

Longevity and Optimal Performance: Routine Maintenance Guide for High-Speed and Ultracentrifuges

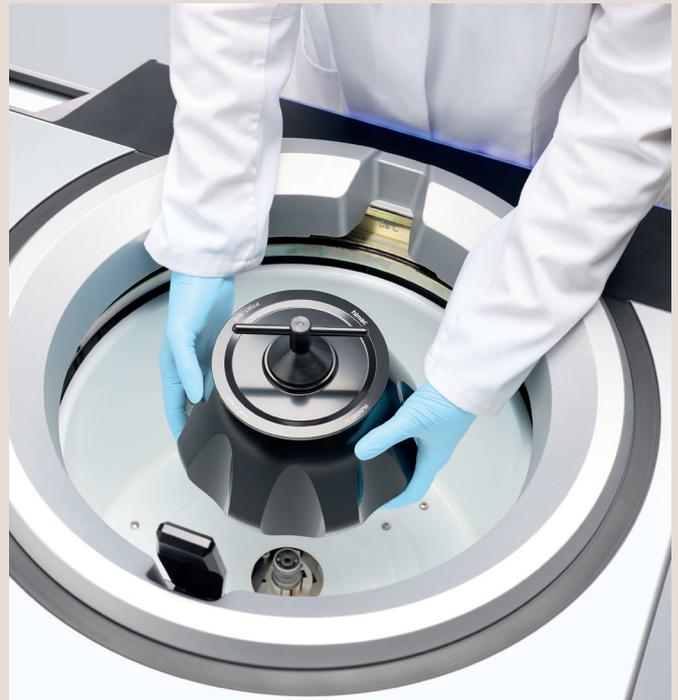
Natascha Weiß, Eppendorf SE, Germany

Executive Summary

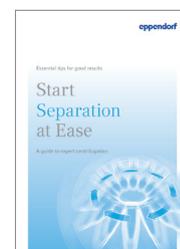
This guide covers the routine maintenance of high-speed and ultracentrifuges; it focuses on ensuring the instruments' longevity and optimal performance. Due to the much higher forces exerted as compared to other centrifuges, regular inspection, cleaning and maintenance of centrifuges and their associated rotors and vessels are even more important.

In addition to describing the causes of damage, such as improper use, high stress levels, and corrosion, strategies for minimizing these risks through regular maintenance are offered. This guide includes standard procedures for inspection, cleaning, decontamination and lubrication, as well as the regular maintenance routines required. The role of technical customer service in preserving the functionality of the devices is also emphasized.

Adhering to these guidelines can ensure the reproducibility of experiments and avoid costly replacements. Equipment maintenance is essential for keeping centrifuges efficient and reliable over long periods of time.



From basic principles to advanced techniques, our centrifuge guide covers everything you need for optimal use of benchtop, high-speed, and ultracentrifuges. Download here: <https://eppendorf.group/CentrifugationGuide>



Introduction

Laboratory equipment should be fully functional and safe to use for as long as possible. In general, the longevity of laboratory equipment depends on the quality of their design, the materials used and the manufacturing process. However, careful handling by the user, including regular inspection and cleaning, as well as maintenance of the equipment by qualified personnel, are also essential.

Centrifuges are used every day as common laboratory equipment. In addition to the general aging process and the resulting fatigue of the materials used, rotors in particular are subject to severe wear due to the forces acting upon them during centrifugation. Furthermore, chemicals – either present in the sample or used to clean or decontaminate the equipment – can damage rotors and tubes. Therefore, careful handling of the equipment plays an important role in ensuring its safe use over a long period of time.

This White Paper describes processes for keeping high-speed and ultracentrifuges, together with their rotors and tubes, in good condition for many years. Besides explaining how damage occurs, standard procedures for inspection, care and maintenance of equipment in everyday use are described. Furthermore, information is provided on the importance of inspection by technical services and on the monitoring of the service life of rotors. Basic information can also be found in **White Paper 14** for micro and multipurpose centrifuges (Routine Maintenance of Centrifuges) [1]. However, there are additional points to consider when operating high-speed and ultracentrifuges, as high speeds, long run times and potentially high loads result in significantly higher forces. In addition, there are some technical differences, such as operation under vacuum. Please note that this document does not replace the operation manuals of the products. The instructions provided with the devices and rotors must be followed at all times.

Inspection, cleaning and maintenance of centrifugation equipment

1. Causes of damage and how to avoid them

Improper use:

If devices, rotors and/or accessories are used outside of their intended parameters and procedures described in the operating manual, severe damage can occur. Always follow the information in the respective operating manual and/or instructions for use. This applies to both centrifugation and maintenance.

Aging and operation:

Over time and with regular use, materials are subject to natural wear and tear. Damage, such as scratches, can also occur during normal operation. Therefore, the maximum service life of the products must be observed and in case of damage, replacement is necessary.

High stress level:

Due to repeated cycles, the rotors, in particular, are subjected to high loads during centrifugation. This is exacerbated in the case of very high speeds, such as during ultracentrifugation, but also by large sample volumes due to the resulting high sample weight. Regular inspection is therefore of great importance for early detection of the resulting signs of wear.

Corrosion:

Corrosion mainly affects the rotors and the rotor chamber. Their surfaces can be attacked by chemical reactions caused by moisture and aggressive chemicals. This leads to an increased risk of cracks and fractures. Aluminum especially is very susceptible to corrosion, which is why rotors made of this material are usually coated with an anodized layer. However, care must be taken not to damage this surface. Titanium rotors are generally more robust. After use, all components must be thoroughly cleaned and dried to remove chemical and moisture residues. Careful maintenance can minimize corrosion of the material and thus extend the lifespan of the rotor.

Malfunctions:

Lack of maintenance can lead to a variety of problems: For example, if high vacuum cannot be achieved by the instrument, the sample may escape, which can lead to contamination and imbalance. If O-rings or threads are not lubricated in advance, lids can become stuck, making them difficult to open.

2. Benefits of proper care and maintenance

In addition to the general functionality of the centrifuge and accessories, proper care and maintenance offer further advantages:

Safety:

Early detection of damage helps prevent severe accidents, such as rotor crashes.

Optimal performance:

Consistent high-efficiency performance is assured when components are functioning properly. This contributes to the reproducibility of experiments.

Sample integrity:

By preventing contamination and ensuring consistent operating conditions, the integrity of the samples is maintained.

Extended lifespan:

Recognizing and fixing wear or damage at an early stage prevents minor problems from becoming major issues which require costly repairs or cause unexpected downtimes. By keeping the equipment in good condition, its operational life is prolonged, ensuring it remains reliable and effective over a longer period of time.

Cost efficiency:

Regular inspection, maintenance and service can save money in the long run by avoiding expensive repairs and premature replacement of equipment. In addition, the efficiency gains from a well-maintained centrifuge can reduce operating costs, e.g., through reduced energy consumption.

3. Standard procedures

This section lists the basic procedures for inspection, cleaning, decontamination and maintenance that generally apply to high-speed and ultracentrifuges as well as to the rotors and vessels used in these devices. Please refer to the respective manual for details and exceptions.



Figure 1: Wiping moisture and frost from the rotor chamber

Centrifuges

Removing spills and dirt:

The cabinet, the table, the lid and rotor chamber including the surface of the drive shaft (crown) are wiped with a cloth or sponge dampened with a diluted solution of neutral detergent (pH 5-9).

Removing moisture and frost:

A clean, dry cloth or sponge is used to wipe the rotor chamber and the inner lid (Figure 1). Frost can be melted by operating the centrifuge at high temperature setting or (if available) by activating the defrost function.

Greasing:

For centrifuges with vacuum function, the O-ring of the lid must be lubricated with a light coat of vacuum grease. High vacuum can only be established if the seal is tight.

Sterilization:

The surface of the centrifuge and the rotor chamber can be wiped with a cloth dampened with 70% ethanol.

Don'ts:

Do not pour liquids (e.g., water, detergents, disinfectants) directly into the rotor chamber. Doing so may cause the liquid to enter the unit. Do not use cleaning or sterilization methods other than those recommended in the instruction manuals.

Rotors

Inspection:

Check all rotor parts (rotor body, rotor bores, crown hole, buckets, lids) for corrosion (discolored or dented surfaces) as well as scratches that extend into the base metal and cracks. Determine whether the anodization on any surface is missing or worn. Examine whether there is wear, deformation or damage at connection points such as threads, nuts, pins and screws. Remove O-rings and check for any damage. Damaged parts such as O-rings must be replaced. In case of doubt contact an authorized service technician/field service engineer, and refrain from using the rotor.

Maintenance of O-rings:

Intact, greased O-rings are necessary to seal the rotor properly. Remove the O-rings from the rotor lid of a fixed-angle rotor without damaging the seals or the lid. If the seal seems to be intact, clean and grease it. Use fingers to check for minor damage while greasing the O-ring. After removing excess grease, insert the O-ring along the groove of the rotor lid (Figure 2). Close the rotor with the lid, open it again and verify the correct placement of the seal. (Proceed accordingly with the O-rings of other rotor types such as swing-out rotors.)

Cleaning:

Open rotor (or rotor buckets) and remove all O-rings. Wash all parts with tap water or a diluted solution of neutral detergent (pH 5-9) and rinse with distilled water (Figure 3 a). Always refer to the respective rotor manual as there may be exceptions with respect to handling, such as for Rotor R9A2. For cleaning the bore holes, a stiff test-tube brush with end bristles and a nonmetallic tip can be used. Wipe off water droplets with a soft cloth and dry rotor and rotor buckets upside down (with rotor lid/caps removed).

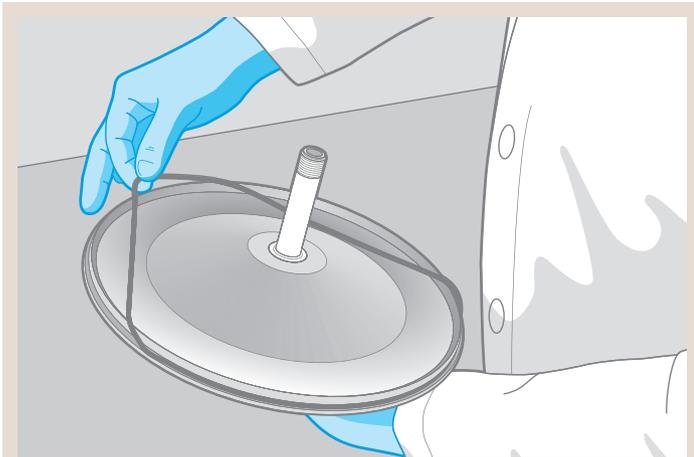


Figure 2: Placing the O-ring into the rotor lid after cleaning and greasing

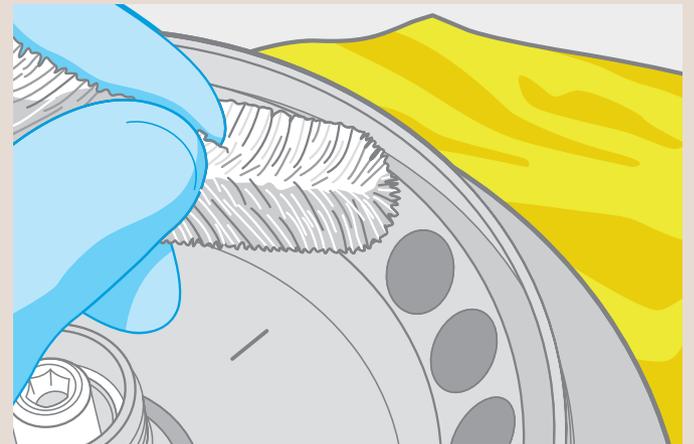


Figure 3: Wash the outside of the rotor with tap water (a) and use a test-tube brush to clean the bore holes (b)

Vessels and accessories (tubes, bottles, caps, adapters)

In addition to single-use consumables, high-speed and ultracentrifuges accommodate a range of vessels that can be used multiple times. These must also be inspected, cleaned and sterilized if necessary.

Inspection:

Check that all parts of the vessel and, if applicable, lid are available and intact. Check the O-ring for cracks by stretching it by hand. Replace damaged or missing parts (e.g., O-rings).

Cleaning:

Disassemble tubes, bottles and lids. Wash all parts with tap water or a dilute solution of neutral detergent (pH 5-9) in hot water (< 50 °C). The parts may also be soaked for short time in this solution or washed with a soft brush (be careful not to scratch surfaces). Ultrasonic cleaning (pH 5-7) is also possible. Then rinse with tap water, and finally with distilled water. Air-dry vessels and lids.

Sterilization:

Only TC Tubes (15 ml and 50 mL) are supplied pre-sterilized. Other vessels and accessories can be sterilized using different methods depending on their material (please refer to the corresponding manuals). After sterilization, check the O-ring (if available) again and replace if necessary.

Storage:

Store the vessels at room temperature in a dry place. Dispose of tubes and bottles that have been stored for longer than 2 years, as the material of the vessels can deteriorate.

Don'ts:

- > Do not use cleaning or sterilization methods other than those recommended in the instruction manuals.
- > Do not expose vessels to chemical vapors, UV light, beta or gamma radiation.

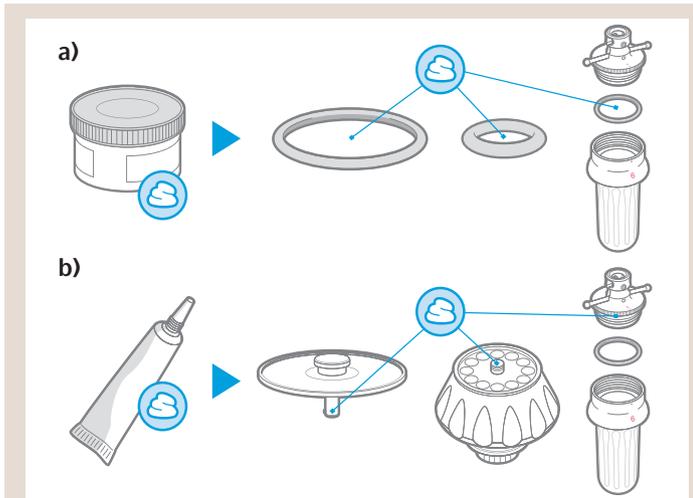


Figure 4: Use silicone grease for O-rings, rotor body and buckets (a) and screw lubricant for all thread parts of rotors and buckets (b).

Greasing:

Lubrication is required after cleaning and after sterilization. When the rotor is completely dry, apply a light coat of silicone grease (vacuum grease) to the rotor body (and buckets) and O-rings as a protective layer (Figure 4 a). Wipe off any excess grease. Apply screw lubricant to all thread parts of the rotor, such as the lid locking screw (Figure 4 b).

Sterilization:

Several rotors of high-speed centrifuges are autoclavable (indicated on the lid and in the manual). The lid must be removed beforehand for this purpose. Never autoclave any other rotors and never autoclave the buckets and adapters of high-speed and ultracentrifuges. Instead, depending on the material, most rotors can be sterilized with gas, (ethylene oxide, formaldehyde), chemicals (70 % ethanol, 3 % hydrogen peroxide, 3 % formalin) or UV irradiation.

Storage:

Store the rotor in a dry place at 4 °C – 30 °C on a rotor stand. Protect rotors with RLM adapters from magnetic fields.

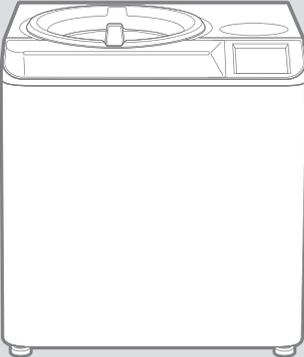
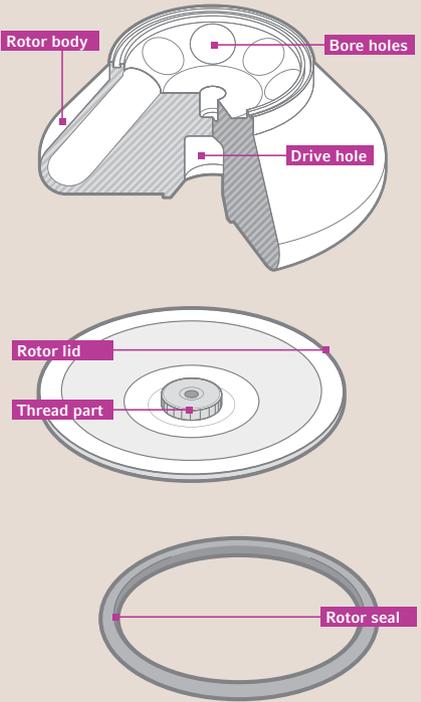
Don'ts:

- > Do not use cleaning or sterilization methods other than those recommended in the instruction manuals.
- > Do not soak rotors for more than 2 hours (or, in the case of Rotor R9A2, do not soak at all).
- > Do not use steel wool or abrasives that may scratch the surface.
- > Do not use a dish washer.

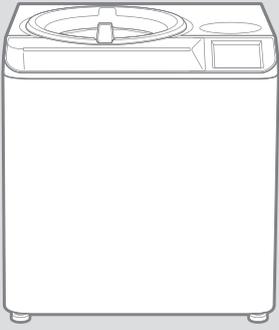
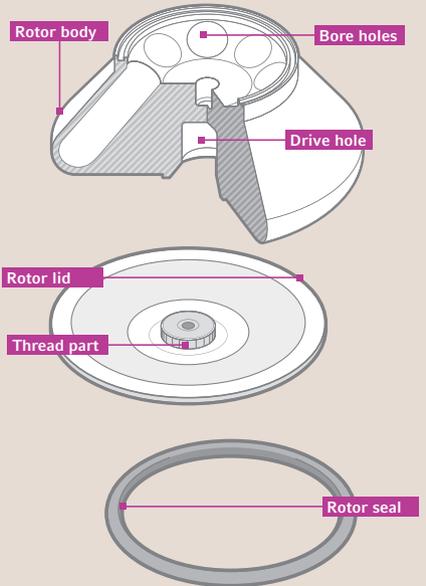
4. Periodic maintenance routines

This section lists when each routine should be performed. There are procedures that should generally be performed before each run, or at least at the beginning of the day, as well as after completion of work, and there are procedures that should be performed at longer intervals.

Prior to use:
Brief inspection of the condition of the centrifuge unit, the rotor and the vessels.

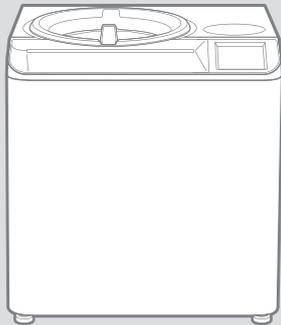
Centrifuge	Rotor	Vessels
	 <p style="text-align: center;">Rotor parts</p>	
<p>Ensure that the centrifuge chamber, the inside of the lid and the drive shaft are dry and clean</p>	<p>Check for scratches, cracks, corrosion, deformation or other damage to rotor parts. Remove any impurities from the drive hole and bores. Make sure O-rings and thread parts of screws are intact and sufficiently greased.</p>	<p>Ensure that all parts are available and intact (no scratches, cracks or deformation). Replace damaged parts. Remove dirt and moisture from the outside of the vessels before loading.</p>

After use:
Perform standard maintenance routine for centrifuges, rotors and vessels.

Centrifuge	Rotor	Vessels
	 <p style="text-align: center;">Rotor parts</p>	
<p>Open the lid and remove the rotor.</p> <p>Decontaminate if necessary.</p> <p>Use a soft cloth to remove moisture, frost or stains from the chamber and inner lid as well as spills and dirt from the drive shaft.</p> <p>Keep the lid open until the chamber is dry.</p>	<p>Take the rotor out of the centrifuge, open the lid and remove the adapters and vessels.</p> <p>Decontaminate if necessary.</p> <p>If corrosive samples were used: Wash all rotor parts with tap water immediately after operation.</p> <p>If impurities adhere to rotor parts soak these parts in warm water (40 – 50 °C) for 1-2 hours. Use a soft brush to remove dirt from the drive hole and the rotor bores or buckets.</p> <p>Then follow the standard cleaning and greasing procedure.</p>	<p>Collect samples from vessels.</p> <p>Dispose of single-use items and damaged parts.</p> <p>If the vessels are reusable, clean (and sterilize if necessary) according to instructions.</p> <p>Replace damaged parts.</p>

Periodically

Centrifuge



As required

Clean centrifuge table and cabinet.

Check drain hose and let water out if necessary.

Clean heat exchanger.

Once a month:

Clean drive shaft (Figure 5).

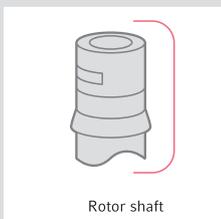
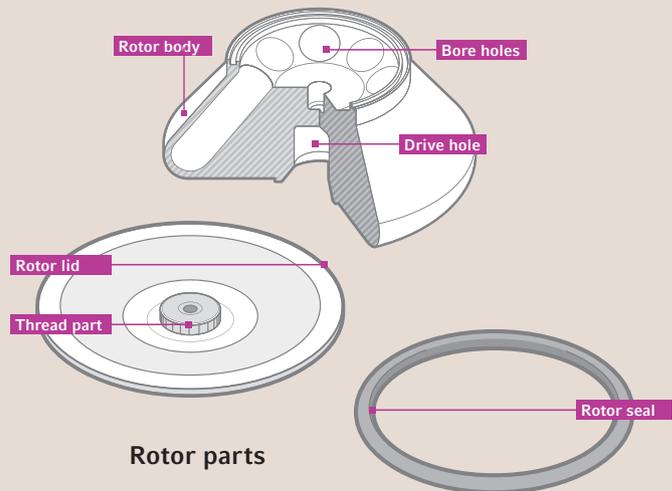


Figure 5: Rotor shaft in centrifuge

Quarterly to annually:

For centrifuges operating under vacuum: Check O-ring of the chamber for deterioration, clean and grease it. Replace the seal if necessary.

Rotor



Every 100 hours of use:

Intensive check of all parts for corrosion.

Once a month:

Clean drive hole (Figure 6).

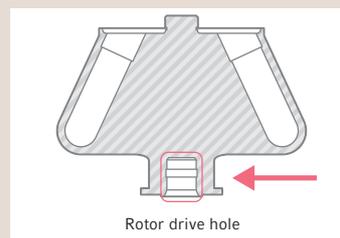


Figure 6: Drive hole in rotor (is placed on rotor shaft of centrifuge)

5. Maintenance by service

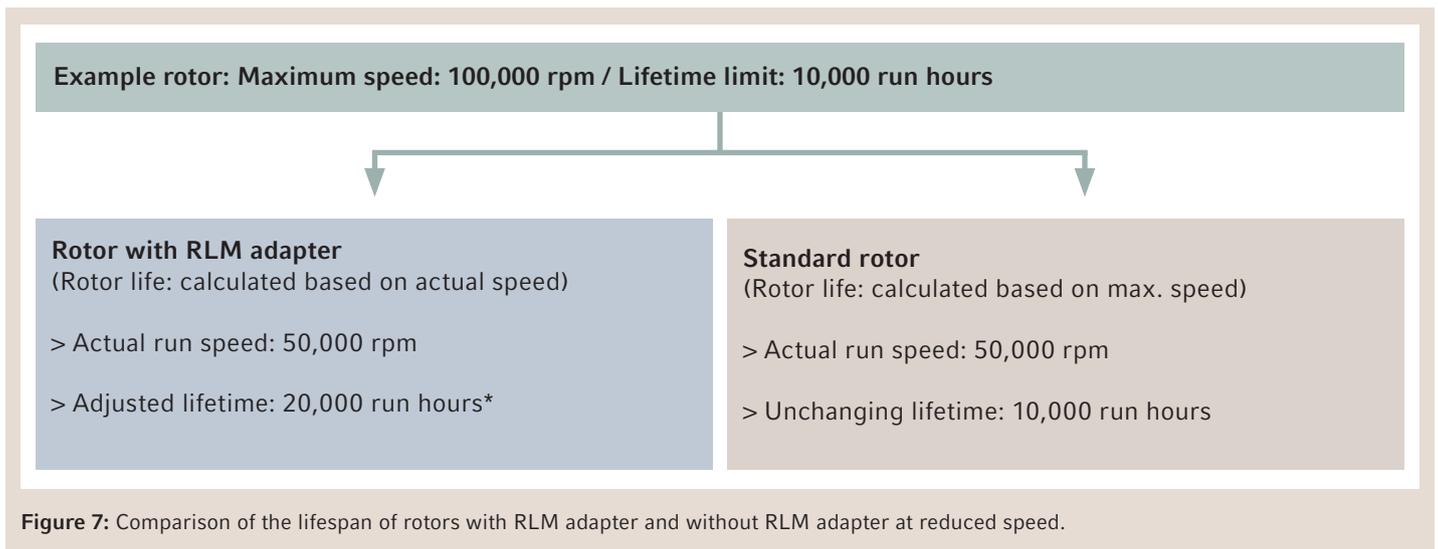
Regular maintenance and care of laboratory equipment is essential to ensure safe operation and extend the life of the instruments. While many tasks can be performed by the user, certain procedures must be carried out by authorized service technicians/field service engineers to maintain the manufacturer’s warranty. For instance, centrifuges equipped with vacuum pumps require regular oil changes. It is important to engage service professionals not only to replace or repair parts, but also for routine preventive maintenance.

Preventive maintenance involves scheduled service activities designed to prevent unexpected downtime and equipment failures. The primary goal is to maintain the instrument’s performance in accordance with the manufacturer’s specifications. For high-speed and ultracentrifuges, this includes cleaning and inspecting both external and internal components, such as a check of temperature and speed sensors, conducting system test runs, and performing software updates when necessary.

6. Rotor lifespan

To ensure safe operation, regulations specify when rotors may no longer be used. The maximum lifespan is usually between 10 and 15 years. In addition, there are limits to the number of runs or hours of operation for rotors that are subjected to high stress. Unless there is damage to the rotor that would prematurely end its life, the limiting parameter reached first determines the end of the service life.

If the use of the rotors is not recorded in the centrifuge, a manual logbook must be kept, to determine when a rotor should be retired. For rotors equipped with an RLM adapter (which enables automatic rotor life management in Eppendorf Ultracentrifuges of the CP-NX series), run data are stored directly on the rotor. By synchronizing with the data in the centrifuge, the rotor lifespan is automatically monitored in the device, even if it is used in different centrifuges. In addition, the service life is calculated based on real run data. This has the advantage that the rotor can be used for a longer period of time when it is not running at its maximum speed (Figure 7).



* The values provided are for illustrative purposes only. Actual results may vary depending on operating conditions.

Summary

Routine maintenance of high-speed and ultracentrifuges is essential in order to ensure their efficiency, reliability and safety. By following recommended inspection, cleaning and maintenance procedures, and by understanding the causes and prevention of equipment damage, the life of centrifuge equipment can be significantly extended. This not only

safeguards the integrity of experimental results but also optimizes operational costs and reduces the risk of equipment failure. A proactive maintenance strategy supported by service is crucial for maintaining high standards of laboratory safety and performance.

Literature

[1] White Paper 14 – Routine Maintenance of Centrifuges

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