staff and students.
- All centrifuge users should be formally instructed by a competent person in the use of the specific type of centrifuge to be used.
- A record of such training should be created.
- High speed ultracentrifuges and high capacity centrifuges should have an individual log book kept adjacent to the centrifuge where information such as rotor run duration, speed, where appropriate cumulative revolutions, defects, and maintenance activity can be recorded.
- This log book can also be used to record authorised users of specific machines.

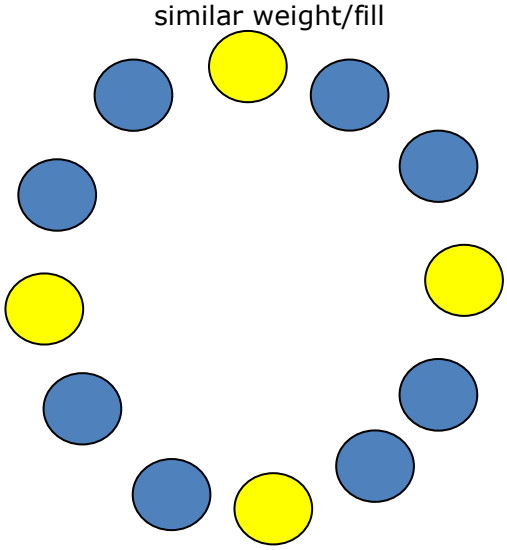
Users should adopt the following measures to minimise risks

Avoiding Vibration/imbalance

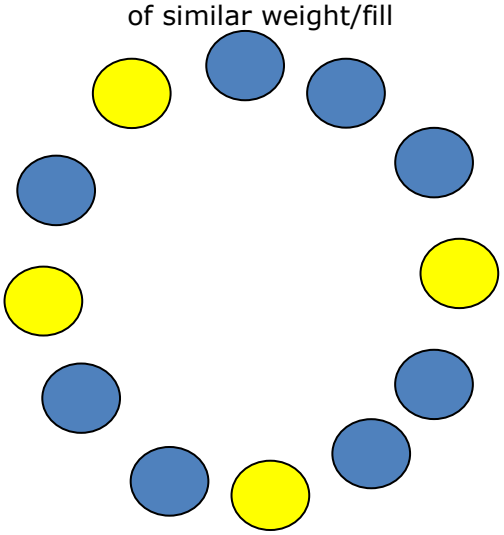
- Choose tubes suitable for the desired speed and for the rotor in use.
- Rubber thimbles or adaptors must fit the bucket or rotor correctly.
- Tubes or containers should be balanced by weighing and should not exceed the limits recommended by the manufacturer.
- Load containers into the rotor ensuring symmetry and balance. In some machines all places must be filled.
- The centre of gravity of opposing containers must be equidistant from the axis of

rotation, and so be of a similar weight/fill level.

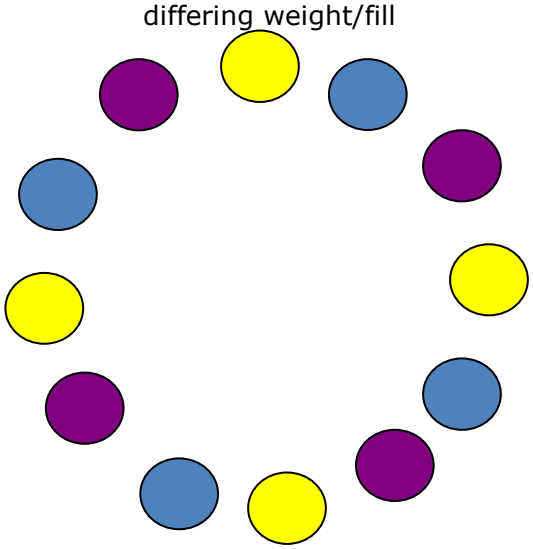
Correctly balanced – multiple tubes of similar weight/fill



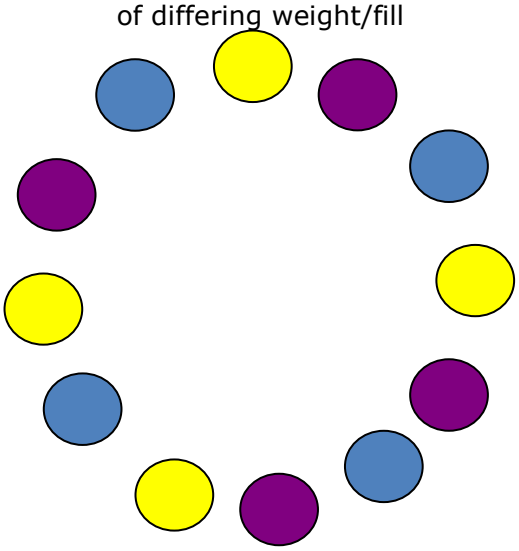
Incorrectly balanced – multiple tubes of similar weight/fill



Correctly balanced – multiple tubes of differing weight/fill



In correctly balanced – multiple tubes of differing weight/fill



- Ensure that the rotor is correctly positioned on the drive shaft using an appropriate tool if necessary. Some rotors have locating pins on their underside which must be correctly aligned.
- On a swing-out rotor, ensure that assembly is correct and enables the buckets to swing freely and properly.
- Fit and secure the rotor lid if necessary, e.g. on some models there are two locking knobs, one secures the lid to the rotor and the other secures the rotor to the drive shaft.
- Never walk away from a centrifuge until the required speed has been attained.
- Any unusual noises must be investigated immediately.

Correct siting

- Ensure that centrifuges are sited away from circulation routes and in such a way as to reduce risk from movement due to uneven load. This is particularly important for bench top models which may fall off in the event of a catastrophic accident.
- Hazardous materials should not be stored or placed on bench within 300mm of the machine.

- Manual handling during the mounting and demounting of rotors can pose a significant risk. Schools and departments should take account of the capabilities of individual staff and students who are required to carry out this operation. Risk can be significantly reduced by carful location and design of rotor storage to reduce carry distances and to minimise the need for reaching and stooping.

Rotor failure - due to either corrosion or overstressing

Corrosion

- Ensure rotors are inspected by competent person.
- Examine the rotor, tubes and caps before each run, making sure they are clean, dry and free from signs of stress or corrosion (pitting or cracks).
- Do not dispense water directly in the buckets when balancing.
- Wash the buckets or rotor after centrifuging corrosive substances such as acids, salt solutions etc.
- Take care not to damage the surface protection of a rotor, especially the anodising on aluminium.
- Rotors should be washed regularly, at least once a week, using a neutral pH detergent, e.g. Neutracon, and a soft plastic brush. Never use harsh high pH detergents (such as Decon).
- Do not leave adaptors inside rotor pockets or buckets.
- Air dry the rotor and/or buckets or use soft none abrasive wipes.
- Regularly apply rotor protection spray.
- Store rotors and tubes clean, dry, upside down and with the lids off.
- Grease 0-rings and centrifuge parts regularly in accordance with manufacturer's recommendations or at least weekly for machines that are in regular use, before each run for those used only occasionally.

Overstressing

- The following will overstress a rotor and ultimately may lead to disintegration.
- Running above the rated maximum speed.
- Failure to observe de-rating due to age and usage.
- Centrifuging samples with a density exceeding 1.2 g/cm^3 without de-rating the maximum speed of the rotor.
- Using tubes which are too heavy.
- Precipitation in a density gradient, e.g. CsCl.

Containment of aerosols

- Hazardous substances must only be centrifuged in capped, leak-proof tubes, and must be contained in sealed buckets/rotors.
- Sealed buckets or rotors containing biological agents at Advisory Committee on Dangerous Pathogens (ACDP) Hazard Group 2 or above must be opened in a Microbiological Safety Cabinet, Class I or II.

Breakage/leakage procedures

A breakage or leak within a centrifuge will generate an aerosol into the machine. The following procedure must be adopted in the event of a centrifuge accident or suspected breakage:

- In the event of an obvious breakage, switch centrifuge off, do not attempt to open for at least 30 minutes. For biological hazards rotor/buckets should be opened in and microbiological safety cabinet.
- Spills must be decontaminated as appropriate using **non-corrosive** disinfectants and/or **neutral pH** detergents.
  Guidance on the selection of suitable disinfectants can be found at - http://www.nottingham.ac.uk/safety/documents/bio-gm5-disinfectant.pdf

- Accidental release or spillage of Genetically Modified Organisms or Biological Agents should be reported via the form found at - http://www.nottingham.ac.uk/safety/documents/bio-gm7-accident.pdf

Maintenance and inspection

- Rotors and accessories must be made non-radioactive, non-pathogenic, non-toxic and otherwise safe prior to maintenance or repair. A signed statement confirming this must be provided to during the handover of the equipment to a maintenance service provider.
- All centrifuges should be serviced in strict accordance with manufacturer's recommendations using competent service providers; this is of particular importance with high speed and ultracentrifuges and larger capacity machines.
- It is suggested that inspections be carried out weekly when the centrifuge is in regular use or pre use for infrequently used machines.
- A record of all maintenance and inspections on centrifuges should be maintained.

Centrifuge rotor management

- The rotor manual should be read before the rotor is put into service and all manufacturers operational specifications incorporated into local operating procedures.
- Maximum speed and sample density ratings designated by the manufacturer for each rotor are intended to prevent stress failures and should always be observed, as should speed reductions required for running high-density solutions, plastic adapters or stainless steel tubes.
- Rotors must be used with the correct centrifuge e.g. Beckman rotors in Beckman centrifuges.
- The purchase date of each rotor should be recorded along with manufacturing date and serial number.
- The warranty period and retirement recommendations for each class of rotor should be strictly observed. Do not use a rotor after the expiration date which is usually permanently marked on the rotor or rotor accessories.
- Some rotors also have a maximum run cycle limit which should be monitored and not exceeded. Signs of deformation, cracking or corrosion should also prompt the removal of a rotor from service.
- Under certain circumstances the life of a rotor may be extended; for example where it can be demonstrated that a particular rotor is used infrequently and is in good condition. The decision to extend the life of a rotor for a defined period must be made by a competent engineer and be communicated in writing.
- Storage is an important factor in maintaining rotors and rotor accessories in good condition. Rotors should be stored in a clean, dry environment, ideally not left in the centrifuge.
- Fixed angle vertical tube and near-vertical tube rotors should be stored upside down, with the lids or plugs removed to prevent condensation.
- Swinging bucket rotors should be stored with the bucket caps removed.