Thermo Fisher Scientific

TH-641

Instruction Manual

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For Research Use Only. Not for use in diagnostic procedures.

Table of contents

This manual is a guide for the use of

Thermo Scientific TH-641 Titanium Swinging Bucket Ultraspeed Centrifuge Rotor

Data herein has been verified and is believed adequate for the intended use of the rotor. Because failure to follow the recommendations set forth in this manual could produce personal injury or property damage, always follow the recommendations set forth herein. Thermo Fisher Scientific does not guarantee results and assumes no obligation for the performance of rotors or other products that are not used in accordance with the instructions provided. This publication is not a license to operate under, nor a recommendation to infringe upon, any process patents.

Publications prior to the Issue Date of this manual may contain data in apparent conflict with that provided herein. Please consider all data in this manual to be the most current.

WARNING, CAUTION, and NOTE within the text of this manual are used to emphasize important and critical instructions.

WARNING informs the operator that injuries or material damage or contamination could occur.

CAUTION informs the operator that material damage could occur.

NOTE highlights essential information.

CAUTION and WARNING are accompanied by a hazard symbol and appear near the information they correspond to.

Important Safety Information

Certain potentially dangerous conditions are inherent to the use of all centrifuge rotors. To ensure safe operation of this rotor, anyone using it should be aware of all safe practices and take all precautions described below and throughout this manual.

WARNING

When using radioactive, toxic, or pathogenic materials, be aware of all characteristics of the materials and the hazards associated with them in the event leakage occurs during centrifugation. In the event of a rotor failure, neither the centrifuge nor the rotor can protect you from particles dispersed in the air. To protect yourself, we recommend additional precautions be taken to prevent exposure to these materials, for example, use of controlled ventilation or isolation areas.

Always be aware of the possibility of contamination when using radioactive, toxic, or pathogenic materials. Take all necessary precautions and use appropriate decontamination procedures if exposure occurs.

Never use any material capable of producing flammable or explosive vapors or creating extreme exothermic reactions.

Never exceed the maximum rated speed of the installed rotor. To do so can cause rotor failure.

Always reduce (derate) rotor speed as instructed in this manual whenever:

- the rotor speed/temperature combination exceeds the solubility of the gradient material and causes it to precipitate.
- the compartment load exceeds the maximum allowable compartment load specified (average fluid density is greater than 1.7 g/ml). See “Compartment Loads in Excess of Design Mass” on page 2-2.

Failure to reduce rotor speed under these conditions can cause rotor failure.

CAUTION

Do not expose the aluminum rotor components to: strong acids, bases, or alkaline laboratory detergents, liquid chlorine bleach, or salts (chlorides) of heavy metals such as cesium, lead, silver, or mercury. Use of these materials with aluminum can cause a chemical reaction that initiates corrosion.

Do not operate or precool a rotor at the critical speed, as this will have a detrimental effect on centrifuge component life. See "Critical Speed" on page 2-2.

Do not operate the rotor unless it is symmetrically balanced as described in this manual. Operating the rotor out of balance can cause damage to the centrifuge drive assembly.

Always maintain the rotor in the recommended manner. The rotor accessories must be clean and inspected prior to each run: do not use rotors showing signs of corrosion or cracking. See "CARE and MAINTENANCE" on page 5-1.

Do not autoclave or expose any aluminum rotor parts to temperatures in excess of 121°C.

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RUN PREPARATION

This chapter contains the information necessary to prepare a TH-641 Rotor for operation and includes important safety information.

Contents

This manual contains information required to operate and maintain the Thermo Scientific TH-641 Swinging Bucket Ultraspeed Centrifuge Rotor. If you require additional information regarding operation or maintenance, please contact Thermo Fisher Scientific for assistance. Contact the nearest Thermo Fisher Scientific office (see Appendix C: "Contact Information") or your local representative for Thermo Fisher Scientific products. Thermo Fisher Scientific product information is available on our internet web site at http:// www.thermo.com .

Rotor Description

The TH-641 Rotor is a titanium swinging bucket ultracentrifuge rotor that can produce up to six sets of data during a single run at speeds up to 41,000 rpm[1]. Each rotor bucket will hold a centrifuge tube having a nominal fluid capacity of 13.2 ml. The buckets are sealed during operation by a gasket and an aluminum bucket cap. The buckets are attach to the rotor body, each at its own numbered position. During a centrifuge run, the buckets swing out horizontally and return to a vertical position during deceleration. A disc with alternative black and reflective segments attach to the bottom of the rotor provides overspeed protection.

Rotor Specifications

Table 1-1. Rotor Specifications

Rotor Type	Swinging Bucket
Maximum Speed (rpm)	41,000*
Relative Centrifugal Force (RCF) at Maximum Speed	
- at $r_{maximum}$ 15.32 cm	287,660
- at $r_{average}$ 11.255 cm	211,333
- at $r_{minimum}$ 7.19 cm	135,005
K Factor at Maximum Speed	114
Critical Speed	3450 rpm
Number of Buckets	6
Bucket Capacity (Nominal)	13.2 ml**
Total Rotor Capacity (Nominal)	79.2 ml**
Tube Compartment Diameter	14 mm (0.5625 inches)
Tube Compartment Length (Nominal)	89 mm (3.50 inches)
Maximum Compartment Mass	16.4 g
Rotor Diameter	18.28 cm (7.2 inches)
Rotor Weight	5.6 kg (12.3 lbs)

*With tubes filled with a homogenous solution having an average density of 1.2 g/ml or less.

**Tube capacity is 11.3 ml with tubes filled to 2 mm to 3 mm of the top.

[1]Speed in revolutions per minute (rpm) is related to angular velocity, w, according to the following:

$$\omega = (\text{rpm})\left(\frac{2\pi}{60}\right) = (\text{rpm})(0.10472)$$

Where w = rad/s. All further references in this manual to speed will be designated as rpm.

Accessories

The accessories that are supplied with the TH-641 Rotor, Catalog No. 54295 are listed in Table 1-2.

Table 1-2. Accessories Supplied

Quantity	Catalog Number	Description
1 set of 6	08225	Titanium Rotor Buckets*
1	52243	Bucket Stand
1	51942	Rotor Stand
1	51353	Overspeed Decal, 41,000 rpm (extra)
1	65937	Vacuum Grease
1 set of 6	08232	Gaskets, Viton® (for rotor buckets)
1	61556	Lubricating Grease
1	08242	Instruction Manual
1	52384	Ultraspeed Centrifuge/Rotor Log Book

* The TH-641 Rotor is supplied with a set of six buckets. Upon opening this set of buckets, you may notice inconsistencies in the surface finish around the top of the buckets (some buckets may have a silver polished finish and others a grey painted finish). To ensure proper balance within each set of buckets, Sorvall machines the top of the bucket(s) as required. It is during this machining process that some of the paint is removed accounting for the inconsistencies in surface finish. This will not effect the performance nor corrosion resistance of the buckets.

The only tool that is not supplied with the rotor but is required to tighten the bucket caps is a standard screwdriver. This item can be ordered from Thermo Fisher Scientific, if desired. The catalog number for the screwdriver is PN 63112.

To order replacement parts or accessories, contact your local representative for Thermo Fisher Scientific products. Be sure to provide the catalog number and description of the item required, along with the rotor name and serial number when ordering

SPECIAL CONSIDERATIONS

This chapter contains the information necessary to prepare the TH-641 Rotor for operation and includes important safety information.

Contents

Compartment Loads in Excess of Design Mass

The maximum run speed of the TH-641 Rotor is based on the recommended design mass that has been established for this rotor, representing the maximum mass that can be carried in each rotor bucket at top speed. To prevent rotor failure, the total contents of each bucket (including bucket, specimen and tube) should not exceed the recommended figure unless the rotor speed is reduced proportionately.

Strict adherence to the maximum allowable compartment mass or reduced speed is required to prevent rotor failure. Observe the WARNING "Important Safety Information" on page P-iii in the front of this manual.

The design mass for each compartment of the TH-641 Rotor is 16.4 grams at 41,000 rpm. This figure is based on the use of a thinwall polyallomer tube filled with a liquid at 1.2 specific gravity.

If the actual load of your rotor is greater than the maximum load, use the following formula to determine the reduced speed:

$$\text{Reduced Speed} = \text{maximum Speed}\sqrt{\frac{\text{maximum load}}{\text{actual load}}}$$

maximum Speed	41,000
derated Speed	36,000

Critical Speed

CAUTION Do not operate or precool a rotor at the critical speed, as this will have a detrimental effect on centrifuge component life.

The critical speed is that speed at which any rotor imbalance will produce a driving frequency equal to the resonant frequency of the rotating system (that is, the rotor and the centrifuge drive). At this speed, the rotor may produce large amplitude vibrations which can be felt in the centrifuge frame. Mass imbalance will contribute to increased vibration intensity at the critical speed. Avoid operating the rotor at the critical speed, which is 3450 rpm for the TH-641 Rotor. Operation at the critical speed will have a detrimental effect on centrifuge component life. Observe the CAUTION on the Safety Information Page in the front of this manual.

Relative Centrifugal Force (RCF) Determination

Relative centrifugal force (RCF) refers to the force during centrifugation that moves the particulate outward from the center of rotation. This force is proportional to the radial distance and the square of the rotor speed. The RCF value, also known as g force, is determined by the following formula:

$$\text{RCF} = 11.17\,(r)\left(\frac{\text{rpm}}{1000}\right)^2$$

when r = the radius in centimeters from the centerline of the rotor to the point in the tube where RCF value is required

and rpm = the rotor speed in revolutions per minute

Figure 2-1 shows the minimum, average, and maximum radii of the TH-641. Table 2-1 gives the RCF value at each radius at speeds from 20 000 rpm to 41,000 rpm (in increments of 500 rpm). The RCF value at any other speed can be calculated by using the above formula.

Note The radii values given are the actual rotor specifications. These values do not take the thickness of the tube into consideration.

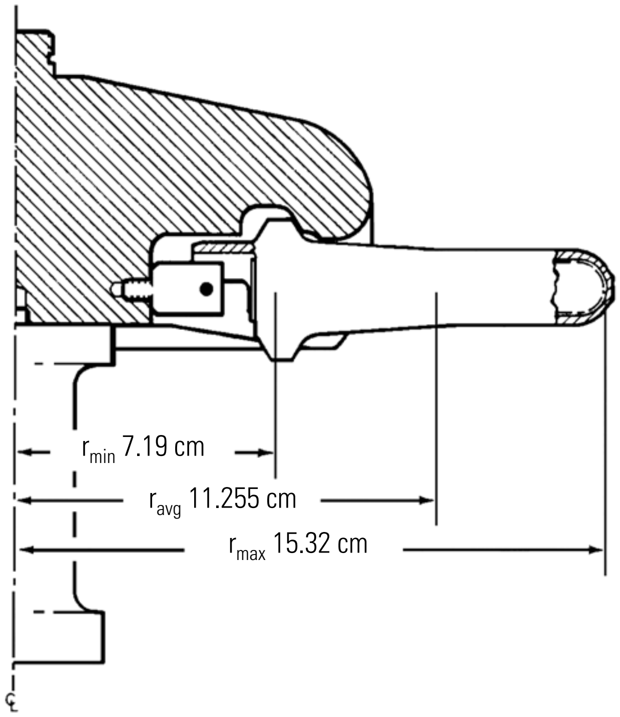

Figure 2-2. TH-641 Rotor Radii

Calculation of Sedimentation Time in Aqueous (Non-gradient) Solutions

The time required to sediment a particle in water at 20°C through the maximum rotor path length (that is, the distance between rminimum and rmaximum) can be calculated using the equation:

$$t = \frac{K}{S_{20},w}$$

where:

t = sedimentation time in hours
K = the clearing factor for the rotor (defined below)
S_{20}, w = the sedimentation coefficient for the particle of interest in water at 20°C as expressed in Svedbergs[1]

The clearing (or K) factor is defined by the equation:

$$K = (253000)\left[\ln\left(\frac{r_{maximum}}{r_{minimum}}\right)\right] \div \left(\frac{\text{rotor speed}}{1000}\right)^2$$

Where $r_{maximum}$ and $r_{minimum}$ are the maximum and minimum rotor radii, respectively, and rotor speed is expressed in rpm.

K factors for the TH-641 Rotor, at speeds from 20,000 rpm to 41,000 rpm (in increments of 500 rpm), have been listed in Table 2-1.

Example: The TH-641 Rotor has a K factor of 114 at the maximum permitted speed (41000rpm). If the particles to be sedimented have a sedimentation coefficient of 40S, the estimated run time required at maximum speed will be:

$$t = \frac{114}{40S} \quad 2.85 \text{ hours} = 2 \text{ hours, } 51 \text{ minutes}$$

Note that the calculation assumes particles in water at 20°C. If the suspending medium is denser or more viscous than water, the sedimentation time will be greater.

Calculation of Sedimentation Time in Gradient Solutions

The time required to sediment a particle through a 5% - 20% (w/w) sucrose density gradient at 5°C can be calculated using the following formula:

$$t = \frac{K}{S_{20},w}$$

where:

t = sedimentation time in hours

K = the clearing factor for the rotor (the value of K' is dependent on the gradient being used, the temperature of the gradient, and the density of the particle being sedimented).

S_{20}, w = the sedimentation coefficient for the particle of interest in water at 20°C as expressed in Svedbergs[1]

Table 2-2 gives K factors for the TH-641 Rotor when operated at maximum speed (that is, 41,000 rpm) with particles ranging in density from 1.1 g/cm^3 to 1.9 g/cm^3. The K factors are based on the use of a 5% - 20% (w/w) linear sucrose density gradient at 5°C.

Table 2-5. K Factor for the TH-641 Rotor (at maximum speed)

Particle Density (g/cm3)	K Factor
1.1	792
1.2	420

[1] The sedimentation coefficient (S) in seconds, for a particle in a centrifugal field is defined by the equation S = (dx/dt) [1/(ω^2x)]. Where dx/dt = sedimentation velocity of the particle in cm/s. ω = rotor speed in rad/s, and x = the distance of the particle from the axis of rotation in centimeters. Conventionally, experimentally determined values of sedimentation coefficients are multiplied by 10^{13} to convert them to Svedberg units (S), so a particle with an experimentally determined sedimentation coefficient of 10^{-11} seconds is usually referred to in the literature as a "100 S particle." Since the value determined for the sedimentation coefficient is dependent on the density and viscosity of the solution in which centrifugation is performed, values are usually reported for the standard conditions of infinite dilution in water at 20°C, and designated S_{20}, w.

Table 2-5. K Factor for the TH-641 Rotor (at maximum speed)

Particle Density (g/cm3)	K Factor
1.3	372
1.4	353
1.5	341
1.6	334
1.7	329
1.8	325
1.9	322

Precautions to Prevent Precipitation of Cesium Chloride

Observe the WARNING on reducing rotor speed found on the Safety Information Page in the front of this manual.

The maximum speed must be reduced for an average fluid density greater than 1.2 g/ml (square root reduction) to prevent excessive hydraulic pressure in a bucket. Although the standard formula (see Compartment Loads in Excess of Design Mass, page 2-2) pertains to sucrose and similar gradient materials, it will not prevent precipitation of heavy crystals when material such as cesium chloride (CsCl) is used in an ultracentrifuge. When solid, crystalline CsCl forms, it places a density of 4 g/ml at the bottom of each bucket. This density is dangerously high and can cause the rotor to fail, with subsequent sample loss. Therefore, cesium chloride solutions must be run at a reduced speed to avoid this precipitation.

The allowable speed is determined by the average density of the CsCl solution and the run temperature. Figure 2-2 should be used to determine the maximum operating speed. Curves are given for specific average densities and various percentage fills at 4°C and 20°C that will prevent both precipitation and excessive hydraulic pressure. Also, figure 2-2 includes a curve that shows the standard speed (square root) reduction to avoid excessive hydraulic pressure only. The standard, square root reduction formula cannot be used when precipitation of CsCl must be considered. For example, standard speed reduction would allow densities up to 1.56 g/ml at 36,000 rpm for a full tube. The dashed line for a full tube shows that precipitation will occur at this speed when the average density is higher than 1.28g/ml at 4°C.

The Gradient Shape

The curves in figure 2-3 show the gradient shape at equilibrium for tubes filled with CsCl solution, using the average density and speed selected from figure 2-2. The shape of a gradient produced in a partially-filled tube can be determined by using the lines shown for 3/4, 1/2 and 1/4 fills. For example, figure 2-2 indicates that a tube filled with a 1.5g/ml homogeneous CsCl solution cannot be run any faster than 25,000 rpm at 4°C. Figure 2-3 illustrates the gradient profile of this tube, 1.30g/ml at the meniscus to 1.81g/ml at the bottom of the tube. The same solution, 1.5g/ml, can be run at 28 500 rpm in a 3/4-filled tube. The shape of the gradient curve from figure 2-3 can be interpolated between the

25,000 rpm curve and the 30,000 rpm curve. This interpolation gives a gradient profile from approximately 1.28g/ml at the top of the gradient to 1.81g/ml at the bottom of the tube. In a half-filled tube, this solution can be run at 33,000 rpm and a 1/4-filled tube at 41,000 rpm.

Note The top portion of the fluid column in a partially-filled tube is assumed to have an overlay of 1.0g/ml density of less. (Polyallomer tubes must be filled to within 3mm of the top to prevent the tube from collapsing during centrifugation.)

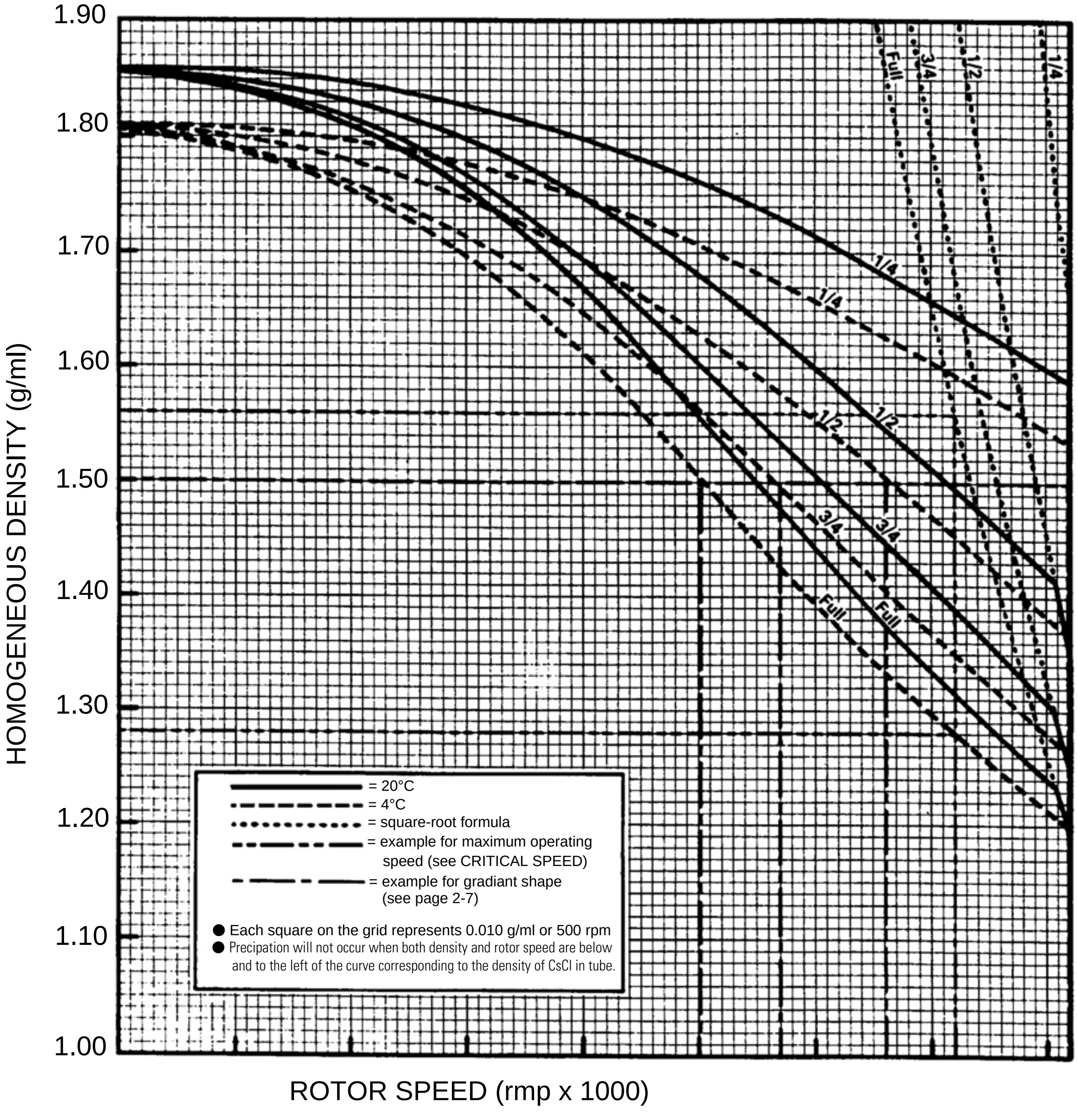

Figure 2-3. CsCl Precipitation Curves for the TH-641 Rotor

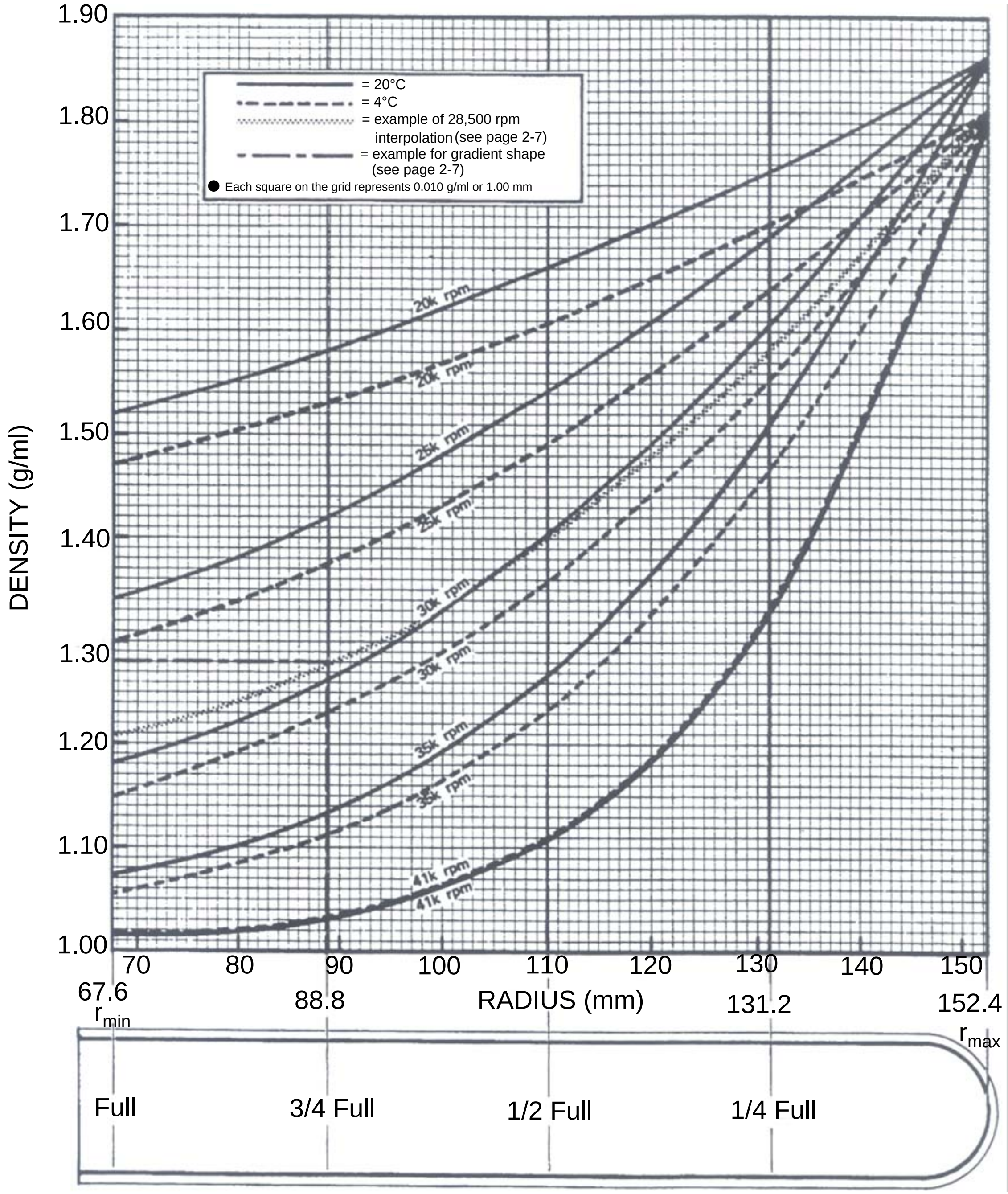

Figure 2-4. CsCl Gradient at Equilibrium

Chemical Compatibility

The critical components of the TH-641 Rotor apt to come in contact with solution are: rotor body and buckets (titanium) bucket caps (aluminum), gaskets (Viton®), plus the material of the tubes (or bottles) being used.

The chemical compatibility of rotor elements and accessory materials is given in the Appendix. Because no organized chemical resistance data exists for materials under the stress of centrifugation, this data is intended to be used only as a guide. When in doubt, we recommend pretesting of sample lots.

RUN PREPARATION

This chapter contains the information necessary to prepare the TH-641 Rotor for operation and includes important safety information.

Contents

Prerun Safety Checks

To ensure safe performance of the rotor, before every run you should:

- read the Safety Information Page in the front of this manual.
- make sure there are no burrs or scratches on the buckets and bucket seats or drive spindle.
- check the centrifuge chamber, drive spindle, and mounting surface of the rotor to be sure they are clean and free of scratches and burrs.
- make sure the buckets are properly seated on the support pins.
- Make sure there is only one gasket in each bucket. Inspect the gasket for cracks, tears, or abrasions. Replace if necessary.
- verify that the proper overspeed decal is firmly attached to the bottom of the rotor. The decal should have 22 black segments or if the rotor has been derated to 36,000 rpm 25 black segments (see page 3-4 for Overspeed Decal Replacement procedure).
- make sure that each bucket cap is on and properly tightened.
- check the chemical compatibility of all materials used (see Appendix).
- be sure that the proper environment has been selected for operation. For example, controlled ventilation or isolation, if required.
- check the top speed capability of the tube (or bottle) being used.

CAUTION When using a tube or bottle assembly other than those supplied by Thermo Fisher Scientific, be sure to check the top speed capability. When in doubt, do a test run for the desired application. If using a Thermo Scientific tube (or bottle) assembly other than those supplied with the rotor, refer to the Product Guide for the maximum speed. Exceeding the top speed capability of the tube (or bottle) can result in its breakage.

Rotor Precool

If samples are routinely processed around 4°C or below, the rotor should be stored in a refrigerator or a cold room. If this is not possible, the rotor can be precooled in a Thermo Scientific Ultracentrifuge. Refer to the ultracentrifuge instruction manual for precooling directions. Be careful not to precool the rotor at its critical speed (read paragraph on page 2-2, Critical Speed).

Tube Filling and Bucket Loading

1. Before every run, remove each bucket cap gasket and apply a thin film of silicone vacuum grease, Catalog No. 65937 to each one. Next, apply a thin film of lubricating grease, Catalog No. 61556

on the threads of the bucket cap. Reinstall the gaskets in the buckets. Be sure to seat them in their proper location (see figure 2-4).

Note Buckets are shipped with a gasket in place. It is not necessary to replace gasket before using bucket for the first time. Periodically check each bucket gasket for cracks, tears, or breaks and replace if necessary.

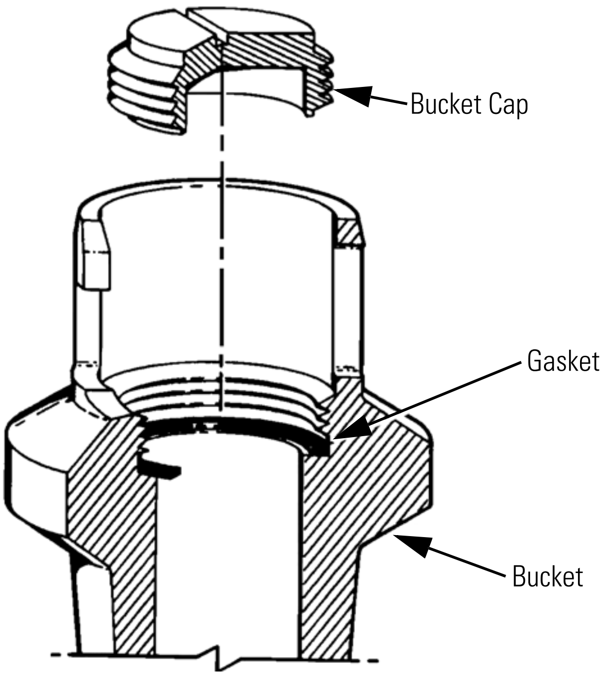

Figure 3-6. Bucket and Cap Assembly

2. Be sure that the outside of the tube and the inside of the bucket are completely dry.

Note Moisture between the tube and the bucket can cause a difficult-to-break vacuum seal to form during centrifugation and can cause the tubes to collapse.

CAUTION Correct balance is essential for swinging bucket ultracentrifuge rotors. The loaded buckets (including tube, bucket cap and sample) must match within 0.1 gram. If not, rotor imbalance with subsequent damage to the rotor chamber may result.

3. Fill each tube to within 3 mm (1/8 inch) from the top to prevent the tube from collapsing during centrifugation. If the sample does not fill the tube to this level, add a light mineral oil above the sample or a dense, inert liquid below it.
4. Hold the rotor bucket in an upright position and insert the tube into the bucket.
5. Seal the bucket by screwing the bucket cap on tightly.

Rotor Balancing

CAUTION For proper rotor balance, always install empty buckets in all unused bucket positions.
Buckets must be attached to the rotor body at the bucket position with the number that matches that on the bucket.
For maximum rotor and bucket life, you should always use the same set of buckets with the same rotor body. Failure to do so invalidates the rotor warranty.

Always balance the rotor according to the following criteria:

a. observe the CAUTION on the Safety Information Page in the front of this manual.

b. when the rotor is used with less than the full capacity, it must be balanced for proper operation.

c. use identically loaded buckets in groups of two, three, or four, with the same type of tube in each bucket. The loaded buckets must be symmetrically positioned as shown in figure 2-5. Empty buckets must be placed in the remaining positions.

To attach the buckets to the rotor:

1. Hold each loaded bucket vertically with the mounting hook opening facing the rotor body. Gently slide it up into the proper (matching number) bucket position on the rotor body and onto the mounting pin.
2. Lower the bucket until the two hooks on the bucket engage the pin on the rotor body.

Note Buckets should hang freely and vertically with bottoms even.

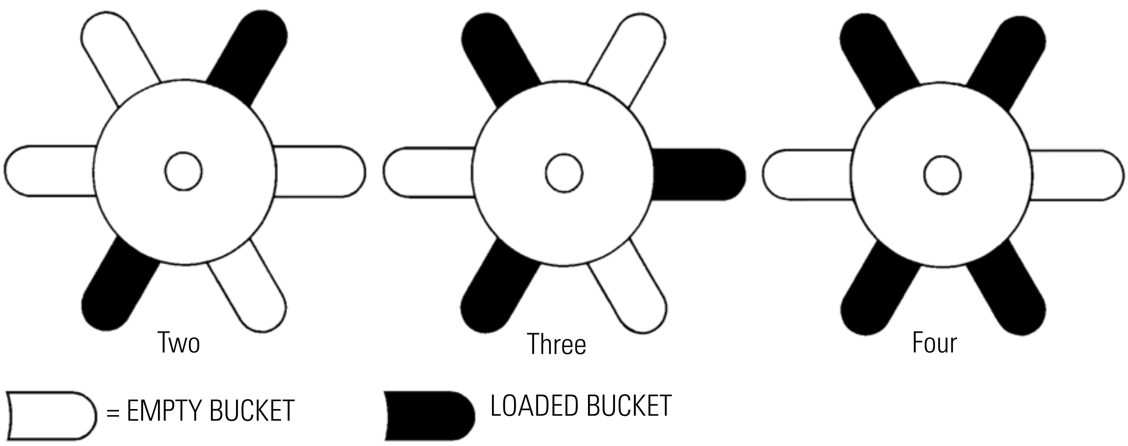

Figure 3-7. Rotor Balancing

Note When loading only three buckets, all three must be equally balanced.

Rotor Installation

To install the rotor in the centrifuge:

1. Carry the rotor carefully, with both hands placed firmly around the rotor body (do not carry the rotor by the pedestal). Then carefully lower it onto the drive spindle smoothly and vertically..

> **Note** Be careful not to bump the buckets against any object. If the buckets are jarred, check them to be sure no fluid has spilled between the tubes and the buckets. Then recheck the bucket seating.

2. Be sure the rotor seats fully and snaps in place on the drive spindle. Check the seating, lift the rotor slightly. There should be some resistance.
3. When the rotor is seated, recheck the buckets to be sure they are free swinging and still engaged on their hooks.

Perform the centrifuge run as explained in the centrifuge instruction manual.

Centrifuge/Rotor Log Book

A Centrifuge/Rotor Log Book is supplied with the TH-641 Rotor so that you can easily record all data necessary to meet the warranty stipulation that any defective ultracentrifuge rotor (or ultracentrifuge) returned to Thermo Fisher Scientific must be accompanied by an up-to-date history of the rotor (see the Warranty Statement in the Appendix).

Each time the TH-641 Rotor is used, record the run in the log book. If desired, the information may be recorded elsewhere, however, it must include all data as shown in Figure 2-6, Sample Centrifuge/ Rotor Log Sheet.

Thermo Scientific Centrifuge and Rotor Log Book					RUN TIME (List by Rotor Used)								This log is for use with one centrifuge ONLY:
					Rotor S/N	AH-629 8731384	Rotor S/N	TV-865 9130129	Rotor S/N	T-1270 8931255	Rotor S/N	T-880 9030040	Model: ULTRA 80 Ser. No.: 9102448
Date	Operator	Rev. Count @ Run Start	TEMP	SPEED	HRS	MIN	HRS	MIN	HRS	MIN	HRS	MIN	Remarks*
09/04/91	J. JONES	00410290	4	57.0			05	30					PLASMID PREP.
09/05/91	B. SMITH	00429100	4	21.0	26	00							SUCROSE GRADIENT
09/07/91	J. JONES	00461860	21	70.0					18	00			LIPOPROTEIN SEP.

Figure 3-8. Sample Centrifuge/Rotor Log Sheet

Chemical Compatibility Chart

CHEMICAL	ALUMINUM	ANODIC COATING for ALUMINUM	BUNA N	CELLULOSE ACETATE BUTYRATE	POLYURETHANE ROTOR PAINT	COMPOSITE Carbon Fiber/Epoxy	DELRIN®	ETHYLENE PROPYLENE	GLASS	NEOPRENE	NORYL®	NYLON	PET*, POLYCLEAR®, CLEARCRIMP® CCCLEARCRIMP®	POLYALLOMER	POLYCARBONATE	POLYESTER, GLASS THERMOSET	POLYTHERMIDE	POLYRTHYLENE	POLYPROPYLENE	POLYSULFONE	POLYVINYL CHLORIDE	RULON A®, TEFLON®	SILICONE RUBBER	STAINLESS STEEL	TITANIUM	TYGON®	VITON®
2-mercaptoethanol	S	S	U	-	S	M	S	-	S	U	S	S	U	S	S	-	S	S	S	S	U	S	S	S	S	S	S
Acetaldehyde	S	-	U	U	-	-	-	M	-	U	-	-	-	M	U	U	U	M	M	-	M	S	U	-	S	-	U
Acetone	M	S	U	U	S	U	M	S	S	U	U	S	U	S	U	U	U	S	S	U	U	S	M	M	S	U	U
Acetonitrile	S	S	U	-	S	M	S	-	S	S	U	S	U	M	U	U	-	S	M	U	U	S	S	S	S	U	U
Alconox®	U	U	S	-	S	S	S	-	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S	S	S	S	U
Allyl Alcohol	-	-	-	U	-	-	S	-	-	-	-	S	-	S	S	M	S	S	S	-	M	S	-	-	S	-	-
Aluminum Chloride	U	U	S	S	S	S	U	S	S	S	S	M	S	S	S	S	-	S	S	S	S	S	M	U	U	S	S
Formic Acid (100%)	-	S	M	U	-	-	U	-	-	-	-	U	-	S	M	U	U	S	S	-	U	S	-	U	S	-	U
Ammonium Acetate	S	S	U	-	S	S	S	-	S	S	S	S	S	S	S	U	-	S	S	S	S	S	S	S	S	S	S
Ammonium Carbonate	M	S	U	S	S	S	S	S	S	S	S	S	S	S	U	U	-	S	S	S	S	S	S	M	S	S	S
Ammonium Hydroxide (10%)	U	U	S	U	S	S	M	S	S	S	S	S	-	S	U	M	S	S	S	S	S	S	S	S	S	M	S
Ammonium Hydroxide (28%)	U	U	S	U	S	U	M	S	S	S	S	S	U	S	U	M	S	S	S	S	S	S	S	S	S	M	S
Ammonium Hydroxide (conc.)	U	U	U	U	S	U	M	S	-	S	-	S	U	S	U	U	S	S	S	-	M	S	S	S	S	-	U
Ammonium Phosphate	U	-	S	-	S	S	S	S	S	S	S	S	-	S	S	M	-	S	S	S	S	S	S	M	S	S	S
Ammonium Sulfate	U	M	S	-	S	S	U	S	S	S	S	S	S	S	S	S	-	S	S	S	S	S	S	U	S	S	U
Amyl Alcohol	S	-	M	U	-	-	S	S	-	M	-	S	-	M	S	S	S	S	M	-	-	-	U	-	S	-	M
Aniline	S	S	U	U	S	U	S	M	S	U	U	U	U	U	U	U	-	S	M	U	U	S	S	S	S	U	S
Sodium Hydroxide (<1%)	U	-	M	S	S	S	-	-	S	M	S	S	-	S	M	M	S	S	S	S	S	S	M	S	S	-	U
Sodium Hydroxide (10%)	U	-	M	U	-	-	U	-	M	M	S	S	U	S	U	U	S	S	S	S	S	S	M	S	S	-	U
Barium Salts	M	U	S	-	S	S	S	S	S	S	S	S	S	S	S	M	-	S	S	S	S	S	S	M	S	S	S
Benzene	S	S	U	U	S	U	M	U	S	U	U	S	U	U	U	M	U	M	U	U	U	S	U	U	S	U	S
Benzyl Alcohol	S	-	U	U	-	-	M	M	-	M	-	S	U	U	U	U	U	U	U	-	M	S	M	-	S	-	S
Boric Acid	U	S	S	M	S	S	U	S	S	S	S	S	S	S	S	S	U	S	S	S	S	S	S	S	S	S	S

CHEMICAL / MATERIAL	ALUMINUM	ANODIC COATING for ALUMINUM	BUNA N	CELLULOSE ACETATE BUTYRATE	POLYURETHANE ROTOR PAINT	COMPOSITE Carbon Fiber/Epoxy	DELRIN®	ETHYLENE PROPYLENE	GLASS	NEOPRENE	NORYL®	NYLON	PET*, POLYCLEAR®, CLEARCRIMP®CCCLEARCRIMP®	POLYALLOMER	POLYCARBONATE	POLYESTER, GLASS THERMOSET	POLYTHERMIDE	POLYRTHYLENE	POLYPROPYLENE	POLYSULFONE	POLYVINYL CHLORIDE	RULON A®, TEFLON®	SILICONE RUBBER	STAINLESS STEEL	TITANIUM	TYGON®	VITON®
Cesium Acetate	M	-	S	-	S	S	S	-	S	S	S	S	-	S	S	-	-	S	S	S	S	S	S	M	S	S	S
Cesium Bromide	M	S	S	-	S	S	S	-	S	S	S	S	S	S	S	-	-	S	S	S	S	S	S	M	S	S	S
Cesium Chloride	M	S	S	U	S	S	S	-	S	S	S	S	S	S	S	-	-	S	S	S	S	S	S	M	S	S	S
Cesium Formate	M	S	S	-	S	S	S	-	S	S	S	S	S	S	S	-	-	S	S	S	S	S	S	M	S	S	S
Cesium Iodide	M	S	S	-	S	S	S	-	S	S	S	S	S	S	S	-	-	S	S	S	S	S	S	M	S	S	S
Cesium Sulfate	M	S	S	-	S	S	S	-	S	S	S	S	S	S	S	-	-	S	S	S	S	S	S	M	S	S	S
Chloroform	U	U	U	U	S	S	M	U	S	U	U	M	U	M	U	U	U	M	M	U	U	S	U	U	U	M	S
Chromic Acid (10%)	U	-	U	U	S	U	U	-	S	S	S	U	S	S	M	U	M	S	S	U	M	S	M	U	S	S	S
Chromic Acid (50%)	U	-	U	U	-	U	U	-	-	-	S	U	U	S	M	U	M	S	S	U	M	S	-	U	M	-	S
Cresol Mixture	S	S	U	-	-	-	S	-	S	U	U	U	U	U	U	-	-	U	U	-	U	S	S	S	S	U	S
Cyclohexane	S	S	S	-	S	S	S	U	S	U	S	S	U	U	U	M	S	M	U	M	M	S	U	M	M	U	S
Deoxycholate	S	S	S	-	S	S	S	-	S	S	S	S	S	S	S	-	-	S	S	S	S	S	S	S	S	S	S
Distilled Water	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Dextran	M	S	S	S	S	S	S	-	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	M	S	S	S
Diethyl Ether	S	S	U	U	S	S	S	U	S	U	U	S	U	U	U	U	U	U	U	U	U	S	S	S	S	M	U
Diethyl Ketone	S	-	U	U	-	-	M	-	S	U	-	S	-	M	U	U	U	M	M	-	U	S	-	-	S	U	U
Diethylpyrocarbonate	S	S	U	-	S	S	S	-	S	S	U	S	U	S	U	-	-	S	S	S	M	S	S	S	S	S	S
Dimethylsulfoxide	S	S	U	U	S	S	S	-	S	U	S	S	U	S	U	U	-	S	S	U	U	S	S	S	S	U	U
Dioxane	M	S	U	U	S	S	M	M	S	U	U	S	U	M	U	U	-	M	M	M	U	S	S	S	S	U	U
Ferric Chloride	U	U	S	-	-	-	M	S	-	M	-	S	-	S	-	-	-	S	S	-	-	-	M	U	S	-	S
Acetic Acid (Glacial)	S	S	U	U	S	S	U	M	S	U	S	U	U	U	U	U	M	S	U	M	U	S	U	U	S	-	U
Acetic Acid (5%)	S	S	M	S	S	S	M	S	S	S	S	S	M	S	S	S	S	S	S	S	M	S	S	M	S	S	M
Acetic Acid (60%)	S	S	U	U	S	S	U	-	S	M	S	U	U	M	U	S	M	S	M	S	M	S	M	U	S	M	U
Ethyl Acetate	M	M	U	U	S	S	M	M	S	S	U	S	U	M	U	U	-	S	S	U	U	S	M	M	S	U	U
Ethyl Alcohol (50%)	S	S	S	S	S	S	M	S	S	S	S	S	U	S	U	S	S	S	S	S	S	S	S	M	S	M	U
Ethyl Alcohol (95%)	S	S	S	U	S	S	M	S	S	S	S	S	U	S	U	-	S	S	S	M	S	S	S	U	S	M	U
Ethylene Dichloride	S	-	U	U	-	-	S	M	-	U	U	S	U	U	U	U	U	U	U	-	U	S	U	-	S	-	S
Ethylene Glycol	S	S	S	S	S	S	S	S	S	S	S	S	-	S	U	S	S	S	S	S	S	S	S	M	S	M	S
Ethylene Oxide Vapor	S	-	U	-	-	U	-	-	S	U	-	S	-	S	M	-	-	S	S	S	U	S	U	S	S	S	U
Ficoll-Hypaque®	M	S	S	-	S	S	S	-	S	S	S	S	-	S	S	-	S	S	S	S	S	S	S	M	S	S	S

CHEMICAL / MATERIAL	ALUMINUM	ANODIC COATING for ALUMINUM	BUNA N	CELLULOSE ACETATE BUTYRATE	POLYURETHANE ROTOR PAINT	COMPOSITE Carbon Fiber/Epoxy	DELRIN®	ETHYLENE PROPYLENE	GLASS	NEOPRENE	NORYL®	NYLON	PET*, POLYCLEAR®, CLEARCRIMP®CCCLEARCRIMP®	POLYALLOMER	POLYCARBONATE	POLYESTER, GLASS THERMOSET	POLYTHERMIDE	POLYRTHYLENE	POLYPROPYLENE	POLYSULFONE	POLYVINYL CHLORIDE	RULON A®, TEFLON®	SILICONE RUBBER	STAINLESS STEEL	TITANIUM	TYGON®	VITON®
Hydrofluoric Acid (10%)	U	U	U	M	-	-	U	-	-	U	U	S	-	S	M	U	S	S	S	S	M	S	U	U	U	-	-
Hydrofluoric Acid (50%)	U	U	U	U	-	-	U	-	-	U	U	U	U	S	U	U	U	S	S	M	M	S	U	U	U	-	M
Hydrochloric Acid (conc.)	U	U	U	U	-	U	U	M	-	U	M	U	U	M	U	U	U	-	S	-	U	S	U	U	U	-	-
Formaldehyde (40%)	M	M	M	S	S	S	S	M	S	S	S	S	M	S	S	S	U	S	S	M	S	S	S	M	S	M	U
Glutaraldehyde	S	S	S	S	-	-	S	-	S	S	S	S	S	S	S	-	-	S	S	S	-	-	S	S	S	-	-
Glycerol	M	S	S	-	S	S	S	S	S	S	S	S	S	S	S	S	-	S	S	S	S	S	S	S	S	S	S
Guanidine Hydrochloride	U	U	S	-	S	S	S	-	S	S	S	S	S	S	S	-	-	S	S	S	S	S	S	U	S	S	S
Haemo-Sol®	S	S	S	-	-	-	S	-	S	S	S	S	S	S	S	-	-	S	S	S	S	S	S	S	S	S	S
Hexane	S	S	S	-	S	S	S	-	S	S	U	S	U	M	U	S	S	U	S	S	M	S	U	S	S	U	S
Isobutyl Alcohol	-	-	M	U	-	-	S	S	-	U	-	S	U	S	S	M	S	S	S	-	S	S	S	-	S	-	S
Isopropyl Alcohol	M	M	M	U	S	S	S	S	S	U	S	S	U	S	U	M	S	S	S	S	S	S	S	M	M	M	S
Iodoacetic Acid	S	S	M	-	S	S	S	-	S	M	S	S	M	S	S	-	M	S	S	S	S	S	M	S	S	M	M
Potassium Bromide	U	S	S	-	S	S	S	-	S	S	S	S	S	S	S	S	S	S	S	-	S	S	S	M	S	S	S
Potassium Carbonate	M	U	S	S	S	S	S	-	S	S	S	S	S	S	U	S	S	S	S	S	S	S	S	S	S	S	S
Potassium Chloride	U	S	S	-	S	S	S	S	S	S	S	S	S	S	S	-	S	S	S	S	S	S	S	U	S	S	S
Potassium Hydroxide (5%)	U	U	S	S	S	S	M	-	S	S	S	S	-	S	U	S	S	S	S	S	S	S	M	U	M	S	U
Potassium Hydroxide (conc.)	U	U	M	U	-	-	M	-	M	S	S	-	U	M	U	U	U	S	M	-	M	U	-	U	U	-	U
Potassium Permanganate	S	S	S	-	S	S	S	-	S	S	S	U	S	S	S	M	-	S	M	S	U	S	S	M	S	U	S
Calcium Chloride	M	U	S	S	S	S	S	S	S	S	S	S	S	S	M	S	-	S	S	S	S	S	S	M	S	S	S
Calcium Hypochlorite	M	-	U	-	S	M	M	S	-	M	-	S	-	S	M	S	-	S	S	S	M	S	M	U	S	-	S
Kerosene	S	S	S	-	S	S	S	U	S	M	U	S	U	M	M	S	-	M	M	M	S	S	U	S	S	U	S
Sodium Chloride (10%)	S	-	S	S	S	S	S	S	-	-	-	S	S	S	S	S	-	S	S	S	S	-	S	S	M	-	S
Sodium Chloride (sat'd)	U	-	S	U	S	S	S	-	-	-	-	S	S	S	S	S	-	S	S	-	S	-	S	S	M	-	S
Carbon Tetrachloride	U	U	M	S	S	U	M	U	S	U	U	S	U	M	U	S	S	M	M	S	M	M	M	M	U	S	S
Aqua Regia	U	-	U	U	-	-	U	-	-	-	-	-	U	U	U	U	U	U	U	-	-	-	-	-	S	-	M
Solution 555 (20%)	S	S	S	-	-	-	S	-	S	S	S	S	S	S	S	-	-	S	S	S	-	S	S	S	S	S	S
Magnesium Chloride	M	S	S	-	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	M	S	S	S
Mercaptoacetic Acid	U	S	U	-	S	M	S	-	S	M	S	U	U	U	U	-	S	U	U	S	M	S	U	S	S	S	S
Methyl Alcohol	S	S	S	U	S	S	M	S	S	S	S	S	U	S	U	M	S	S	S	S	S	S	S	M	S	M	U
Methylene Chloride	U	U	U	U	M	S	S	U	S	U	U	S	U	U	U	U	U	M	U	U	U	S	S	M	U	S	U

CHEMICAL \ MATERIAL	ALUMINUM	ANODIC COATING for ALUMINUM	BUNA N	CELLULOSE ACETATE BUTYRATE	POLYURETHANE ROTOR PAINT	COMPOSITE Carbon Fiber/Epoxy	DELRIN®	ETHYLENE PROPYLENE	GLASS	NEOPRENE	NORYL®	NYLON	PET*, POLYCLEAR®, CLEARCRIMP®CCCLEARCRIMP®	POLYALLOMER	POLYCARBONATE	POLYESTER, GLASS THERMOSET	POLYTHERMIDE	POLYRTHYLENE	POLYPROPYLENE	POLYSULFONE	POLYVINYL CHLORIDE	RULON A®, TEFLON®	SILICONE RUBBER	STAINLESS STEEL	TITANIUM	TYGON®	VITON®
Methyl Ethyl Ketone	S	S	U	U	S	S	M	S	S	U	U	S	U	S	U	U	U	S	S	U	U	S	S	S	S	U	U
Metrizamide®	M	S	S	-	S	S	S	-	S	S	S	S	-	S	S	-	-	S	S	S	S	S	S	M	S	S	S
Lactic Acid (100%)	-	-	S	-	-	-	-	-	-	M	S	U	-	S	S	S	M	S	S	-	M	S	M	S	S	-	S
Lactic Acid (20%)	-	-	S	S	-	-	-	-	-	M	S	M	-	S	S	S	S	S	S	S	M	S	M	S	S	-	S
N-Butyl Alcohol	S	-	S	U	-	-	S	-	-	S	M	-	U	S	M	S	S	S	S	M	M	S	M	-	S	-	S
N-Butyl Phthalate	S	S	U	-	S	S	S	-	S	U	U	S	U	U	U	M	-	U	U	S	U	S	M	M	S	U	S
N, N-Dimethylformamide	S	S	S	U	S	M	S	-	S	S	U	S	U	S	U	U	-	S	S	U	U	S	M	S	S	S	U
Sodium Borate	M	S	S	S	S	S	S	S	S	S	S	U	S	S	S	S	-	S	S	S	S	S	S	M	S	S	S
Sodium Bromide	U	S	S	-	S	S	S	-	S	S	S	S	S	S	S	S	-	S	S	S	S	S	S	M	S	S	S
Sodium Carbonate (2%)	M	U	S	S	S	S	S	S	S	S	S	S	S	S	U	S	S	S	S	S	S	S	S	S	S	S	S
Sodium Dodecyl Sulfate	S	S	S	-	S	S	S	-	S	S	S	S	S	S	S	-	S	S	S	S	S	S	S	S	S	S	S
Sodium Hypochlorite (5%)	U	U	M	S	S	M	U	S	S	M	S	S	S	M	S	S	S	S	M	S	S	S	M	U	S	M	S
Sodium Iodide	M	S	S	-	S	S	S	-	S	S	S	S	S	S	S	-	-	S	S	S	S	S	S	M	S	S	S
Sodium Nitrate	S	S	S	-	S	S	S	S	S	S	S	S	S	S	S	S	-	S	S	S	S	S	U	S	S	S	S
Sodium Sulfate	U	S	S	-	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	M	S	S	S
Sodium Sulfide	S	-	S	S	-	-	-	S	-	-	-	S	S	S	U	U	-	-	S	-	-	-	S	S	M	-	S
Sodium Sulfite	S	S	S	-	S	S	S	S	M	S	S	S	S	S	S	M	-	S	S	S	S	S	S	S	S	S	S
Nickel Salts	U	S	S	S	S	S	-	S	S	S	-	-	S	S	S	S	-	S	S	S	S	S	S	M	S	S	S
Oils (Petroleum)	S	S	S	-	-	-	S	U	S	S	S	S	U	U	M	S	M	U	U	S	S	S	U	S	S	S	S
Oils (Other)	S	-	S	-	-	-	S	M	S	S	S	S	U	S	S	S	S	U	S	S	S	S	-	S	S	M	S
Oleic Acid	S	-	U	S	S	S	U	U	S	U	S	S	M	S	S	S	S	S	S	S	S	S	M	U	S	M	M
Oxalic Acid	U	U	M	S	S	S	U	S	S	S	S	S	U	S	U	S	S	S	S	S	S	S	S	U	M	S	S
Perchloric Acid (10%)	U	-	U	-	S	U	U	-	S	M	M	-	-	M	U	M	S	M	M	-	M	S	U	-	S	-	S
Perchloric Acid (70%)	U	U	U	-	-	U	U	-	S	U	M	U	U	M	U	U	U	M	M	U	M	S	U	U	S	U	S
Phenol (5%)	U	S	U	-	S	M	M	-	S	U	M	U	U	S	U	M	S	M	S	U	U	S	U	M	M	M	S
Phenol (50%)	U	S	U	-	S	U	M	-	S	U	M	U	U	U	U	U	S	U	M	U	U	S	U	U	U	M	S
Phosphoric Acid (10%)	U	U	M	S	S	S	U	S	S	S	S	U	-	S	S	S	S	S	S	S	S	S	U	M	U	S	S
Phosphoric Acid (conc.)	U	U	M	M	-	-	U	S	-	M	S	U	U	M	M	S	S	S	M	S	M	S	U	M	U	-	S
Physiologic Media (Serum, Urine)	M	S	S	S	-	-	S	-	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Picric Acid	S	S	U	-	S	M	S	S	S	M	S	U	S	S	S	U	S	S	S	S	U	S	U	M	S	M	S

CHEMICAL / MATERIAL	ALUMINUM	ANODIC COATING for ALUMINUM	BUNA N	CELLULOSE ACETATE BUTYRATE	POLYURETHANE ROTOR PAINT	COMPOSITE Carbon Fiber/Epoxy	DELRIN®	ETHYLENE PROPYLENE	GLASS	NEOPRENE	NORYL®	NYLON	PET*, POLYCLEAR®, CLEARCRIMP®CCCLEARCRIMP®	POLYALLOMER	POLYCARBONATE	POLYESTER, GLASS THERMOSET	POLYTHERMIDE	POLYRTHYLENE	POLYPROPYLENE	POLYSULFONE	POLYVINYL CHLORIDE	RULON A®, TEFLON®	SILICONE RUBBER	STAINLESS STEEL	TITANIUM	TYGON®	VITON®
Pyridine (50%)	U	S	U	U	S	U	U	-	U	S	S	U	U	M	U	U	-	U	S	M	U	S	S	U	U	U	U
Rubidium Bromide	M	S	S	-	S	S	S	-	S	S	S	S	S	S	S	-	-	S	S	S	S	S	S	M	S	S	S
Rubidium Chloride	M	S	S	-	S	S	S	-	S	S	S	S	S	S	S	-	-	S	S	S	S	S	S	M	S	S	S
Sucrose	M	S	S	-	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Sucrose, Alkaline	M	S	S	-	S	S	S	-	S	S	S	S	S	S	U	S	S	S	S	S	S	S	S	M	S	S	S
Sulfosalicylic Acid	U	U	S	S	S	S	S	-	S	S	S	U	S	S	S	-	S	S	S	-	S	S	S	U	S	S	S
Nitric Acid (10%)	U	S	U	S	S	U	U	-	S	U	S	U	-	S	S	S	S	S	S	S	S	S	M	S	S	S	S
Nitric Acid (50%)	U	S	U	M	S	U	U	-	S	U	S	U	U	M	M	U	M	M	M	S	S	S	U	S	S	M	S
Nitric Acid (95%)	U	-	U	U	-	U	U	-	-	U	U	U	U	M	U	U	U	U	M	U	U	S	U	S	S	-	S
Hydrochloric Acid (10%)	U	U	M	S	S	S	U	-	S	S	S	U	U	S	U	S	S	S	S	S	S	S	S	U	M	S	S
Hydrochloric Acid (50%)	U	U	U	U	S	U	U	-	S	M	S	U	U	M	U	U	S	S	S	S	M	S	M	U	U	M	M
Sulfuric Acid (10%)	M	U	U	S	S	U	U	-	S	S	M	U	S	S	S	S	S	S	S	S	S	S	U	U	U	S	S
Sulfuric Acid (50%)	M	U	U	U	S	U	U	-	S	S	M	U	U	S	U	U	M	S	S	S	S	S	U	U	U	M	S
Sulfuric Acid (conc.)	M	U	U	U	-	U	U	M	-	-	M	U	U	S	U	U	U	M	S	U	M	S	U	U	U	-	S
Stearic Acid	S	-	S	-	-	-	S	M	S	S	S	S	-	S	S	S	S	S	S	S	S	S	M	M	S	S	S
Tetrahydrofuran	S	S	U	U	S	U	U	M	S	U	U	S	U	U	U	-	M	U	U	U	U	S	U	S	S	U	U
Toluene	S	S	U	U	S	S	M	U	S	U	U	S	U	U	U	S	U	M	U	U	U	S	U	S	U	U	M
Trichloroacetic Acid	U	U	U	-	S	S	U	M	S	U	S	U	U	S	M	-	M	S	S	U	U	S	U	U	U	M	U
Trichloroethane	S	-	U	-	-	-	M	U	-	U	-	S	U	U	U	U	U	U	U	U	U	S	U	-	S	-	S
Trichloroethylene	-	-	U	U	-	-	-	U	-	U	-	S	U	U	U	U	U	U	U	U	U	S	U	-	U	-	S
Trisodium Phosphate	-	-	-	S	-	-	M	-	-	-	-	-	-	S	-	-	S	S	S	-	-	S	-	-	S	-	S
Tris Buffer (neutral pH)	U	S	S	S	S	S	S	-	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Triton X-100®	S	S	S	-	S	S	S	-	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Urea	S	-	U	S	S	S	S	-	-	-	-	S	S	S	M	S	S	S	S	-	S	S	S	M	S	-	S
Hydrogen Peroxide (10%)	U	U	M	S	S	U	U	-	S	S	S	U	S	S	S	M	U	S	S	S	S	S	S	M	S	U	S
Hydrogen Peroxide (3%)	S	M	S	S	S	-	S	-	S	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S	S	S
Xylene	S	S	U	S	S	S	M	U	S	U	U	U	U	U	U	M	U	M	U	U	U	S	U	M	S	U	S
Zinc Chloride	U	U	S	S	S	S	U	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	U	S	S	S
Zinc Sulfate	U	S	S	-	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Citric Acid (10%)	M	S	S	M	S	S	M	S	S	S	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S	S	S

*Polyethyleneterephthalate

Key

S Satisfactory

M = Moderate attack, may be satisfactory for use in centrifuge depending on length of exposure, speed involved, etc., suggest testing under actual conditions of use.

U Unsatisfactory, not recommended.

-- Performance unknown, suggest testing, using sample to avoid loss of valuable material.

Chemical resistance data is included only as a guide to product use. Because no organized chemical resistance data exists for materials under the stress of centrifugation, when in doubt we recommend pretesting sample lots.

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