



# Laboratory Centrifuge 1-6P Operating Manual

From Serial No. 119956

**Please retain for later use!**



Dear Customer,

Congratulations on your purchase of a SIGMA laboratory centrifuge. You have selected a device that combines many advantages.

The SIGMA 1-6P is a small, microprocessor-controlled centrifuge. The electronic operation control enables a trouble-free use of the centrifuge. With its quiet 3-phase maintenance-free drive, operation without any carbon dust pollution is guaranteed.

Your device is equipped with user-friendly options that make the operation and standard settings easier for you. Built-in error-detecting functions keep the user from entering erroneous values and they also check the entire operation.

All of the settings are executed via the control panel with a coated surface that protects the device against moisture and dust. In addition, the interior of the centrifuge is also rather easy to clean. We offer you a device that combines functional variety along with practical applications.

Our centrifuges are carefully manufactured according to the highest quality standards, in which we are certain that your demands will always be met.

We wish you much success in the use of the centrifuge.

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**Konformitätserklärung**  
(2006/42/EG; 2006/95/EG; 2004/108/EG)  
**Declaration of Conformity**  
(2006/42/EG; 2006/95/EG; 2004/108/EG)  
**Déclaration de conformité**  
(2006/42/EG; 2006/95/EG; 2004/108/EG)

Die nachfolgend bezeichnete Maschine wurde in Übereinstimmung mit den Richtlinien 2006/42/EG; 2006/95/EG und 2004/108/EG hergestellt und geprüft.

The following machine is manufactured and tested in compliance with directives 2006/42/EG; 2006/95/EG und 2004/108/EG.

La machine désignée ci-dessous est produit et examiné conforme aux directives 2006/42/EG; 2006/95/EG und 2004/108/EG

Bezeichnung der Maschine: Laborzentrifuge  
Machine: Laboratory Centrifuge  
Désignation de la machine: Centrifugeuse de laboratoire

Maschinentyp : 1 – 6 P  
Type:  
Type de la machine:

Bestell Nr. : 10056, 10055  
Part No.:  
Réf. usine:

Normen: EN 61010-2-020:2007  
Standards: EN 61000-3-2:2006; EN 61000-3-3:1995, A2:2005  
Normes : EN 61326-1:2006

**Sigma Laborzentrifugen**  
An der Unteren Söse 50  
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23.11.2007



Geschäftsführer  
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Fabr. Nr. Serial No. Numéro de série

1-6P 20071123.DOC



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## 1 General Information

### 1.1 Importance of the Operating Manual

- A fundamental requirement for the safe and trouble-free operation of the centrifuge is to be familiar with the fundamental safety instructions and all possible hazards.
- The operating manual includes important information concerning the safe operation of the centrifuge.
- This operating manual and in particular the notes on safety and hazards must be observed by all persons operating the centrifuge.
- In addition, the local rules and regulations for the prevention of accidents must be complied with.

### 1.2 Intended Use

Centrifuges are power-driven machines that separate liquids from solid matter, liquid mixtures, or solid mixtures by centrifugal force (see BGR 500, chapter 2.11, part 3). They are solely intended for this purpose. Any other use beyond this area of application is regarded as improper use. SIGMA Laborzentrifugen GmbH cannot be held liable for any damage resulting from such improper use.

The intended use also includes

- observation of all the notes and instructions included in the operating manual and
- compliance with the care, cleaning, and maintenance instructions.



### 1.3 Technical Data

Manufacturer:	S I G M A Laborzentrifugen GmbH An der Unteren Söse 50 37520 Osterode
Type:	1-6P
Electr. connection: Protection class: IP code	See name plate I 20
Connected load (kVA): Power consumption (kW): Max. current consumption (A):	0.37 0.22 1.5 (at 230 V/50 Hz) 3.0 (at 120 V/60 Hz)
<u>Performance data:</u> Max. speed (rpm): Max. capacity (ml): Max. gravitational field (x g): Max. kin. energy (Nm):	5 650 180 3 050 980
<u>Other parameters:</u> Time range:  Storage locations:	10 sec - 11 h 59 min; short run, continuous run 10
<u>Physical data:</u> Depth (mm): Width (mm): Height (mm): Weight (kg): EMC as per EN 61326: Noise level (dBA):	320 240 245 13 Class B < 58
<u>Notes by the user (please fill in):</u> Serial number: Date of delivery: Inventory number: Installation site: Responsibility:	..... ..... ..... ..... .....

*Fig. 1.1: Technical Data*

#### 1.3.1 Ambient Temperature

The figures are valid for an ambient temperature of 23°C +/- 2°C and a nominal voltage of 220-240 V +/- 5%.

Allowable ambient temperature +4°C to +40°C; max. humidity 80%.

Lowest storage and transport temperature -20°C (see chapter 3 "Transport and Storage", page 22).



## 1.4 Scope of Supply

### The centrifuge comprises:

- Connecting cable Part no. 269 010
- Rotor wrench Part no. 930 050
- 20 ml slushing oil Part no. 70 104
- Spare fuses Part no. 70149 for 230 V  
Part no. 70102 for 100-120 V

### Documentation:

Operating manual incl.

- EU Declaration of Conformity (page 5)
- Equipment Decontamination Certificate (page 59)

### Accessories

according to your order, our order confirmation, and our delivery note.

## 1.5 Standards and Regulations

Please refer to the enclosed EU Declaration of Conformity (page 5).

## 2 Safety Instructions and Hazard Warnings

### 2.1 Symbols used in the Safety Instructions

International symbols used for SIGMA centrifuges:

Symbol	Title
	Gefährliche elektrische Spannung Dangerous voltage Courant haute tension
	Achtung, Bedienungsanleitung lesen Attention, consult instruction manual Attention, consulter mode d'emploi
	Ein (Netzverbindung) On (Power) Marche (mise sous tension)
	Aus (Netzverbindung) Off (Power) Arrêt (mise hors tension)
	Schutzleiteranschluss Protective earth (ground) Liaison à la terre
	Erde Earth (ground) Terre
	Netzstecker ziehen Unplug mains plug Tirer la fiche de prise
	Vorsicht Quetschgefahr Caution! Risk of bruising Attention! Danger de blessure
	Drehrichtungspfeil Arrow direction of rotation Flèche sens de rotation
	Heiße Oberfläche Hot surface Surface chaude
	Nicht mit dem Hausmüll entsorgen Do not dispose as part of domestic waste Ne pas jeter avec les déchets ménager

Fig. 2.1: Symbols used for SIGMA centrifuges

## 2.2 Symbols used in the Operating Manual

Symbols used in the Operating Manual:

Symbol	Title
	Gefährliche elektrische Spannung Dangerous voltage Courant haute tension
	Achtung, mögliche gefährliche Situation Attention, potentially dangerous situation Attention, situation potentiellement dangereuse
 <b>Attention!</b>	Hinweis auf wichtige Sachverhalte Note concerning important facts Information très importante

*Fig. 2.2: Symbols used in the Operating Manual*

## 2.3 Informal Notes on Safety

The operating manual is an integral part of the product.

- Please retain the operating manual throughout the service life of the centrifuge.
- Please hand the operating manual over to any subsequent owner or user of the centrifuge.
- Please add any amendments that you receive to the manual.
- Please make the operating manual readily available at the exact location of the centrifuge at all times.
- The operating personnel must have read and understood the operating manual prior to operation.
- Please also comply with the general and company-specific rules and regulations for the prevention of accidents.

## 2.4 Safety Instructions for Centrifugation

- Ensure that the centrifuge was set up properly (see section 4.2 "Installation", page 24).
- Check the centrifuge, rotor, and accessories for external signs of damage prior to start-up.
- Do not use the centrifuge with rotors and accessories that have not been approved by the manufacturer. In case of doubt contact our service team (See 6.2.7 "Service Contact", page 43).
- Ensure that the rotor is correctly fitted (see 5.2.3 "Installation of Rotors", page 30).
- The load of the rotor as defined by the manufacturer and the maximum speed must not be exceeded (see the engraving on the rotor).
- The rotor must be loaded symmetrically at equal weights.
- Please follow the instructions concerning the installation of accessories (see 5.2.4 "Installation of Accessories", page 31).

### 2.4.1 Special Instructions

- If liquids with a density  $> 1.2 \text{ g/cm}^3$  are used, reduce the speed (see 11.1.2 "Density", page 53).
- Protective clothing is not required for the operation of the centrifuge. The materials to be centrifuged may, however, require special safety measures (e.g. centrifugation of infectious, toxic, radioactive, or pathogenic substances).
- Spin infectious material in sealed rotors only.
- Avoid the corrosion of the centrifuge and its accessories by careful maintenance (see chapter 7 "Care and Maintenance", page 44 ff).
- When not using the centrifuge, open the lid so that all liquids can evaporate.
- Stop the centrifuge immediately in the event of a malfunction. Eliminate the problem (see 6.2, page 41) or inform the SIGMA Laborzentrifugen GmbH service team (see 6.2.7 "Service Contact", page 43).

## 2.4.2 Resistance of Plastics



Chemical influences have a strong effect on the polymeric chains of plastics, and therefore, on their physical properties. Plastic parts can be damaged if solvents, acids, or alkaline solutions are used.

- **Please refer to the resistance table (see 11.3, page 61)!**

## 2.5 Prohibited Centrifuging Operations and Hazard Warnings

Under the rules stipulated by the German trade association BGR 500, chapter 2.11, part 3, the operator is obliged to:

- take measures in order to prevent all danger to life or health during work.
- ensure that centrifuges are operated properly and entirely as intended (see chapter 1.2 , page 11 of this Operating Manual).
- take measures for the safe opening of centrifuges.



**Please comply with the following hazard warnings. In the case of non-compliance with the instructions, the manufacturer cannot be held liable or subject to any warranty claims.**

- Only persons who have read and understood the operating manual in whole are authorized to operate the centrifuge (see 2.3 "Informal Notes on Safety", page 17).
- Keep informed about local fire prevention regulations and measures to contain harmful emissions (depending on the substances to be centrifuged).
- Do not use the centrifuge if it was installed incorrectly.
- Do not use the centrifuge without panels.
- Do not hit or move the centrifuge during its operation.
- Do not lean against or rest on the centrifuge during its operation.
- Maintain a safety distance of at least 30 cm around the centrifuge.
- Do not store any dangerous goods in the centrifuge area.
- Only use the centrifuge with rotors and accessories that have been approved by the manufacturer. We explicitly warn against the use of equipment of poor quality. Breaking glass or bursting vessels can cause dangerous imbalances at high speeds.
- Do not spin any substances that could damage the material of the rotors of the centrifuge in any way. Highly corrosive substances, for example, damage the material and affect the mechanical strength of the rotors and inserts.

- Infectious, toxic, pathogenic, and radioactive substances must be centrifuged in certified rotors and vessels. **Take suitable precautions for your own safety if there is a risk of toxic, radioactive, or pathogenic contamination.**



- **Please comply with the special precautions for taking care of the centrifuges and accessories. These are measures for maintaining operational safety!** (see chapter 7 "Care and Maintenance", page 44)



#### **Attention!**

- Ensure that all repairs are performed only by authorized and specialized personnel (see 6.2.7 "Service Contact", page 43).

### 2.5.1 Special Hazards



- Do not open the lid when the rotor is in motion!
- Do not reach into the rotor chamber when the rotor is in motion!
- Do not use the centrifuge if the rotor is overloaded. (see 2.4 "Safety Instructions for Centrifugation", page 18).
- Do not use the centrifuge if the rotors and inserts show signs of corrosion or other defects.
- Do not use the centrifuge if the rotor is loaded asymmetrically.
- Do not use the centrifuge with tubes that are excessively long.
- Do not use the centrifuge within hazardous locations.
- Do not spin explosive or inflammable substances.
- Materials that chemically react with each other with a high level of energy are prohibited.

## 2.6 Checks by the Operator

Check all of the safety-relevant parts of the centrifuge at least once per month for any visible signs of damage (e.g. cracks, corrosion). This applies particularly to the following:

- Concentricity of the motor shaft:
  - Visual inspection: Slowly rotate the rotor by hand without the rotor tie-down screw. If the motor shaft does not turn around on a perpendicular axis, the motor and motor shaft must be replaced.
  - Refit the rotor correctly after visual inspection (see 5.2.3 "Installation of Rotors", page 30).
  - Auditory inspection: Check the unit for atypical running noises.
- Screw connections
- Rotors and accessories. (see 5.2.5 "Service Life of Rotors an Accessories", page 32).

## 2.7 Instructions for Emergency Situations

- If an emergency arises, actuate the emergency switch at the exit (if installed) or in the room next door (see 4.2.3 "Fuses/Emergency Circuit Breaker on Site", page 24).  
Or:
- Disconnect the main power plug.

Fire-fighting measures or measures for the containment of harmful emissions depend on the local conditions and on the substances processed in the centrifuge. Please be informed about the rules and regulations that are applicable on-site.

## 2.8 Remaining Hazards

The centrifuge was built state-of-the-art and according to the accepted safety rules. Danger to life and limb of the user or of third parties, or impairments of the unit or other material assets cannot be completely excluded when the centrifuge is used.

- Use the centrifuge only for the purpose that it was originally intended for (see 1.2, page 11).
- Use the centrifuge only if it is in a perfect running state.
- Immediately eliminate any problems that can affect safety.

### 3 Transport and Storage

#### 3.1 Dimensions and Weight

Depth:	320 mm
Width:	240 mm
Height:	245 mm
Weight:	13 kg

*Fig.3.1: Dimensions and weight*

#### 3.2 Notes on Transport

- When lifting or carrying the centrifuge, always reach under the centrifuge from the side.
- Transport the centrifuge within suitable packaging, and if at all possible, in its original packaging.

#### 3.3 Notes on Storage

The centrifuge can be stored for up to a year without any problems.

- Store the centrifuge only in dry rooms.
- The storage temperature must not exceed  $-20^{\circ}\text{C}$ .
- If you would like to store it for more than one year, or if you intend to ship it overseas, please contact the manufacturer.

## 4 Set-up and Connection

### 4.1 Unpacking the Centrifuge

- Open the cardboard box.
- Take out the box containing the accessories.
- Remove the upper foam cushion.
- Lift the centrifuge upwards. When lifting or carrying the centrifuge, always reach under the centrifuge from the side.



#### **Attention!**

**The centrifuge weighs approx. 13 kg!**

- Please retain the packaging for any possible future transport of the centrifuge.

#### 4.1.1 Transport Safety Device

The SIGMA 1-6P centrifuge is not equipped with a transport safety device.

## 4.2 Installation

### 4.2.1 Installation Site

All the energy supplied to the centrifuge is converted into heat and emitted to ambient air.

- Ensure sufficient ventilation.
- Keep a safety distance of at least 30 cm from the wall so that the vents in the centrifuge remain fully effective.
- Do not position the centrifuge near heat generators.
- Avoid direct sunlight (UV radiation).
- The table must be stable and have a solid, even surface.



#### **Attention!**

During transport from cold to warmer places, condensation will collect inside the centrifuge. It is important to allow sufficient time for drying before the centrifuge can be used again.

### 4.2.2 Connection



**The operating voltage on the name plate must correspond to the local supply voltage!**

SIGMA laboratory centrifuges are units of safety class I in accordance with DIN VDE 0700 and have a three-wire power cord (2.5 m) and a shockproof right-angle plug.

On the back, next to the mains power input, there is an additional ground wire connector (see Fig. 5.2, page 25) where a separate ground wire can be connected. This ensures that the admissible leakage current cannot shock anyone if a problem with the protective ground wire system were to occur. Only authorized and specialized personnel are permitted to connect the unit. Please contact the head of our service team (see 6.2.7 "Service Contact", page 43).

### 4.2.3 Fuses/Emergency Circuit Breaker on Site

Typically, the centrifuges must be protected with 16 A fuses of class "G".

An on-site emergency circuit breaker to disconnect the centrifuge from the power supply in the event of a malfunction is recommended. This switch should be located away from the centrifuge, preferably outside the room where the centrifuge is located or at the exit of this room.

## 5 Using the Centrifuge

### 5.1 Description

#### 5.1.1 Operating Elements

- 1 Mains power switch
- 2 Stop key
- 3 Lid key
- 4 Lid
- 5 Display
- 6 Start key
- 7 Left rotary knob
- 8 Right rotary knob

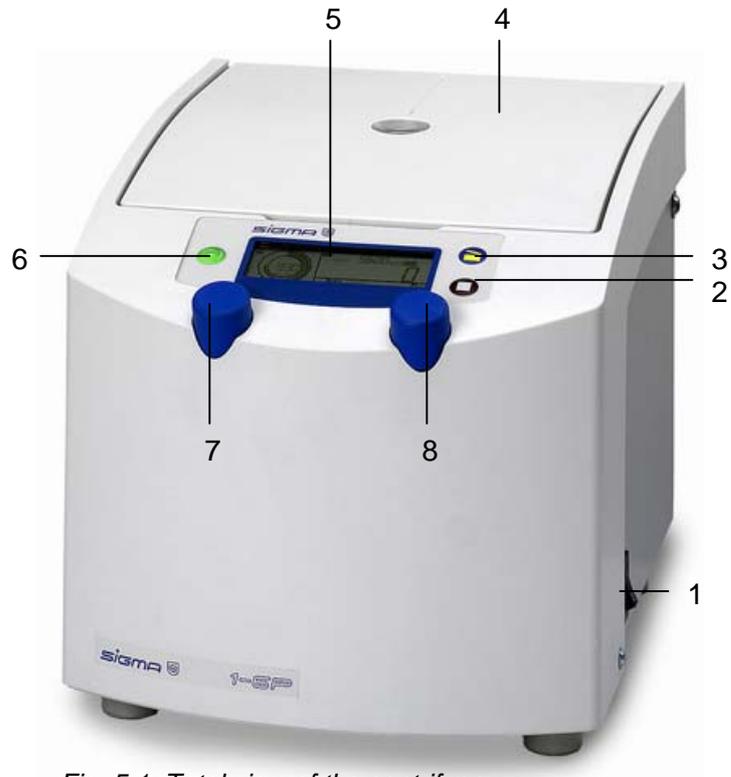


Fig. 5.1: Total view of the centrifuge

- 9 Name plate
- 10 Equipotential bonding screw
- 11 Mains power input



Fig. 5.2: Rear view of the centrifuge

### 5.1.1.1 Operating Panel



Fig 5.3: Operating Panel

The centrifuge is started directly via the operating panel. When the centrifuge is switched on, all of the operating keys and displays will be illuminated for a short time. It is now ready for operation.

### 5.1.1.2 Name Plate

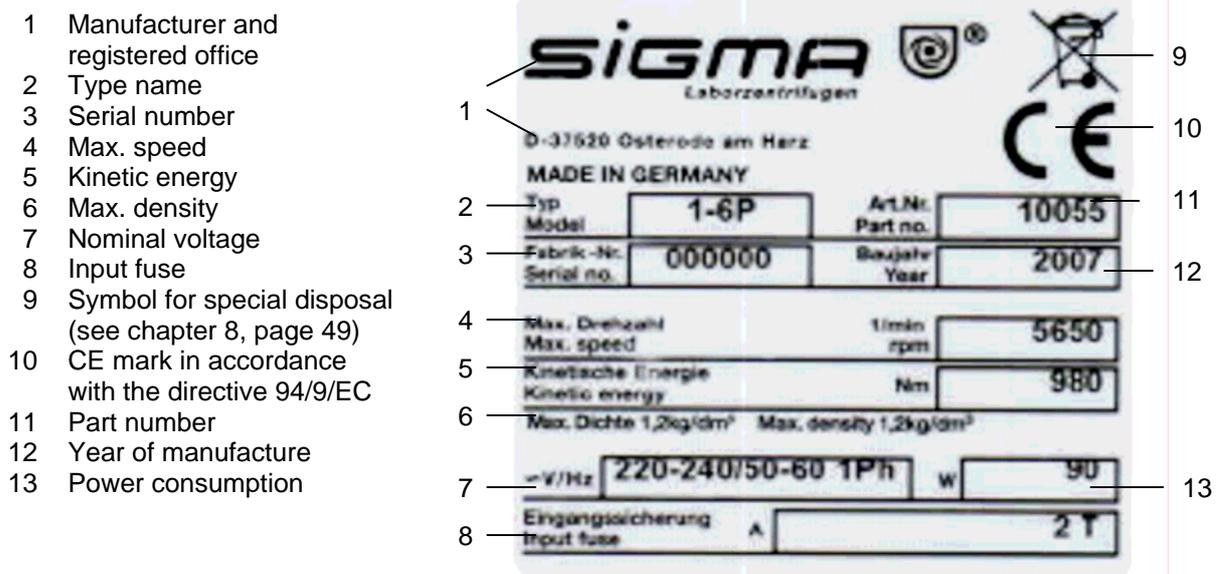


Fig. 5.4: Name plate

### 5.1.2 Construction and Constructive Safety Measures

The centrifuge is installed within a solid construction. On the back, the lid is secured by solid hinges and on the front by two separate lid locks.

### 5.1.3 Drive

The drive motor is a well-dimensioned, collector-less asynchronous motor.

### 5.1.4 Operation and Display

The display is a hermetically sealed LCD display. It is operated by way of two rotary knobs and indicates the operating statuses.

### 5.1.5 Electronic System

The microprocessor-controlled electronic system ensures a wide range of adaptations of the centrifuge for various tasks. The following parameters can be set:

- Speed in steps of 100 or 10 rpm
- Relative centrifugal force RCF in steps of 10 x g
- Time between 10 sec and 11h 59min max.
- Continuous run
- Short run
- Acceleration and deceleration curves
- Storage and call-up of programs

## 5.1.6 Safety Devices

Apart from the mentioned passive safety devices due to the solid design, the following active precautions are in place for your safety:

### 5.1.6.1 Lid Lock and Lid Closing Device

The centrifuge can only be started when the lid is properly closed. The electrical locks must be locked. The lid can only be opened when the rotor has stopped. If the lid is opened by way of the emergency release system during operation, the centrifuge will immediately switch off and decelerate brakeless. If the lid is open, the drive is completely separated from the mains power supply, i.e. the centrifuge cannot be started (see 6.2.5 "Emergency Lid Release", page 42).

### 5.1.6.2 Standstill Monitoring

Opening of the centrifuge lid is only possible if the rotor is at a standstill. This standstill is checked by the microprocessor.

### 5.1.6.3 System Check

An internal system check monitors the data transfer and sensor signals with regard to plausibility. Errors are detected with extreme sensitivity and displayed as error messages with a number on the speed display (see 6.2.6 "Error Codes", page 43).

### 5.1.6.4 Ground Wire Check

For the ground wire check, there is an equipotential bonding screw on the rear panel of the centrifuge. A ground wire check can be carried out by authorized and specialized personnel using a suitable measuring instrument (see 4.2.2 "Connection", page 24). Please contact the head of our service team (see 6.2.7 "Service Contact", page 43).

## 5.2 Initial Start-Up



**Before the initial start-up, please ensure that your centrifuge is properly set up and installed** (see 4.2 "Installation", page 24).

### 5.2.1 Switching the Centrifuge ON

- Press the mains power switch on the right side of the front (see Fig. 5.1, page 25).

The centrifuge display then illuminates.

### 5.2.2 Opening and Closing the Lid



The lid can be opened if the centrifuge is at a standstill and if the lid key is illuminated.

- Press the lid key in order to open the lid (see 5.3.7 "Activating/Deactivating the Automatic Lid Opening Function", page 40).

The centrifuge cannot be started if the lid is opened.

- To close the lid, press on the left and right side of the lid to ensure that both of the lid locks lock into place.



#### **Attention!**

A flashing lid key indicates that only one lid lock has locked.

## 5.2.3 Installation of Rotors



- Open the centrifuge lid by pressing the lid key.
- Unscrew the rotor tie-down screw from the motor shaft (anti-clockwise).
- Lower the rotor with its central bore straight down onto the motor shaft.
- Tighten the rotor tie-down screw clockwise with the supplied rotor wrench with 5 Nm. In doing so, hold the rotor at its outer rim.
- After frequent use, the rotor tie-down screw must be loosened by some turns and fastened again. This must be done once a day or after 20 cycles. This ensures a proper connection between the rotor and the motor shaft.
- The rotor tie-down screw should only be tightened when a rotor is installed in order to prevent the collet chuck from being expanded.



- 1 Angle rotor
- 2 Rotor-tie down screw
- 3 Motor shaft

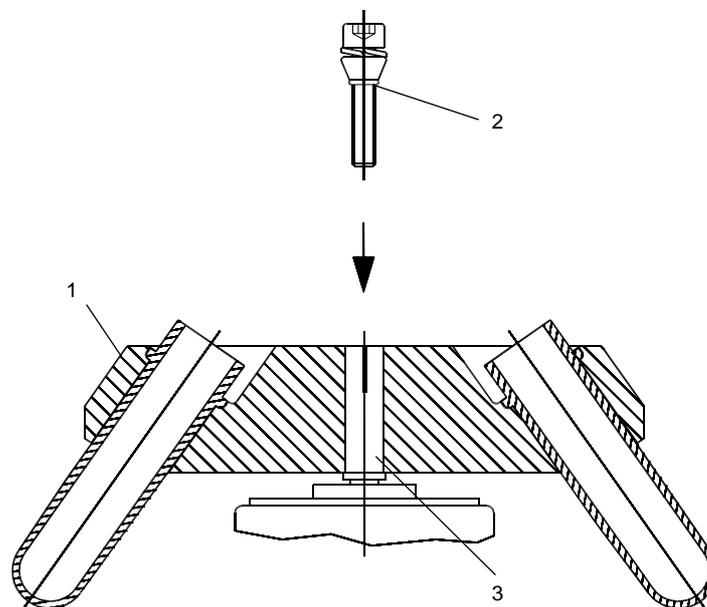
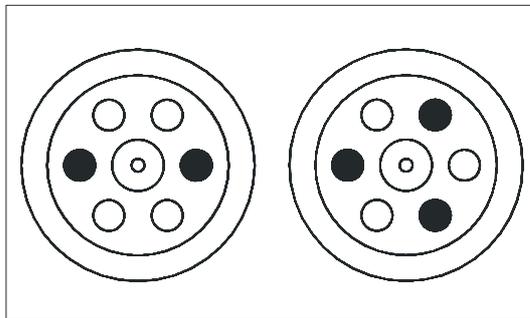


Fig. 5.5: Installation of a rotor

## 5.2.4 Installation of Accessories

- Only use vessels that are suitable for the rotor (see chapter 10 "Suitable Accessories", page 50 f).
- Always load the opposite compartments of the rotors with the same accessories and filling to avoid imbalance.
- Centrifugation with low capacity:  
The tubes must be installed symmetrically so that the rotor is loaded evenly (Fig 5.6).



*Fig. 5.6:  
Correct loading of the angle rotor*

### 5.2.4.1 Tubes

- Load the tubes outside of the centrifuge. Liquids in the bores of the rotors cause corrosion.
- Fill the tubes carefully and arrange them according to their weight. Imbalances result in the excessive wear of the bearings.
- When using glass tubes, please refer to the information provided by the manufacturer concerning the maximum speed for glass tubes.



#### **Attention!**

- **Please observe the instructions on safety and hazards in chapter 2, page 16 ff!**

### 5.2.5 Service Life of Rotors and Accessories

The rotors and accessories have a limited service life.



- Please perform regular checks (at least once per month) for safety reasons!
- Pay special attention to changes, such as corrosion, cracks, material abrasion etc.
- **After 7 years, they must be inspected by the manufacturer.**
- **After 50,000 cycles, the rotor must be scrapped for reasons of safety.**
- **If other data concerning the service life are engraved on the rotor, these data shall apply accordingly!**

## 5.2.6 Starting the Centrifuge



The centrifuge is ready for operation when the start key is illuminated.

- Press the start key in order to start a centrifugation run.

## 5.2.7 Interrupting a Centrifugation Run



- Press the stop key in order to interrupt a centrifugation run.

The centrifugation run will be terminated prematurely.

### 5.2.7.1 Interrupting a Deceleration Process

- Press the start key during a deceleration process in order to interrupt it and to restart the centrifuge.

### 5.2.7.2 Softstart and Softstop Function

The softstart function is used to extend the acceleration time, whereas the softstop function is used to extend the deceleration time. The current combination is shown on the display. The stop key can be used to cyclically select various combinations:

- Press the key once to activate the softstart function.
- Press the key twice to activate the softstart function and the softstop function.
- Press the key three times to activate the softstop function alone.
- Press the key four times to activate the softstart function and the brakeless deceleration. The “soft stop” display flashes when the brakeless deceleration is active.
- Press the key five times to activate the “brakeless deceleration” function alone (the “soft stop” display flashes).
- Press the key once more to return to the standard operating mode.

### 5.3 Display/Program Options

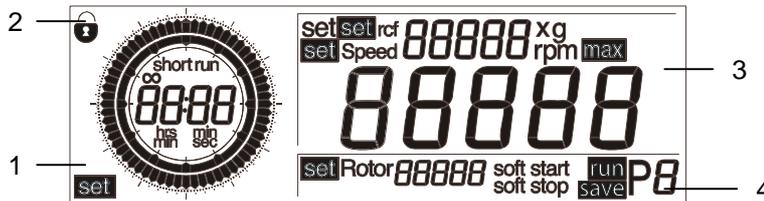


Fig. 5.7:  
 Display completely active

The centrifuge display has the following display fields:

- 1 Time field
- 2 "Lock" symbol for lockdown
- 3 Speed/RCF field
- 4 Field for rotor selection, imbalance indication, run mode, and program selection

#### 5.3.1 Time

The runtime of the centrifuge can be set at different intervals in a range from 10 seconds to 11 hours and 59 minutes.

To select the desired centrifugation time:

- Turn the left rotary knob until the “set” cursor appears in the lower left area of the display (see Fig. 5.8).
- Select the option by pressing or turning the right rotary knob. The “set” cursor will now flash.
- Turn the right rotary knob until the desired duration is displayed.
- Press the right rotary knob in order to confirm the input. If this is not done, the value will be automatically reset to the last setting.

After 11:59 min, the display changes from “min:sec” to “hrs:min“. The time can then be changed in steps of 10 minutes.

It is also possible to change the runtime during the centrifugation run.



**Attention!**

If the centrifugation time is changed during the run, the centrifuge will run for the entire new time and will disregard the previous runtime that has already elapsed.

In this example (Fig 5.8) is 3:20 min.

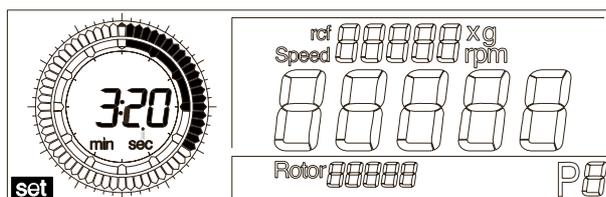


Fig. 5.8: Setting the time

### 5.3.1.1 Changing the Time Increments

In order to change the time in steps of 1 second (instead of in steps of 10 seconds in the min:sec mode) or in steps of 1 minute (instead of in steps of 10 minutes in the hrs:min mode):

- Keep the stop key pressed while setting the desired runtime with the right rotary knob.

### 5.3.1.2 Short Run

During the short run, the centrifuge accelerates at maximum power until the maximum speed is reached.

- Keep the start key pressed during the short run.

The message “short run” is displayed in the time display (Fig. 5.9) and the duration of the short run is also displayed. When the start key is released, the centrifuge decelerates at maximum power to a standstill.

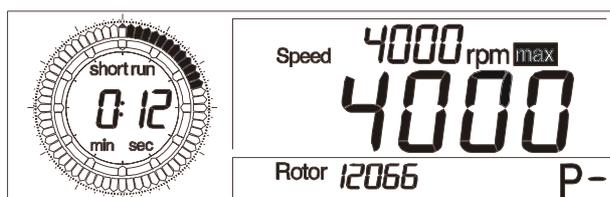


Fig. 5.9: Short run display

### 5.3.1.3 Continuous Run

During the continuous run, the runtime of the centrifuge is unlimited and must be stopped manually. The centrifuge accelerates during the continuous run until the set speed is reached.

To start the continuous run of the centrifuge:

- Starting with the time setting 0:10 (see 5.3.1, page 34), turn the knob anti-clockwise.
- Or:
- Starting with the time setting 11:59, turn the knob clockwise to the next setting. The message “cont” and the symbol “∞” will be displayed (Fig. 5.10).

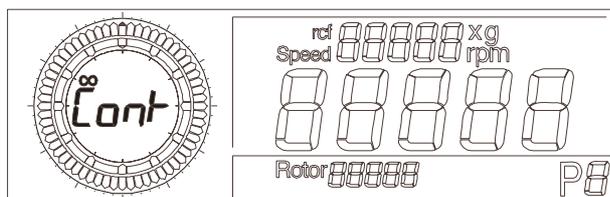


Fig. 5.10: Continuous run display

### 5.3.2 Speed

The desired speed of the centrifuge (revolutions per minute) can be set here (1,000 rpm in the example shown below). When the maximum permissible speed of the rotor is reached, the “max” display lights up.

To preselect a speed value:

- Turn the left rotary knob until the “set” cursor appears in front of the parameter “Speed” on the display (Fig. 5.11).
- Select the option by pressing or turning the right rotary knob. The “set” cursor will now flash.
- Turn the right rotary knob until the desired value is displayed.
- Press the right rotary knob to confirm the selected value. If this is not done, the value will be automatically reset to the last setting.

It is possible to change the speed value during the centrifugation run.

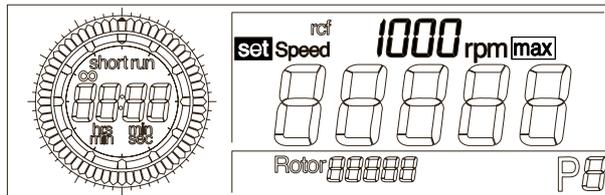


Fig. 5.11:  
 Setting the speed

#### 5.3.2.1 Changing the Speed Increments

In order to change the speed in steps of 10 rpm (instead of in steps of 100 rpm):

- Keep the stop key pressed while setting the desired speed with the right rotary knob.

### 5.3.3 Relative Centrifugal Force (RCF)

The relative centrifugal force (RCF) is the acceleration that the sample is subject to.

The RCF value is determined by the rotor geometry and speed. The RCF and speed values, therefore, depend on each other. When the maximum permissible RCF value of the rotor is reached, the "max" display lights up.

To preselect the RCF value:

- Turn the left rotary knob until the "set" cursor appears in front of the parameter "rcf" on the display (Fig. 5.12).
- Select the option by pressing or turning the right rotary knob. The "set" cursor will now flash.
- Turn the right rotary knob until the desired value is displayed.
- Press the right rotary knob to confirm the selected value. If this is not done, the value will be automatically reset to the last setting.

It is also possible to change the RCF value during a centrifugation run.

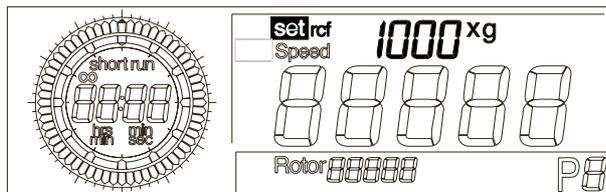


Fig. 5.12:  
 Setting the relative centrifugal force

### 5.3.4 Rotor

The available rotors for the centrifuge can be selected here (rotor 12066 in the example). This is only possible at a standstill.

- Turn the left rotary knob until the "set" cursor appears in front of the option "Rotor" on the display (Fig. 5.13).
- Select the option by pressing or turning the right rotary knob. The "set" cursor will now flash.
- Turn the right rotary knob until the desired rotor number is displayed.
- Press the right rotary knob to confirm the input. If this is not done, the value will be automatically reset to the last setting.

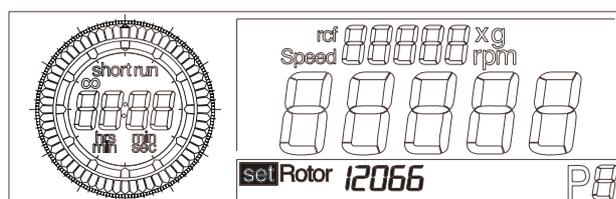


Fig. 5.13: Preselection of a rotor

### 5.3.5 Program

The program is used to save or load certain recurrent settings of the centrifuge. This saves time and prevents typing errors. Ten different programs (0-9) can be saved and called up. This is only possible at a standstill.

#### 5.3.5.1 Saving the Current Settings

To save the current settings:

- Turn the left rotary knob until the “save” cursor appears on the display (Fig. 5.14).
- Select the option by pressing the right rotary knob. The “save” cursor will now flash.
- Turn the right rotary knob until the desired program number is displayed. Empty storage location numbers flash.
- Press the right rotary knob to confirm the input.

The settings are now saved under this program number (program number 8 in the example).

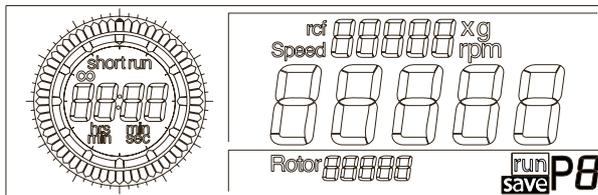


Fig. 5.14: Saving programs; here program number 8

#### 5.3.5.2 Calling Up Stored Programs

If necessary, the saved programs can be called up:

- Turn the left rotary knob until the “run” cursor appears on the display (Fig 5.15).
- Select the option by pressing the right rotary cursor. The “run” cursor will now flash.
- Turn the right rotary knob until the desired program number is displayed.
- Press the right rotary knob to confirm the input.

The saved program settings will be adopted.

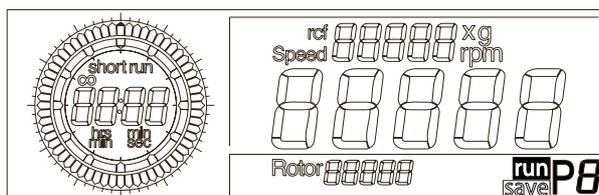


Fig. 5.15: Calling up stored programs; here program number 8

## 5.3.6 Lockdown

This function locks the parameters against all inadvertent changes.

- Turn the left rotary knob until a padlock symbol is displayed in the upper left corner of the display (Fig. 5.16).

As long as the padlock symbol is displayed, the parameters cannot be changed.

### 5.3.6.1 Permanent Lockdown

The parameter settings can also be locked with the help of the start key when the lid is open:

- Press the start key three times and on the third time hold it down for approx. two seconds.

After the activation of the function, the padlock symbol (Fig. 5.16) will flash. Now the centrifuge can be started and stopped, but the settings cannot be changed.

- Proceed in the same way in order to deactivate the function.

The current status remains active even if the centrifuge is switched off with the help of the mains power switch.

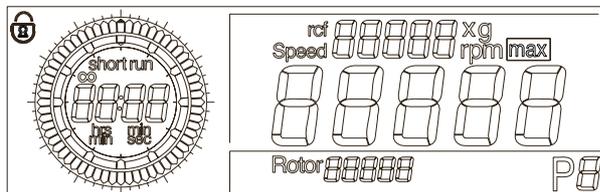


Fig. 5.16: Padlock symbol

### 5.3.7 Activating/Deactivating the Automatic Lid Opening Function

The Auto-Lid-Open function must be activated so that the lid opens automatically at the end of the operation:

- Press the lid key three times when the lid is open and on the third time hold it down for approx. two seconds.
- Proceed in the same way in order to deactivate the function.

After every change, the current status of the setting is displayed in the form of a message running over the display ("Auto-Lid-Open" or "off").

### 5.3.8 Activating/Deactivating the Sound Signal

If this function is active, a sound signal can be heard at the end of the operation as well as in the event of an error message.

- Press the lid key five times and on the fifth time hold it down for approx. two seconds.
- Proceed in the same way in order to deactivate the function.

After every change, the current status of the setting is displayed in the form of a message running in the display ("Buzzer on" or "off").

## 6 Malfunctions and Error Correction

### 6.1 Error Mode

Malfunctions are indicated by error messages with a number in the speed display. If the sound signal is activated, it sounds when the error message is displayed (see 5.3.8 "Activating/Deactivating the Sound Signal", page 40).

### 6.2 Error Correction

- Eliminate the source of the problem (see 6.2.1 to 6.2.6, page 41 ff).
- Acknowledge the error messages with the lid key.

#### 6.2.1 No Indication on the Display

- Voltage in the socket?
- Power cord plugged in and line voltage present?
- Fuse OK?
- Mains power switch on?
- Lid closed?
- Check fuse in the mains supply.
- Plug in power cord correctly.
- Replace fuse (see fig. 5.4 "name plate", page 26).
- Switch on power.
- Close lid (see 6.2.4 "Lid cannot be opened", page 42).

#### 6.2.2 Centrifuge cannot be started

- Start key LED not illuminated:
- Lid key LED flashes:
- Power off/on. If the error occurs again, call the service.
- Open and close the lid again. If error occurs again although both locks are locked, call the service.

#### 6.2.3 Centrifuge decelerates during Operation

- There was a brief mains power failure (at least 2 sec), error message 61
- Centrifuge displays an error from 1 to 11 after powering on.
- Press the start key in order to restart the centrifuge.
- Power off/on (see 6.2.6 "Error Codes", page 43). If the error occurs again, call the service.

## 6.2.4 Lid cannot be opened

- When first trying to open the lid, the locks are not released. Lid key LED flashes.
- The lid cannot be opened, although both locks have audibly unlocked.
- Close the lid again. Press down both sides of the lid until the locks audibly lock. Open the lid again. If the error occurs again, unlock the lid manually (see 6.2.5 "Emergency lid release", page 42) and call the service.
- Check/clean the lid seal. Apply talcum powder to the seal to avoid sticking.

## 6.2.5 Emergency Lid Release

In the event of a power supply failure, it is possible to manually open the centrifuge lid using a stopper that is secured with a screw. It is located on the front of the bottom panel.



- Switch off the mains power switch and disconnect the power cord from the socket.
- Unscrew the screw in the stopper.
- Remove the stopper, e.g. with a screwdriver.
- Pull the visible string in order to release the lid. Then, reinsert the stopper into the opening.
- Reinsert the screw centrally.



*Fig. 6.1: Screw for the emergency lid release*



**The lid may only be unlocked and opened when the rotor is at a standstill.**

If the lid is opened by way of the emergency lid release during operation, the centrifuge will be switched off immediately and decelerate brakeless.

## 6.2.6 Error Codes

Error no.	Kind of error	Measure	Note
1-9	System error	<ul style="list-style-type: none"> <li>allow to slow down</li> <li>power off/on</li> </ul>	All these errors stop the centrifuge or cause it to slow down.
10-19	Speedometer error	<ul style="list-style-type: none"> <li>allow to slow down</li> <li>power off/on</li> </ul>	
20-29	Motor error	<ul style="list-style-type: none"> <li>power off/on</li> <li>ensure ventilation</li> </ul>	
30-39	EEPROM error	<ul style="list-style-type: none"> <li>allow to slow down</li> <li>power off/on</li> </ul>	With errors 34,35,36, the centrifuge will stop. With errors 37,38, error message only.
40-45	Temperature error (only for refrigerated centrifuges)	<ul style="list-style-type: none"> <li>allow to slow down</li> <li>power off/on</li> <li>allow to cool down</li> <li>provide better ventilation</li> </ul>	
46-49	Imbalance error	<ul style="list-style-type: none"> <li>allow to slow down</li> <li>power off</li> <li>eliminate the imbalance</li> </ul>	
50-59	Lid error	<ul style="list-style-type: none"> <li>press lid key</li> <li>close lid</li> <li>remove foreign matter from the opening of the lid lock device</li> </ul>	With error 50 and 51, the centrifuge will stop.
60-69	Process error	<ul style="list-style-type: none"> <li>allow to slow down</li> <li>power off/on</li> </ul>	With error 60, message "power failure during run". With error 61, message "stop after power on".
70-79	Communication error	<ul style="list-style-type: none"> <li>allow to slow down</li> <li>power off/on</li> </ul>	
80-99	Parameter error	<ul style="list-style-type: none"> <li>allow to slow down</li> <li>provide for better ventilation</li> <li>power off/on</li> </ul>	With error 83, error message only.



### Attention!

**If it is impossible to eliminate the errors, please call the service!**

Fig.6.2: Error Codes

## 6.2.7 Service Contact

Please contact your supplier for support or in the event of malfunctions and the supply of spare parts:

SIGMA Laborzentrifugen GmbH  
 An der Unteren Söse 50  
 37520 Osterode

Service +49 55 22 50 07-25  
 Zentrale +49 55 22 50 07-0

service@sigma-zentrifugen.de  
 info@sigma-zentrifugen.de

## 7 Care and Maintenance

### 7.1 Cleaning and Care

The centrifuge, rotor, and accessories are subject to high mechanical stress. Thorough maintenance care performed by the user extends the service life and prevents premature failure.



#### **Attention!**

**If corrosion or other damage occurs due to improper care, the manufacturer cannot be held liable or subject to any warranty claims.**

- Use soap water or other water-soluble, mild cleaning agents (pH value between 6 and 8).
- Avoid corrosive and aggressive substances.
- Do not use alkaline solutions or solvents.
- Do not use agents with abrasive particles.
- Do not expose the centrifuge and rotors to intensive UV radiation or thermal stress (e.g. by heat generators).

#### 7.1.1 Centrifuge



- Disconnect the power cord from the socket before cleaning.
- Carefully remove all liquids, including water and particularly all the solvents, acids, and alkaline solutions from the centrifuge chamber using a cloth in order to avoid damage to the motor bearings.
- If the centrifuge has been contaminated with toxic, radioactive, or pathogenic substances, clean the centrifuge chamber immediately with a suitable decontamination agent (depending on the type of contamination). **Take suitable precautions for your own safety if there is a risk of toxic, radioactive, or pathogenic contamination.**



- Grease the motor shaft slightly after cleaning (grease for load-bearing bolts part no. 70284).
- Open the centrifuge when it is not in use so moisture can evaporate. This prevents the increased wear of the motor bearings.

## 7.1.2 Accessories



For the care of the accessories, special safety measures must be considered as these are measures that will ensure operational safety at the same time.

- Immediately rinse off the rotor or accessories if any liquids that may cause corrosion come into contact with them.
- Clean the accessories outside the centrifuge once a week or preferably after each use. Rubber cushions should be removed.
- If the rotors or accessories have been contaminated with toxic, radioactive, or pathogenic substances, clean them immediately with a suitable decontamination agent (depending on the type of contamination). **Take suitable precautions for your own safety if there is a risk of toxic, radioactive, or pathogenic contamination.**



- Dry the accessories with a soft cloth or in a drying chamber at approx. 50°C.

### 7.1.2.1 Plastic Accessories

- If solvents, acids, or alkaline solutions have been used, clean the plastic accessories thoroughly. The chemical resistance of plastic decreases with rising temperatures (e.g. during drying).

### 7.1.2.2 Aluminum Accessories

Especially aluminum parts are susceptible to corrosion.

- Acid-containing cleaning agents and alkaline cleaning agents must be avoided (see 7.1 "Cleaning and Care", page 44).
- Grease aluminum parts at least once a week with slushing oil (part no. 70104).

This essentially increases their service life and reduces susceptibility to corrosion.

### 7.1.3 Rotors

Chemical reactions as well as stress-corrosion (combination of oscillating pressure and chemical reaction) can affect or destroy the metals. Barely detectable cracks on the surface can expand and weaken the material without any visible signs.

- Check the material regularly (at least once a month) for
  - cracks
  - visible damage of the surface
  - pressure marks
  - signs of corrosion
  - other changes.
- Check the bores of the rotors.
- Replace any damaged components immediately for your own safety.
- Protect the rotors, lid seals, and rubber cushions (if included) at least once per week with the supplied slushing oil (part no. 70104).
- Grease the rotor tie-down screw after cleaning (grease for load-bearing bolts part no. 70284).

#### 7.1.4 Glass Breakage



- Glass particles will damage the surface coating (e.g. Eloxal) of the accessories, which will then lead to corrosion.
- Glass particles in the rubber cushions will cause glass breakage again.
- Glass particles in the centrifuge chamber will cause metal abrasion due to the strong air circulation. This metal dust will not only pollute the centrifuge chamber, rotor, and materials to be centrifuged but also damage the surfaces of the accessories, rotors, and centrifuge chamber.

**In the case of glass breakage, immediately remove all glass particles (e.g. with a vacuum cleaner). Replace the rubber cushions since even thorough cleaning will not remove all glass particles.**

In order to completely remove the glass particles and the metal dust from the rotor chamber:

- Grease the upper third of the centrifuge chamber with e.g. Vaseline.
- Then, let the rotor rotate for a few minutes at a moderate speed (approx. 2,000 rpm). The glass and metal particles will now collect at the greased part and can easily be removed with a cloth together with the grease.
- Remove the grease with glass and metal particles with a cloth.
- If necessary, repeat this procedure.

#### 7.2 Sterilization and Disinfection of the Rotor Chamber and Accessories

- Use commercially-available disinfectants such as, for example, Sagrotan<sup>®</sup>, Buraton<sup>®</sup>, or Terralin<sup>®</sup> (available at chemist's shops or drugstores).
- The centrifuges and the accessories consist of various materials. A possible incompatibility must be considered.
- Before using cleaning or decontamination agents that were not recommended by us, contact the manufacturer to ensure that such a procedure will not damage the centrifuge.
- For autoclaving, consider the continuous heat resistance of the individual materials (see 7.2.1 "Autoclaving", page 48). Please contact us if you have any queries (see 6.2.7 "Service Contact", page 43).



**If dangerous materials (e.g. infectious and pathogenic substances) are used, the centrifuge and accessories must be disinfected.**

## 7.2.1 Autoclaving

The service life of the accessories essentially depends on the frequency of autoclaving and use.

- Replace the accessories immediately when the parts show changes in color or structure or in the occurrence of leaks etc.
- During autoclaving, the caps of the tubes must not be screwed on in order to avoid the deformation of the tubes.

It cannot be excluded that plastic parts, e.g. lids, may deform during autoclaving.

### Autoclaving:

Accessories	max. temp. °C	min. time min	max. time min	max. cycles
Glass tubes	134-138	3	40	-
Polycarbonate tubes	115-118	30	40	20
Polypropylene tubes	115-118	30	40	30
Teflon tubes	134-138	3	5	100
Aluminum rotors	134-138	3	5	-
Polycarbonate/Polyallomer lids for angle rotors	115-118	30	40	20
Polysulfone lids for angle rotors	134-138	3	5	100
Aluminum buckets	134-138	3	5	-
Polycarbonate caps for buckets	115-118	30	40	50
Polypropylene caps for buckets	115-118	30	40	50
Polysulfone caps for buckets	134-138	3	5	100
Rubber adapters	115-118	30	40	-
Rubber cushions	115-118	30	40	-
Round carriers made of polypropylene	115-118	30	40	-
ditto, made of polyallomer and polycarbonate	115-118	30	40	-
Rectangular carriers made of polypropylene	115-118	30	40	-
ditto, made of polyallomer and polycarbonate	115-118	30	40	-

*Fig. 7.1: Autoclaving table*

## 8 Disposal

### 8.1 Disposal of the Centrifuge



In accordance with the directive 2002/96/EC, SIGMA centrifuges are marked with the symbol shown to the left. This symbol means that it is not permissible to dispose of the unit among household trash.

- You can return these centrifuges free of cost to SIGMA Laborzentrifugen GmbH.
- Please ensure that the unit is decontaminated.
- Please fill in the enclosed declaration of decontamination.
- Please comply with any other applicable local rules and regulations.

### 8.2 Disposal of the Packaging

- Use the packaging to return the centrifuge for disposal.
- Or:
- Dispose of the packaging, after having separated the individual materials.
  - Please comply with all local rules and regulations.

## 9 Warranty and Liability

The warranty and liability are subject to our "General Conditions" that were distributed to the operator upon the conclusion of the contract.

Warranty and liability claims are excluded if they are due to:

- Improper use
- Non-compliance with the safety instructions and hazard warnings in the operating manual
- Force majeure

## 10 Suitable Accessories for SIGMA 1-6P

Part no.	Description	Max. speed (min <sup>-1</sup> )	Max. gravitational field (x g)
12066	Angle rotor 6 x 15 ml for round or conical tubes, max. Ø 17 x 120 mm, e.g. 15015, 15020, 15023, 15024, Monovettes or culture tubes 15 ml (Nunc, Corning, Falcon or Greiner) e.g. 15115, max. radius 8.5 cm, min. radius 2 cm (with 100 mm tube length), angle 30°, incl. buckets 13011	5 650	2 980

### Adaptors, plastic vessels an glass tubes

Part no.	Description	Max. speed (min <sup>-1</sup> )	Max. gravitational field (x g)
13070	Adapter for 1 round bottom tube, max. Ø 13.5 / 17 x 70-82 mm, e.g. Vacutainer, polypropylene		
13071	Adapter for 1 round bottom tube approx. 5 ml, max. Ø 12.8 x 75-90 mm, e.g. 15060 (RIA) or hemolyse tubes, polypropylene		
13072	Adapter for 1 round bottom tube 4.5-6 ml, max. Ø 12.3 x 90-105 mm, e.g. 15007, 15027, polypropylene		
15060	Polystyrene tube 5 ml (RIA-tube), Ø 12 x 75 mm, suitable for 13071		
15007	Centrifuge glass tube 6 ml, Ø 12 x 100 mm, suitable for 13072		
15027	ditto, graduated, 0 - 5.5 ml in steps of 0.1 ml		
15015	Centrifuge glass 10-12 ml, Ø 16 x 100 mm, suitable in 12066		
15024	ditto, graduated, 0 - 10 ml in steps of 0.1 ml		
15020	Polystyrene tube 14 ml, Ø 17 x 100 mm, suitable in 12066		
15021	Polypropylene stopper for 15020, 15023		
15023	Polypropylene tube 14 ml, Ø 17 x 100 mm, suitable for 12066		
15115	Culture tube with screw cap 15 ml, pointed bottom, suitable for 12066, polypropylene		

Part no.	Description	Max. speed (min <sup>-1</sup> )	Max. gravitational field (x g)
12067	Angle rotor for 6 sterilin tubes 30 ml, graduated up to 20 ml, with skirt, incl. cap, max. Ø 25/31 x 65 - 95 mm, polypropylene, see <a href="http://www.barloworld-scientific.com">www.barloworld-scientific.com</a>	5 650	3 050

Further accessories available upon request.

Maximum speed for tubes:

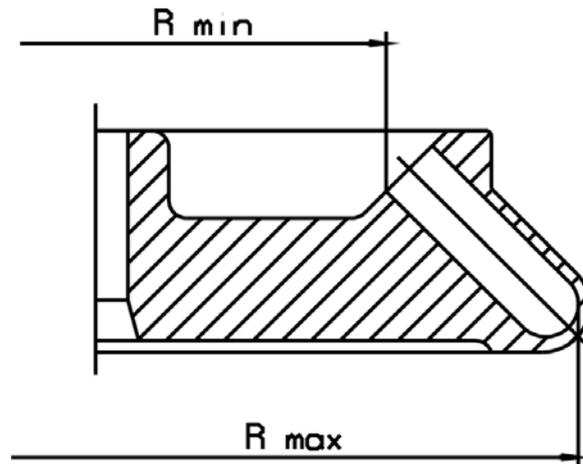
Some tubes, such as centrifuge glass tubes, microtubes, culture tubes, fluoropolymer tubes and especially high-volume tubes can be used in our rotors and adapters at higher speeds than their breaking limit.

- Always fill the tubes up to their useful volume (= the volume that is stated for the tube).
- Follow the manufacturer's recommendations.

## 10.1 Graphical Representation of the Rotors

The graphical representation of the rotors shows the maximum and minimum radii of the accessories used. If necessary, the values must be manually calculated (see 11.1.1 “RCF”, page 53).

*Fig. 10.1: Minimum and maximum radius of an angle rotor*



## 11 Appendix

### 11.1 Formulae – Mathematical Relations

#### 11.1.1 Relative Centrifugal Force (RCF)

The parameters speed, RCF, and the group rotor and radius cannot be specified independently. They are interrelated via the following formula:

$$\text{RCF} = 11.18 \times 10^{-6} \times r \times n^2$$

If two values are given, the third value is determined by the equation. If then the speed or the rotation radius is changed, the resulting RCF will be recalculated. If the RCF is altered, the speed will be adapted accordingly under the consideration of the radius.

r = radius in cm  
n = speed in min<sup>-1</sup>  
RCF without dimension

#### 11.1.2 Density

If the density of the liquid is higher than 1.2 g/cm<sup>3</sup>, the maximum permissible speed of the centrifuge is calculated according to the following formula:

$$n = n_{\max} \times \sqrt{(1.2 / \text{Rho})}$$

Rho = density in g/cm<sup>3</sup>

#### 11.1.3 Speed-Gravitational-Field-Diagram

Additional help can be found in the enclosed speed-gravitational-field-diagram (page 54).

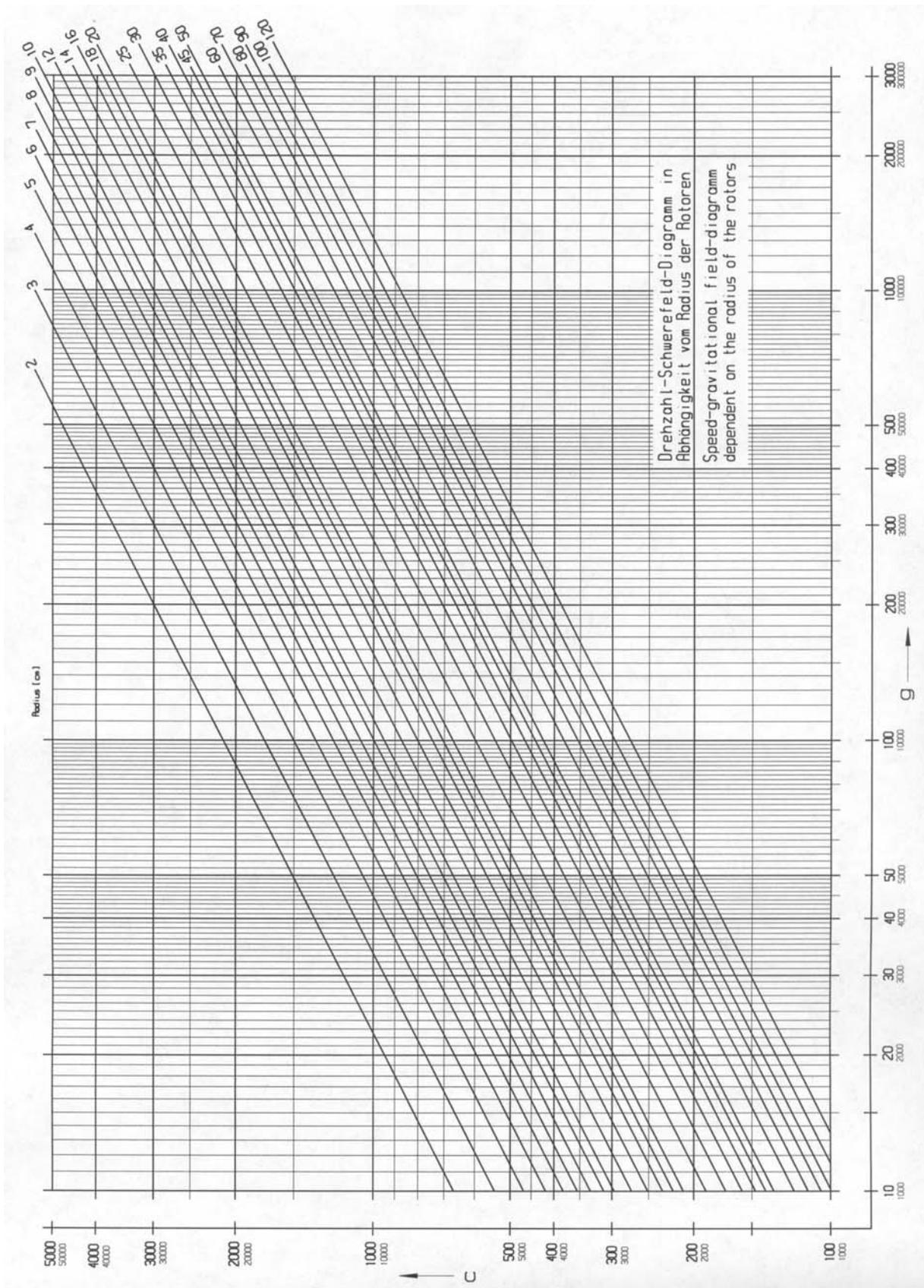


Abb. 11.1: Drehzahl-Schwerefeld-Diagramm

## 11.2 Declaration of Decontamination/Return Declaration

The Return Declaration (page 57) and the Declaration of Decontamination (page 59) serve for maintaining the safety and health of our employees.

Fill out the forms and attach them when returning centrifuges, accessories, and spare parts. Please understand that we cannot carry out any work before we have the declarations. **We recommend several copies of this page to be made.**



**!!! Note – this form must be glued onto the outside of the box !!!**

## Return Declaration

	YES	NO
<b>Decontamination declaration inside:</b>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Unit / component contaminated:</b>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Unit / component unused:</b>	<input type="checkbox"/>	<input type="checkbox"/>

Thank you very much for a brief problem description.  
 This may reduce the repair costs.

**Please make some copies before removing this page!**

*Fig. 11.2: Return Declaration*



## Declaration of Decontamination by the Operator

Concerning the contamination of centrifuges, accessories, and spare parts.



This declaration may only be filled out and signed by authorized staff.

Repair order no. \_\_\_\_\_ Date \_\_\_\_\_

Type of unit	_____	Serial no.	_____	Year	_____
Type of unit	_____	Serial no.	_____	Year	_____
Type of unit	_____	Serial no.	_____	Year	_____
Type of unit	_____	Serial no.	_____	Year	_____

Accessories \_\_\_\_\_  
\_\_\_\_\_

Are the components free from harmful substances? YES  NO

If not, which substances has the equipment come into contact with?

Names of the substances \_\_\_\_\_  
\_\_\_\_\_

Remarks: \_\_\_\_\_  
\_\_\_\_\_

(e.g. to handle with gloves only)

General characteristics of the substances

Caustic	<input type="checkbox"/>	Toxic	<input type="checkbox"/>	Corrosive	<input type="checkbox"/>
Explosive	<input type="checkbox"/>	Biologically hazardous	<input type="checkbox"/>	Radioactive	<input type="checkbox"/>

In Combination with which substances can hazardous mixtures develop?

Names of the substances \_\_\_\_\_  
\_\_\_\_\_

Have the components been cleaned before shipment! YES  NO

Is the equipment decontaminated and not harmful to human health? YES  NO

Prior to repair, radioactive contaminated components must be decontaminated according to the valid regulations for radiation protection!

### Legally Binding Declaration

I / we hereby declare that the information on this declaration is correct and complete.

Company/Institute \_\_\_\_\_  
Street \_\_\_\_\_  
Postcode, City \_\_\_\_\_  
Phone \_\_\_\_\_ Fax \_\_\_\_\_  
Name \_\_\_\_\_  
Date \_\_\_\_\_

Signature \_\_\_\_\_ Stamp \_\_\_\_\_

**Please make some copies before removing this page!**

Fig. 11.3: Declaration of Decontamination



## 11.3 Resistance Data

### Resistant at +20 °C

		Concentration	High Density Polyethylene	Polyamide	Polycarbonate	Polyoxymethylene	Polypropylene	Polysulfone	Polyvinyl chloride, hard	Polyvinyl chloride, weak	Polytetrafluorethylene	Aluminum
Medium	Formula	[%]	HDPE	PA	PC	POM	PP	PSU	PVC	PVC	PTFE	AL
- no data												
1 resistant												
2 practically resistant												
3 partially resistant												
4 not resistant												
Acetaldehyde	C <sub>2</sub> H <sub>4</sub> O	40	3	2	4	2	3	4	4	-	1	1
Acetamide	C <sub>2</sub> H <sub>5</sub> NO	saturated	1	1	4	1	1	4	4	-	1	1
Acetone	C <sub>3</sub> H <sub>6</sub> O	100	1	1	4	1	1	4	4	-	1	1
Acrylonitrile	C <sub>3</sub> H <sub>3</sub> N	100	1	1	4	3	3	4	4	4	1	1
Allyl alcohol	C <sub>3</sub> H <sub>6</sub> O	96	1	3	3	2	2	2	2	4	1	1
Aluminum chloride	AlCl <sub>3</sub>	saturated	1	3	2	4	1	-	1	-	1	4
Aluminum sulfate	Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub>	10	1	1	1	3	1	1	1	1	1	1
Ammonium chloride	(NH <sub>4</sub> )Cl	aqueous	1	1	1	2	1	1	1	1	1	3
Ammonium hydroxide	NH <sub>3</sub> + H <sub>2</sub> O	30	1	3	4	1	1	2	1	-	1	1
Aniline	C <sub>6</sub> H <sub>7</sub> N	100	1	3	4	1	2	4	4	4	1	1
Anisole	C <sub>7</sub> H <sub>8</sub> O	100	3	4	4	1	4	4	2	-	1	1
Antimony trichloride	SbCl <sub>3</sub>	90	1	4	1	4	1	-	1	-	1	4
Benzaldehyde	C <sub>7</sub> H <sub>6</sub> O	100	1	3	4	1	1	3	4	4	1	1
Benzene	C <sub>6</sub> H <sub>6</sub>	100	3	2	4	1	3	4	4	-	1	1
Boric acid	H <sub>3</sub> BO <sub>3</sub>	aqueous	1	3	1	2	1	-	-	-	1	1
Butyl acrylate	C <sub>7</sub> H <sub>12</sub> O <sub>2</sub>	100	1	2	4	2	3	4	4	4	1	1
Butyl alcohol, normal	C <sub>4</sub> H <sub>10</sub> O	100	1	1	2	1	1	2	2	4	1	1
Calcium chloride	CaCl <sub>2</sub>	alcoholic	1	4	2	3	1	-	-	4	1	3
Carbon disulfide	CS <sub>2</sub>	100	4	3	4	2	4	4	4	4	1	1
Carbon tetrachloride (TETRA)	CCl <sub>4</sub>	100	4	4	4	2	4	4	4	4	1	1
Chlorine	Cl <sub>2</sub>	100	4	4	4	4	4	4	4	4	1	3
Chlorine water	Cl <sub>2</sub> x H <sub>2</sub> O		3	4	4	4	3	-	3	3	1	4
Chlorobenzene	C <sub>6</sub> H <sub>5</sub> Cl	100	3	4	4	1	3	4	4	4	1	1
Chloroform	CHCl <sub>3</sub>	100	3	3	4	4	3	4	4	4	1	3
Chromic acid	CrO <sub>3</sub>	10	1	4	2	4	1	4	1	-	1	1
Chromic potassium sulfate	KCr(SO <sub>4</sub> ) <sub>2</sub> x 12H <sub>2</sub> O	saturated	1	2	1	3	1	-	1	-	1	3
Citric acid	C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	10	1	1	1	2	1	1	1	1	1	1
Citric acid	C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>	50	1	3	1	2	1	-	-	-	1	1
Copper sulfate	CuSO <sub>4</sub> x 5H <sub>2</sub> O	10	1	1	1	1	1	1	1	1	1	4
Cyclohexanol	C <sub>6</sub> H <sub>12</sub> O	100	1	1	3	1	1	1	1	4	1	1
Decane	C <sub>10</sub> H <sub>22</sub>	100	-	1	2	1	3	-	-	-	1	1
Diaminoethane	C <sub>2</sub> H <sub>8</sub> N <sub>2</sub>	100	1	1	3	1	1	-	3	4	1	1
Diesel fuel	—	100	1	1	3	1	1	-	1	3	1	1
Dimethyl formamide (DMF)	C <sub>3</sub> D <sub>7</sub> NO	100	1	1	4	1	1	4	3	-	1	1
Dimethyl sulfoxide (DMSO)	C <sub>2</sub> H <sub>6</sub> SO	100	1	2	4	1	1	4	4	-	1	1
Dimethylaniline	C <sub>8</sub> H <sub>11</sub> N	100	-	3	4	2	4	-	-	-	1	1
Dioxane	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	100	2	1	4	1	3	2	3	4	1	1

## Resistant at +20 °C

			Concentration	High Density Polyethylene	Polyamide	Polycarbonate	Polyoxymethylene	Polypropylene	Polysulfone	Polyvinyl chloride, hard	Polyvinyl chloride, weak	Polytetrafluorethylene	Aluminum
Medium	Formula	[%]	HDPE	PA	PC	POM	PP	PSU	PVC	PVC	PTFE	AL	
- no data													
1 resistant													
2 practically resistant													
3 partially resistant													
4 not resistant													
Dipropylene glycol (mono)methyl ether	C <sub>4</sub> H <sub>10</sub> O	100	3	1	4	1	4	4	4	4	1	1	
Ethyl acetate	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	100	1	1	4	1	1	4	4	4	1	1	
Ethylene chloride	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	100	3	3	4	1	3	4	4	4	1	1	
Ferrous chloride	FeCl <sub>2</sub>	saturated	1	3	1	3	1	1	1	1	1	4	
Formaldehyde solution	CH <sub>2</sub> O	30	1	3	1	1	1	-	-	-	1	1	
Formic acid	CH <sub>2</sub> O <sub>2</sub>	100	1	4	3	4	1	3	3	1	1	1	
Furfural	C <sub>5</sub> H <sub>4</sub> O <sub>2</sub>	100	1	3	3	2	4	-	-	-	1	1	
Gasoline	C <sub>5</sub> H <sub>12</sub> - C <sub>12</sub> H <sub>26</sub>	100	2	1	3	1	3	3	2	-	1	1	
Glycerol	C <sub>3</sub> H <sub>8</sub> O <sub>3</sub>	100	1	1	3	1	1	1	1	2	1	1	
Heptane, normal	C <sub>7</sub> H <sub>16</sub>	100	2	1	1	1	2	1	2	4	1	1	
Hexane, n-	C <sub>6</sub> H <sub>14</sub>	100	2	1	2	1	2	1	2	4	1	1	
Hydrogen chloride	HCl	5	1	4	1	4	1	1	1	-	1	4	
Hydrogen chloride	HCl	concentrated	1	4	4	4	1	1	2	3	1	4	
Hydrogen peroxide	H <sub>2</sub> O <sub>2</sub>	3	1	3	1	1	1	1	1	-	1	3	
Hydrogen peroxide	H <sub>2</sub> O <sub>2</sub>	30	1	4	1	4	1	1	1	-	1	3	
Hydrogen sulfide	H <sub>2</sub> S	10	1	1	1	1	1	1	1	3	1	1	
Iodine, tincture of	I <sub>2</sub>		1	4	3	1	1	-	4	4	1	1	
Isopropyl alcohol	C <sub>3</sub> H <sub>8</sub> O	100	1	1	1	1	1	1	1	4	1	2	
Lactic acid	C <sub>3</sub> H <sub>6</sub> O <sub>3</sub>	3	1	3	1	2	1	1	2	-	1	1	
Magnesium chloride	MgCl <sub>2</sub>	10	1	1	1	1	1	1	1	1	1	1	
Mercuric chloride	HgCl <sub>2</sub>	10	1	4	1	3	1	1	1	1	1	4	
Mercury	Hg	100	1	1	1	1	1	1	1	3	1	3	
Methyl acetate	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	100	1	1	4	2	1	-	4	4	1	1	
Methyl alcohol	CH <sub>4</sub> O	100	1	2	4	1	1	3	1	3	1	1	
Methyl benzene	C <sub>7</sub> H <sub>8</sub>	100	3	1	4	1	3	4	4	4	1	1	
Methyl ethyl ketone (MEK)	C <sub>4</sub> H <sub>8</sub> O	100	1	1	4	1	1	4	4	4	1	1	
Methylene chloride	CH <sub>2</sub> Cl <sub>2</sub>	100	4	3	4	3	3	4	4	4	1	1	
Mineral oil	—	100	1	1	1	1	1	1	1	-	1	1	
Nitric acid	HNO <sub>3</sub>	10	1	4	1	4	1	1	1	-	1	3	
Nitric acid	HNO <sub>3</sub>	100	4	4	4	4	4	-	4	-	1	1	
Nitrobenzene	C <sub>6</sub> H <sub>5</sub> NO <sub>2</sub>	100	3	4	4	3	2	4	4	4	1	1	
Oleic acid	C <sub>18</sub> H <sub>34</sub> O <sub>2</sub>	100	1	1	1	2	1	-	1	-	1	1	
Oxalic acid	C <sub>2</sub> H <sub>2</sub> O <sub>4</sub> x 2H <sub>2</sub> O	100	1	3	1	4	1	1	1	1	1	1	
Ozone	O <sub>3</sub>	100	3	4	1	4	3	1	1	-	1	2	
Petroleum	—	100	1	1	3	1	1	1	1	3	1	1	
Phenol	C <sub>6</sub> H <sub>6</sub> O	10	1	4	4	4	1	4	1	3	1	1	
Phenol	C <sub>6</sub> H <sub>6</sub> O	100	2	4	4	4	1	3	4	3	1	1	
Phosphoric acid	H <sub>3</sub> PO <sub>4</sub>	20	1	4	2	4	1	-	-	-	1	4	
Phosphorus pentachloride	PCl <sub>5</sub>	100	-	4	4	4	1	-	4	4	1	1	
Potassium hydrogen carbonate	CHKO <sub>3</sub>	saturated	1	1	2	1	1	-	-	-	1	4	
Potassium hydroxide	KOH	30	1	1	4	3	1	1	1	1	1	4	

## Resistant at +20 °C

		Concentration	High Density Polyethylene	Polyamide	Polycarbonate	Polyoxymethylene	Polypropylene	Polysulfone	Polyvinyl chloride, hard	Polyvinyl chloride, weak	Polytetrafluorethylene	Aluminum
Medium	Formula	[%]	HDPE	PA	PC	POM	PP	PSU	PVC	PVC	PTFE	AL
- no data												
1 resistant												
2 practically resistant												
3 partially resistant												
4 not resistant												
Potassium hydroxide	KOH	50	1	1	4	3	1	1	1	1	1	4
Potassium nitrate	KNO <sub>3</sub>	10	1	1	1	1	1	-	-	-	1	1
Potassium permanganate	KMnO <sub>4</sub>	100	1	4	1	1	1	-	1	-	1	1
Pyridine	C <sub>5</sub> H <sub>5</sub> N	100	1	1	4	1	3	4	4	4	1	1
Resorcinol	C <sub>6</sub> H <sub>6</sub> O <sub>2</sub>	5	1	4	2	3	1	4	2	-	1	2
Silver nitrate	AgNO <sub>3</sub>	100	1	1	1	1	1	1	1	1	1	4
Sodium bisulfite	NaHSO <sub>3</sub>	10	1	1	2	4	1	-	-	-	1	1
Sodium carbonate	Na <sub>2</sub> CO <sub>3</sub>	10	1	1	1	1	1	-	-	-	1	3
Sodium chloride	NaCl	30	1	1	1	1	1	1	1	1	1	3
Sodium hydroxide	NaOH	30	1	1	4	1	1	1	1	1	1	4
Sodium hydroxide	NaOH	50	1	1	4	1	1	1	1	-	1	4
Sodium sulfate	Na <sub>2</sub> SO <sub>4</sub>	10	1	1	1	1	1	1	1	1	1	1
Spirits	C <sub>2</sub> H <sub>6</sub> O	96	1	1	1	1	1	1	1	3	1	1
Styrene	C <sub>8</sub> H <sub>8</sub>	100	4	1	4	1	3	-	4	4	1	1
Sulfuric acid	H <sub>2</sub> SO <sub>4</sub>	6	1	4	1	4	1	1	1	-	1	3
Sulfuric acid	H <sub>2</sub> SO <sub>4</sub>	fuming	4	4	4	4	4	4	4	4	1	3
Tallow	—	100	1	1	1	1	1	-	1	1	1	1
Tetrahydrofuran (THF)	C <sub>4</sub> H <sub>8</sub> O	100	3	1	4	1	3	4	4	4	1	1
Tetrahydronaphthalene	C <sub>10</sub> H <sub>12</sub>	100	3	1	4	1	4	4	4	4	1	1
Thionyl chloride	Cl <sub>2</sub> SO	100	4	4	4	2	4	4	4	4	1	3
Transformer oil	—	100	1	1	3	3	1	1	1	-	1	1
Trichloroethane	C <sub>2</sub> H <sub>3</sub> Cl <sub>3</sub>	100	3	3	4	2	4	4	4	4	1	4
Urea	CH <sub>4</sub> N <sub>2</sub> O	10	1	1	1	1	1	-	-	-	1	1
Urine	—	100	1	1	1	1	1	-	1	1	1	2
Vinegar	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	10	1	4	1	1	1	1	1	1	1	1
Vinegar	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	90	1	4	4	4	1	3	1	4	1	1
Wax	—	100	-	1	1		1	-	-	-	1	1
Wines	—	100	1	1	1	2	1	1	1	1	1	4
Xylene	C <sub>8</sub> H <sub>10</sub>	100	3	1	4	1	4	4	4	4	1	1
Zinc chloride	SnCl <sub>2</sub>	10	1	4	2	2	1	-	-	-	1	4

Fig. 11.4: Resistance data



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