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Routine Maintenance of Centrifuges

Cleaning, Maintenance and Disinfection of Centrifuges, Rotors and Adapters

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Executive Summary

In general, handling centrifuges is a safe process, as long as high quality equipment is used, such as anodized or PTFE coated aluminum rotors for instance, and the following conditions are met: the centrifuges and their equipment are used properly, are in an undamaged condition and maintained as recommended here. Prevention from long-term exposure to residues like salts or aggressive chemicals through routine maintenance by customers themselves can help to largely avoid extensive corrosion incidents and to achieve the full lifetime of equipment. Therefore, instructions how centrifuges and their equipment can be cleaned, autoclaved, lubricated and decontaminated by the user himself are presented here. Finally, information is given in case professional inspection and certification services are required in labs with highest safety demands.

Introduction

Centrifuge maintenance, as the name says, is to be understood as an everyday tool to maintain optimal condition and safety of laboratory devices. To follow cleaning and maintenance recommendations is highly important in case of contamination with salts and chemicals. In case of long-term exposure aggressive chemicals can develop corrosive spots on rotors and rotor-buckets, which may constantly grow and form small holes if ignored (Fig. 1). If small scratches and cracks are already present on the rotor surface, this further facilitates corrosion processes as protective coatings are missing on those spots. In case of advanced corrosion, rotors or buckets could be damaged in a way that makes centrifugation processes unsafe. In worst case, damaged rotors can even lead to a crash. Centrifuges manufactured according to IEC standards ensure that no harm or damage will be done to persons or surrounding lab equipment. However the centrifuge and rotor themselves may be destroyed.

High quality aluminum rotors and rotor-buckets are usually protected against corrosion caused by commonly-used laboratory chemicals, for instance by means of an anodized coating. Nevertheless aggressive chemicals can still damage the equipment! Such chemicals include concentrated and mild alkalis, concentrated acids, solutions containing mercury ions, copper ions and other heavy-metal ions, chlorinated hydrocarbons, and concentrated saline solutions.
Normally steel rotors are protected against corrosion by the use of coatings as well, but of course they also require continuous care.
In addition contact with organic solvents (e. g. phenol, chloroform) may have an adverse effect on transparent caps (mainly manufactured from polycarbonate) of aerosol-tight buckets.

We recommend checking the rotors and rotor bores visually for residue and corrosion on a weekly or monthly basis. Rotors, buckets, lids or adapters, which have been subject to chemical or mechanical damage or which have exceeded their maximum operating life, should not be used any longer. Damaged tubes or plates should not be centrifuged. Important information regarding cleaning and maintenance can not only be found in this paper, but also in the operating manual of your centrifuge. If unsure about the cleaning or decontamination methods of the centrifuge or rotor, one should contact the manufacturer and follow his recommendation. If in doubt whether a rotor is still safe, an authorized technician should be contacted.

Figure 1: Localized corrosion in bore hole

Cleaning, Maintenance and Disinfection

Centrifuges

Remove buckets and rotor from the centrifuge. For refrigerated centrifuges: Leave centrifuge lid open and defrost the ice on the rotor chamber surface. If your centrifuge is equipped with a water collection tray, empty and clean it, then wipe the rotor chamber with a moist cloth. The outside of the centrifuge and the rotor chamber should be cleaned regularly with a moist cloth and neutral detergents (Fig. 2). Switch off the centrifuge, before you do so.

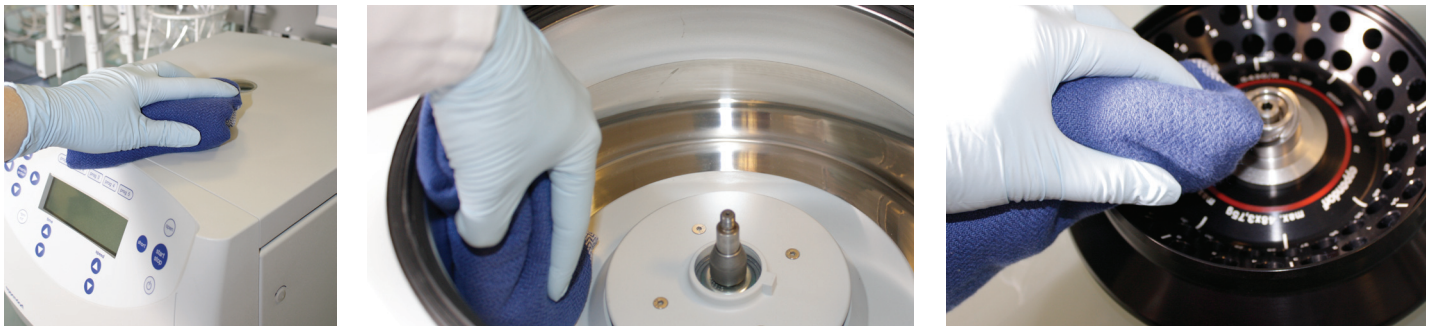

Figure 2: Wipe outside of centrifuge and clean rotor chamber and rotor with moist cloth and neutral detergents.

In the event of contamination caused by high-risk substances (bio hazardous or aggressive chemical reagents and radioactive reagents) wear a laboratory coat, gloves and goggles. If there is broken glass: Retrieve the bigger broken glass with forceps, remove small and powder shards with a damp lint-free cloth. Absorb blood with gauze or paper towel and subsequently, seal the material in a biohazard bag for safe disposal (Fig. 3). Wipe the contaminated parts with neutral agents for cleaning and disinfection (e.g. diluted neutral alcohol-based disinfectant or 70 % isopropanol mixture). Use a soaked gauze or lint-free cloth.

If necessary, remove still contaminated rotor, rotor lid, buckets, and bucket caps out of centrifuge to decontaminate areas which are difficult to access. After decontamination the equipment should be wiped with distilled water.

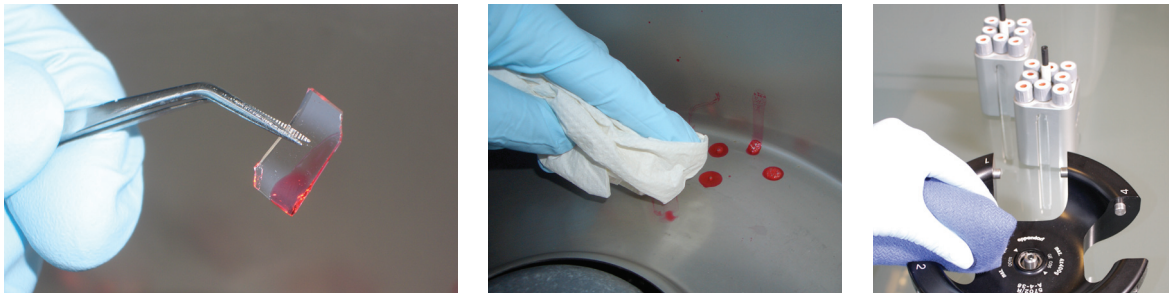

Figure 3: Decontamination of centrifuge, rotor and rotor buckets.

Rotors, adapters, buckets and rubber seal

Use neutral cleaning solutions (alcohol or alcohol-based disinfectant) and a soft cloth to clean your rotors and accessories. Wipe contaminated parts with neutral agents for cleaning and disinfection (e.g. diluted neutral alcohol-based disinfectant or 70 % isopropanol mixture). Use a soaked gauze or lint-free cloth.
In case of spilling some aggressive liquid on your centrifuge equipment, please clean it immediately. If there is stubborn stain, clean with a plastic scrub pad and rinse equipment with distilled water. Avoid immersing the rotor in water as liquid could flow into rotor cavities, and dry thoroughly with a soft cleaning cloth.
As salt crystals located on metal surface will corrode the surface, we strongly recommend cleaning rotors and buckets immediately. If there is a need to clean the rotor's tube cavities or boreholes, use a stiff test-tube brush that has end bristles and a non-metallic tip.
For swing-bucket rotors, ensure that the grooves in which the buckets are fitted are free of contamination. Take care to ensure that the buckets can still swing freely.

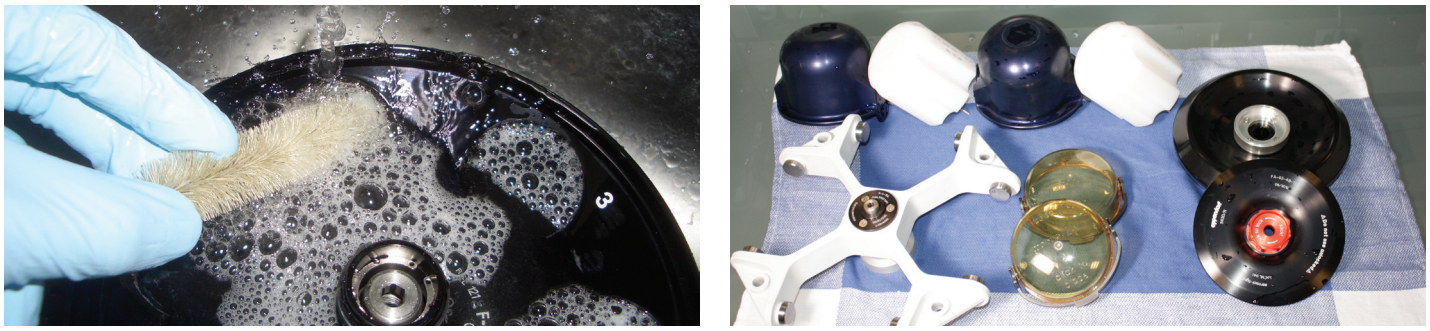

Figure 4: Clean rotor and rotor bores with plastic scrub pad and/or stiff test-tube brush in case of stubborn stain. Then rinse with water and dry.

After decontamination the equipment should be wiped with distilled water. If needed, autoclave rotor, rotor lids and buckets as recommended by the manufacturer. Never use UV, beta, gamma radiation, or any high-energy radiation source. Place parts on dry cloth upside down to dry (Fig. 4).

Alternatively dry rotors, rotor boreholes and accessories with absorbent towels. To prevent aerosol-tight lids/caps and seals from getting worn out/damaged, store lids/caps separately from the bucket/rotor.

Caution:
Do not use acetone, caustic detergents, or detergents that contain chlorite ions. Corrosion is most frequently caused by using chlorite ion solutions, such as sodium hypochlorite (household bleach). Do not use steel wool, wire brushes, abrasives, or sandpaper, since they may damage the rotor coating (anodized coating) and thus increase the risk for corrosion. We do not recommend usage of *dishwashers* for rotors or lids due to the aggressive cleaning agents used in these devices. These agents may result in corrosion.

Autoclaving

To protect human beings from pathogens or samples from contamination, sterilization of rotors and accessories might be desirable. Sterilization is a term referred to a process that eliminates all forms of microbial life, including transmissible agents such as bacteria, viruses, fungi, spore forms etc. A widely-used method for heat sterilization is autoclaving, where hot steam sterilizes equipment and other objects. A typical autoclaving program is performed at 121 °C and 2 bar atmospheric pressure for 15 to 20 min for instance.

A few rotors in the market have been tested for autoclaving at 121 °C. Especially the aluminum made fixed-angle and swing-out rotors from Eppendorf have been vigorously tested and approved within this setting. They possess a special anodized coating which protects the metal from deeper corrosion effects. Steel made rotors are commonly of limited suitability for autoclaving. If you are in doubt about your rotor, please ask the manufacturer about autoclaving possibilities.

To achieve an outstanding chemical resistance against phenol, acetonitrile, DMSO, acetone, trichloroacetic acid, acetic acid and sodium hypochlorite, Eppendorf offers a second type of aluminum fixed-angle rotor with a special PTFE coating. This coating is applied on top of the actual anodic coating. Autoclaving (121 °C, 20 min.) this rotor type even improves the already enhanced chemical resistance due to the material properties of the coating.

However, prions, such as those associated with Creutzfeldt-Jakob disease, may not be destroyed by autoclaving at the typical 121 °C for 20 minutes. Some manufacturers state that autoclaving at 134 °C for at least 18 minutes should usually be sufficient [1]. But in some cases this also is not enough to deactivate the agent of disease, especially if you use material with very high infectiousness. The prions are generally quite resistant to heat, although their infectivity can be reduced by such a treatment. To destroy prions, rotors which are only tested to be autoclaved at a max temperature of 121 °C are therefore not suitable for such an application. According to available marketing material, only a few rotors in the market are allowed to be autoclaved at higher temperatures. But are the rotors really tested within this setting? Only very few companies can provide customers with rotors really being tested with higher temperatures than 121 °C. So in this application field, the customer has a very limited choice of available rotors, including Eppendorf's high quality aluminum made rotors. Selected Eppendorf rotors were extensively tested at 142 °C for 2 hours. These Eppendorf rotors can be used with confidence for such an application.

- You should exchange aerosol tight lids after each autoclaving run at 142 °C to guarantee the aerosol-tightness.
- Never autoclave the rotor with the lid attached.
- Please check recommendations in your rotor »instructions for use« info or contact the manufacturer's application support, if you are in doubt.

Lubrication

After cleaning your equipment take a small amount of centrifuge lubricant (e.g. glycerol, talcum or peg fat from Eppendorf, order number 5810 350.050) onto your finger. Lubricate bucket grooves, pivots of swing-bucket rotors, and rubber seals (Fig. 5). Check if seals of aerosol tight lids/caps need to be replaced. Aerosol-tightness is limited to undamaged seals. Lubricate the threads of the fixed angle rotors after cleaning and autoclaving. Light waxing of the rotor surface may also extend the life-time of the anodized surface. Use a soft cloth for waxing procedure.

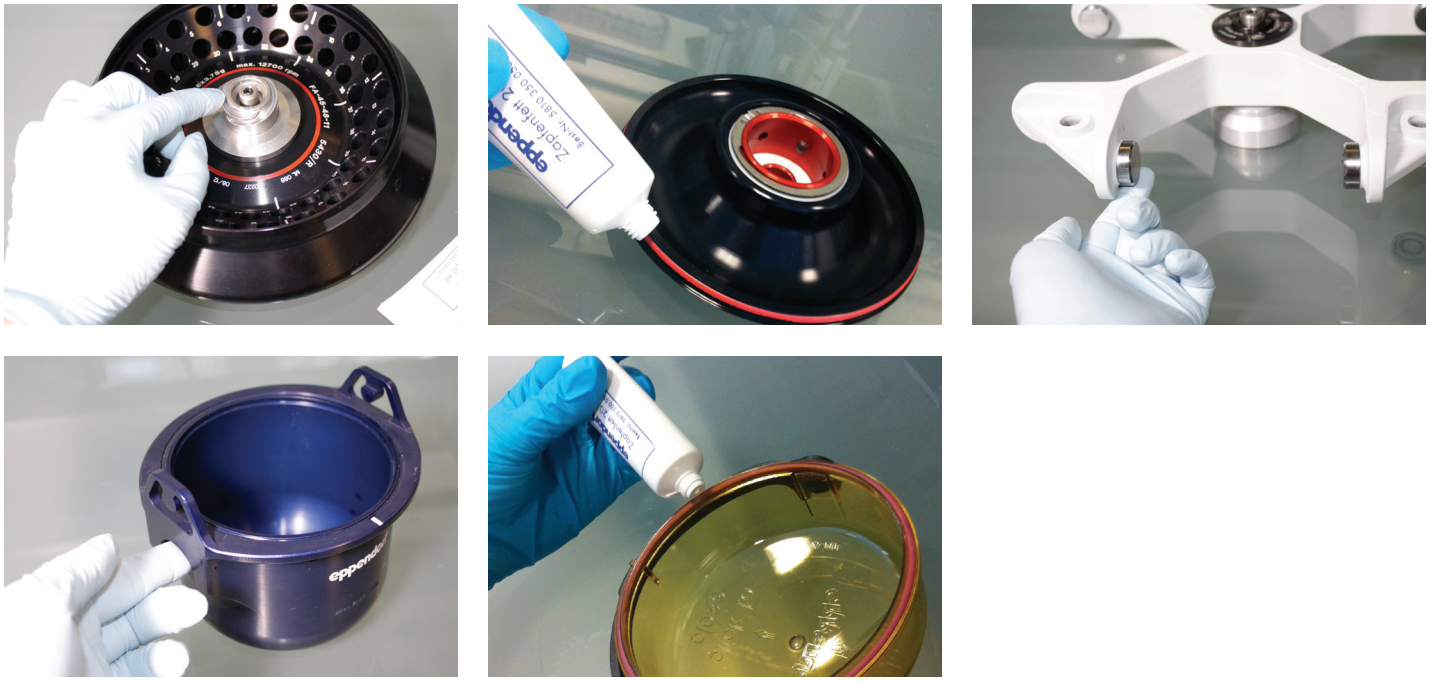

Figure 5: Lubrication of bucket grooves and pivots of swing-bucket rotor equipment, rubber seals, as well as threads of fixed-angle rotors.

Decontamination/Disinfection

Even when working accurately, a contamination of the rotor by biological (for example blood) or radioactive material may happen. Please consult your laboratory safety officer first about suitable methods of cleaning and disinfecting any hazardous spill within the centrifuge/rotor. Successful disinfection can only be granted by the suppliers of the chemicals. Before using any cleaning or disinfection method other than the one recommended by the centrifuge manufacturer, please check that the intended method will not damage the rotors, accessories, or other parts of the centrifuge. For decontamination, disinfection with alcohol-containing liquids and autoclaving are the recommended methods. Below you also find some recommendations for disinfection reagents based on research done by Eppendorf.

You should not use UV, beta, gamma, or any other high-energy radiation source for disinfection.
Do not use any gassing for disinfection.

Examples of disinfection chemicals

Within the following table, some disinfection reagents are presented (Table 1). Please be aware that the detergents and disinfectants are only recommended due to their compatibility with the robust materials of Eppendorf centrifuges. As this is only a recommendation, no guarantee of safety is expressed or implied. The test procedure was performed under laboratory conditions with maximized care. The test results are referred to the tested material. Liability for preservation of the tested surfaces in combination with incubation of disinfection reagents in practice based on the test results cannot be assumed. Printed areas may be discolored when being incubated with the disinfection chemical.

In general, disinfection with a cloth is more efficient than spraying only, which may also result in a short circuit within the centrifuge housing. After cleaning with detergent, the rubber seals in the rotor chamber should be rinsed well with distilled water and lubricated with glycerol in order to prevent the seals from becoming brittle.

Table 1: Resistance of Eppendorf rotors and buckets against common disinfection reagents

Disinfectant	Provider	Anodized aluminum (fixed-angle rotors)	Anodized aluminum (buckets)	Stainless steel	Polycarbonate housing surface
Sterillium®	Bode Chemie®	S	S	S	S
Sterillium® Virugard	Bode Chemie®	(S)*	S	S*_	(S)p
Bacillol® AF	Bode Chemie®	S	S	S*_	Sp
Bacillol® plus	Bode Chemie®	S	S	S	S
Dismozon® pur (5 %)	Bode Chemie®	S	S	S*_	S
Korsolex® basic (conc.)	Bode Chemie®	S	S	S*_	S*_
Microbac® forte (conc.)	Bode Chemie®	S	S	S*_	S*_
Kohrsolin® FF (conc.)	Bode Chemie®	S	S	S*_	S*_
Desderman® pure (conc.)	Schülke Mayr	S	S	S	Sp
Mikrozid® AF	Schülke Mayr	S	S	S	S
Meliseptol®	Braun	S	S	S	S
Helipur®	Braun	S	S	S*_	S
Hexaquart® (2 %)	Braun	S	S	S	S
RNAse AWAY®	Molecular BioProducts	S	S	S	S
DNA AWAY™	Molecular BioProducts	S	S	S	S
HI-TOR plus	Ecolab®	((S))* – M*	S	S*_	S
Sodium hypochlorite (12 %)	Ecolab®	((S))* – M*	M**	M*_	S
Barrycidal	Biohit®	S	S	S	S
Extran® MA 02 neutral	Merck	S	S	M*_	S*
Count-Off™	Perkin Elmer®	U	M**	M	M
Isopropanol (70 %)	Perkin Elmer®	(S)*	S	S	Sp
Ethanol (70 %)	Perkin Elmer®	S	S	S	S

S = Satisfactory resistance
M = Marginal resistance
U = Unsatisfactory resistance
_ = coating/ film (mostly reversible)
* = slight discoloration
** = discoloration
p = discoloration of printing (housing)

Conclusion

Cleaning and routine maintenance (can be performed by user)
Sufficient awareness about the need of proper centrifuge care is important. Long term exposure to contaminants like salts or chemicals may affect the equipment by developing corrosive sites. Continuous failure of cleaning and routine maintenance will enhance the chemical wear. Loss of material and even holes in the equipment may result in the worst case. Therefore, checking the rotors and rotor bores visually for residue and corrosion on a weekly or monthly basis is suggested. If needed, following the described cleaning and routine maintenance procedures is recommended. Rotors or buckets, if damaged, should be replaced to avoid possible rotor crashes. A technician might be asked if in doubt.
If these instructions are being followed, the centrifuge operator will be provided with confidence all around centrifuges. He will be able to guide other team members and spread a consciousness for proper centrifuge care.

Furthermore, in this paper an insight into the variety of different rotor quality levels was given. Good chemical resistance of aluminum rotors is achieved when anodized coating is present, as it is the case for all Eppendorf aluminum made rotors as a standard. If outstanding resistance is essential, because of regular work with aggressive solvents such as phenol, acetonitrile, DMSO, acetone, trichloroacetic acid, acetic acid and sodium hypochlorite, Eppendorf offers special PTFE coated fixed-angle aluminum rotors.

In summary: Good quality rotors as those from Eppendorf and proper centrifuge care performed as recommended will support a safe working standard in the laboratory and extend the life-time of centrifuge equipment to its maximum. On top, Eppendorf offers professional inspection and certification services for customers with highest lab safety demands.

Eppendorf Rotor Assurance Plans (performed by Eppendorf service technician)
As rotors and buckets are subject to normal wear and tear, over the years, all rotor structures will eventually suffer from fatigue due to the stress of high numbers of cycles.
If not maintained correctly, surface scratches can lead to microscopic cracks, followed by critical cracks. Regular qualified inspection of the rotor equipment will detect damages early in order to prevent further problems and/or equipment failure. Eppendorf Rotor Assurance Plans offer professional inspection and evaluation of Eppendorf rotors. Our certified, expertly trained and experienced service technicians use highly sophisticated borescope equipment for inspections. Additional information, service inquiries and local offers can be found at:
www.eppendorf.com/epServices.
Rotor Assurance Plans are only available in selected countries and service may vary according to country.

References

[1] Lawson, V. A. et al. (2007). Enzymatic detergent treatment protocol that reduces protease-resistant prion protein load and infectivity from surgical-steel monofilaments contaminated with a human-derived prion strain. J Gen Virol vol. 88 no. 10: 2905–2914

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