



Thermo Fisher Scientific

TV-1665

Instruction Manual

11670-8

March 2010

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Release history: 11670-8 printed in March 2010.

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Table of contents

	Thermo Scientific TV-1665 Titanium Vertical Ultracentrifuge Rotor	iii
	Important Safety Information	iv
Chapter 1	DESCRIPTION	1-1
	Rotor Description	1-2
	Rotor Application	1-2
	Rotor Specifications	1-2
	Accessories	1-3
Chapter 2	RUN PREPARATION	2-1
	Prerun Safety Checks	2-2
	Rotor Holding Fixture	2-2
	Rotor Precool	2-3
	Chemical Compatibility	2-3
	Sample Preparation	2-3
Chapter 3	SPECIAL OPERATING CONSIDERATIONS	3-1
	Compartment Loads in Excess of Design Mass	3-2
	Precautions to Prevent Precipitation of Cesium Chloride	3-2
	Critical Speed	3-3
Chapter 4	CARE and MAINTENANCE	4-1
	Rotor Balancing	4-2
	Rotor Loading and Sealing	4-3
	Rotor Installation	4-5
	Acceleration and Deceleration	4-5
	Tube Removal	4-5
	Tube Trimmer Accessory (for use with Optional Tubes)	4-6
	Centrifuge/Rotor Log Book	4-6
Chapter 5	TECHNICAL NOTES	5-1
	Relative Centrifugal Force (RCF) Determination	5-2
	Calculation of Sedimentation Time in Aqueous (Non-gradient) Solutions	5-6
	Calculation of Sedimentation Time in Gradient Solutions	5-6
Chapter 6	DESCRIPTION	6-1
	Corrosion	6-2
	Cleaning and Decontamination	6-2
	Overspeed Decal Replacement	6-3
	Storage	6-3
	Inspection	6-3
	Service Decontamination Policy	6-4

Table of contents

Chemical Compatibility Chart	A-1
Contact Information	B-1

This manual is a guide for the use of

Thermo Scientific TV-1665 Titanium Vertical Ultracentrifuge 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.

NOTES, CAUTIONS, and WARNINGS within the text of this manual are used to emphasize important and critical instructions.

WARNING informs the operator of a hazard or unsafe practice that could result in personal injury, affect the operator's health, or contaminate the environment.

CAUTION informs the operator of an unsafe practice that could result in damage of equipment.

NOTE highlights essential information.



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

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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 Chapter 3, page 3-1.

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



CAUTION

Do not use aluminum rotor components with, or expose them to: strong acids, bases, or strong 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 Chapter 3, page 3-3.

Do not operate the rotor unless it is symmetrically balanced as described in Chapter 4, page 4-1. 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 Chapter 6, Care and Maintenance.

DESCRIPTION

This manual provides you with the information that you will need to operate and maintain your Thermo Fisher Scientific TV-1665 Vertical Ultracentrifuge Rotor. If you encounter any problem concerning either operation or maintenance that is not covered in the manual, contact Thermo Fisher Scientific for assistance. In the United States, telephone toll free 1-866-9THERMO. Outside the United States, contact your distributor or agent for Thermo Fisher Scientific products. Thermo Fisher Scientific product information is available on our internet web site at <http://www.thermo.com/centrifuge>.

Contents

- “Rotor Description” on page 1-2
- “Rotor Application” on page 1-2
- “Rotor Specifications” on page 1-2
- “Accessories” on page 1-3

Rotor Description

The TV-1665 Rotor assembly consists of sixteen sealing assemblies and a sixteen place compartment rotor body that is machined from a titanium forging for strength and corrosion resistance. The rotor has a black coating which provides surface protection and aids temperature regulation. The tube compartments are bored parallel to the rotor axis and, occasionally, are counterbored to achieve precision balance. A disc with alternative black and reflective segments is attached to the bottom of the rotor; this disc will prevent the rotor from being operated at a speed above the recommended maximum speed of the rotor.

Rotor Application

The TV-1665 Rotor is used in an ultracentrifuge, primarily for density gradient separations; the design of the vertical rotor allows these separations to be done in shorter times than the conventional fixedangle or swinging-bucket rotor. Specifically, the TV-1665 can be used for many isopycnic and some rate zonal applications. Proper operation of the TV-1665 Rotor may require the use of the automatic slow acceleration and deceleration controls that are standard on all Thermo Fisher Scientific Ultracentrifuges. Without the use of this feature, the gradient will orient and reorient too fast — the slow acceleration and slow deceleration prevents disturbance of the gradient.

Rotor Specifications

Table 1-1. Rotor Specifications

Rotor Type	Vertical
Maximum Speed (rpm)*	65 000**
Relative Centrifugal Force (RCF) at Max. Speed	
- at r_{maximum} 8.78 cm	414 357
- at r_{average} 8.12 cm	383 209
- at r_{minimum} 7.46 cm	352 062
K Factor at Maximum Speed	9.8
Number of Tube Compartments	16
Tube Compartment Diameter	13 mm (0.5 inch)
Tube Compartment Length	51 mm (2 inches)
ULTRACRIMP® Tube Volume (Nominal)	6.0 ml
Total Rotor Capacity (Nominal)	96.0 ml
Critical Speed	750 rpm
Maximum Compartment Mass	18.7 grams
Rotor Mass (Weight)	9.07 kg (20 lbs)

* Speed in revolutions per minute (rpm) is related to angular velocity, ω , according to the following:

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

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

**With tubes filled with a homogeneous solution having an average density of 1.7 g/ml or less.

Accessories

Accessories Supplied

The accessories that are supplied with the TV-1665 Rotor, Catalog No. 11665 (rotor with complete accessories) are listed in Table 1-2. Those items indicated by an asterisk (*) are not supplied with the TV-1665 Rotor, Catalog No. 11672, which is the rotor with basic accessories only..

Note In order to seal the ULTRACRIMP® Tubes supplied with the rotor (Catalog No. 11665) you must have an ULTRACRIMP® Sealing Tool (Catalog No. 03920) and a Tool Kit (Catalog No. 12770).

To order replacement accessories, telephone 1-800-522-7746 in the United States. Outside the United States contact your local representative, distributor, or agent for Thermo Fisher Scientific products. Be sure to provide a description of the part, catalog number, plus the rotor model and serial number.

Table 1-2.Accessories Supplied

Quantity	Catalog Number	Description
4	03945*	ULTRACRIMP® Tubes, Polyallomer, 6.0 ml (package of 50)**
16	03991*	Rotor Cap
2	03921*	Tube Rack, 4-place (1 pair)
1	12826*	Tube Removal Tool
1	51345	Overspeed Decal, 65 000 rpm (extra)
1	51942	Rotor Stand
1	61556	Lubricant
1	52384	Ultraspeed Centrifuge/Rotor Log Book
1	11670	Instruction Manual

* Not supplied with Catalog No. 11672 (rotor with basic accessories only).

** Each package of tubes is supplied with an equal number of tube caps and tube plugs.

Tool Kit, Catalog No. 12770

This kit is required for use with the TV-1665 Rotor when used with the ULTRACRIMP® Sealing System. Table 1-3 lists the items supplied in the Tool Kit. If you already have these tools, it is not necessary to order the kit. Any of the tools listed can be ordered individually; to do so, specify the catalog number given in the table.

Table 1-3.Tool Kit (Catalog No. 12770) for use with ULTRACRIMP® Tube Sealing System

Catalog Number	Description
52580	Torque Wrench, 3/8 inch drive
52882	Torque Wrench Socket, 7/16 inch
52540	Rotor Holding Fixture (with mounting screws)

Optional Sealing Assembly

If you prefer, you can use the TV-1665 with the optional sealing assembly which consists of a rotor body cap and a tube plug. When the cap is tightened, the tube plug is pushed into the tube to form the seal.

To use this style sealing assembly, you must purchase the TV-1665 Rotor with basic accessories only, Catalog No. 11672; a Tool Kit, Catalog No. 52598; the tubes; and all sealing assembly components listed in Table 1-4. Table 1-5 lists the components of the Tool Kit; any of the tools listed can also be purchased individually.

Table 1-4. Optional Multipiece Sealing Assembly Component

Catalog Number	Description
52521	Rotor Body Cap, Black (each); 16 required
52522*	Tube Plug, White (package of 8)
52387	Tube Trimmer
03127	Tube, Polyallomer (package of 25)

* White plugs are for use with polyallomer tubes only.

Table 1-5. Tool Kit (Catalog No. 52598) for use with Optional Sealing Assembly

Catalog Number	Description
52363	Body Cap Wrench
52540	Rotor Holding Fixture (with mounting screws)

RUN PREPARATION

This chapter contains the information necessary to prepare the TV-1665 Rotor for operation and includes important safety information.

Contents

- “Prerun Safety Checks” on page 2-2
- “Rotor Holding Fixture” on page 2-2
- “Rotor Precool” on page 2-3
- “Chemical Compatibility” on page 2-3
- “Sample Preparation” on page 2-3

Prerun Safety Checks

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

- a. read the Safety Information Page in the front of this manual.
- b. make sure each tube compartment is clean and that there is no sign of corrosion.
- c. be sure the rotor itself is clean and shows no sign of corrosion or cracking.
- d. check the centrifuge chamber and drive spindle to be sure they are clean and free of scratches and burrs.
- e. verify that the proper overspeed decal is firmly attached to the bottom of the rotor; the decal should have 14 black segments (see page 6-2 for Overspeed Decal Replacement procedure).
- f. check the chemical compatibility of all materials used (see Appendix A).
- g. be sure that the rotor caps (or body caps) are torqued to the recommended value (see page 4-1, Rotor Loading and Sealing).
- h. check that the rotor caps are properly installed.
- i. be sure the proper environment has been selected for operation; for example, controlled ventilation or isolation, if required.
- j. check the top speed capability of the tube being used.



CAUTION When using a tube or bottle assembly other than those supplied by Thermo Fisher Scientific, be sure to check its top speed capability; when in doubt, do a test run for the desired application. Exceeding the top speed capability of the tube or bottle assembly can result in its breakage.

Rotor Holding Fixture

The rotor holding fixture (Catalog No. 52540) is used to hold the rotor during the rotor loading and unloading procedures to prevent disturbance of the gradient.

Secure the fixture to a workbench with the two flathead screws supplied as shown in figure 2-1.

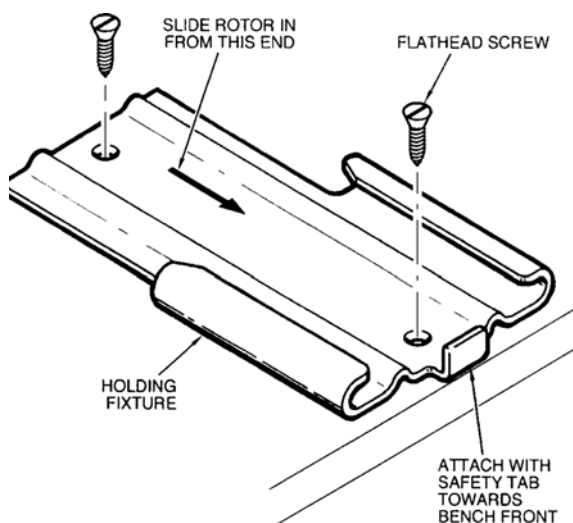


Figure 2-1. Rotor Holding Fixture Installation

Rotor Precool

If samples are routinely processed around 4°C or below, the rotor can be stored in a refrigerator or a cold room. If this is not possible, the rotor can easily be precooled in a Thermo Fisher Scientific Ultracentrifuge. Refer to the individual Thermo Fisher Scientific Ultracentrifuge Instruction Manual for precooling directions. Be careful not to precool the rotor at its critical speed (see page 3-3).

Chemical Compatibility

The critical components of the TV-1665 Rotor that are apt to come in contact with solution are: the rotor body (titanium), the tubes (polyallomer), and all sealing assembly components. ULTRACRIMP® sealing assembly components include: rotor caps and tube caps (aluminum) and the tube plugs (Buna N). Optional sealing assembly components include: tube plugs (Delrin®) and rotor body caps (aluminum).

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 to the selection of tube materials. When in doubt, we recommend pretesting of sample lots.

Sample Preparation

ULTRACRIMP® Tubes

Prepare the ULTRACRIMP® tubes for use following the tube filling procedure given in the ULTRACRIMP® Tube Sealing System Instruction Manual.

Optional Tubes (Catalog No. 03127)

When using tubes, Catalog No. 03127, each tube must contain a total of 4.4 ml of solution; the recommended capacity for each tube is: 4.0 ml of gradient, 0.2 ml of sample and 0.2 ml of overlay (for example, mineral oil).



CAUTION To prevent the tube from collapsing or leaking during centrifugation, each tube must always contain 4.4 ml of solution. Use a new tube for each operation — do not reuse these tubes.

SPECIAL OPERATING CONSIDERATIONS

Follow the instructions in this chapter if your sample has an average fluid density greater than 1.7 g/ml or if you are using a cesium chloride gradient. You may need to lower the speed of your run to reduce the stress on the rotor or to prevent cesium chloride from precipitating from solution.

Contents

- “Compartment Loads in Excess of Design Mass” on page 3-2
- “Precautions to Prevent Precipitation of Cesium Chloride” on page 3-2
- “Critical Speed” on page 3-3

Compartment Loads in Excess of Design Mass

A recommended design mass has been established for each ultracentrifuge rotor representing the maximum mass that each tube compartment can contain at top speed operation. To prevent rotor failure, the total contents of each compartment, including specimen, rotor cap, tube cap, tube plug, and the tube, should not exceed the recommended figure unless rotor speed is reduced proportionately. (If using the optional sealing assembly, include the weight of all components.)

Strict adherence to the maximum allowable compartment mass or reduced speed is required to prevent rotor failure. Read the WARNING.



WARNING Always reduce (derate) rotor speed as instructed whenever the compartment load exceeds the maximum compartment load specified. Failure to reduce rotor speed under these conditions can cause rotor failure, which may result in centrifuge damage or personal injury.

The design mass for each tube compartment of the TV-1665 Rotor is 18.7 grams at 65 000 rpm. This figure is based on the use of a thinwall polyallomer tube with a liquid at 1.7 specific gravity. If the density is greater than 1.7 g/ml, use the following formula to determine the reduced speed:

$$\text{Reduced Speed} = 65000 \sqrt{\frac{1.7}{\text{Average Fluid Density (g/ml)}}}$$

Refer to figures 3-1 for derating factors when using cesium chloride solutions.

Precautions to Prevent Precipitation of Cesium Chloride

Reducing Speed to Prevent Precipitation

Maximum speed must be reduced for an average fluid density greater than 1.7 g/ml (square-root reduction) to prevent excessive hydraulic pressure in a rotor. Although the standard formula 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 rotor.

When solid, crystalline CsCl forms, it places a density of 4 g/ml along the outside edge of each tube compartment. This density is dangerously high and can cause the rotor to fail, with subsequent sample loss. Therefore, cesium chloride solutions must be run at reduced speeds to avoid this precipitation. The allowable speed is determined by the average density of the CsCl solution and the run temperature. Figure 3-1 should be used to determine the maximum operating speed. Curves are given for specific average densities at 5°C and 25°C that will prevent precipitation. Also, figure 3-1 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 allows you to run a solution having a density of 1.77 g/ml at 53 500 rpm; however, you can see that a cesium chloride solution will precipitate at this speed. This graph shows that the highest speed you can run a cesium chloride solution of this density is 43 000 rpm at 25°C or 26 000 rpm at 5°C.

Note The solubility limit of cesium chloride in an aqueous solution is 1.86 g/ml at 25°C and 1.81 g/ml at 5°C.

The Gradient Shape

The curves in figures 3-2 and 3-3 show the gradient shape at equilibrium, 5°C and 25°C respectively, for tubes filled with a CsCl solution. Using the examples illustrated in figure 3-1, refer to figure 3-2 and 3-3 respectively to determine the shape of the gradient that will be formed at each speed. Interpolate to find gradient shapes at speeds other than those illustrated.

Effects of Temperature

Solubility limits of CsCl in aqueous solutions are temperature dependent. The solubility limit of 1.86 g/ml at 25°C becomes 1.81 g/ml at 5°C. The curve in figure 3-1 for a 5-degree run shows that the maximum speed a solution having a density of 1.77 g/ml can be run at is 26 000 rpm, or 17 000 rpm less than the speed allowed for the same density at 25°C. The maximum run speed for temperatures other than 5°C and 25°C can be determined by interpolation. Similarly, figures 3-2 and 3-3 show the gradient shapes at 25°C and 5°C. Again, interpolate to plot the gradient shapes at temperatures between 5°C and 25°C.

Effects of Reorientation

Figures 3-2, 3-3 and 3-4 can be used to determine the position a band of particles in the tube after reorientation. Following the same example given in paragraph c, Effects of Temperature, and using figure 3-2 for 25°C, locate the position of a band of particles after equilibrium, that have a density of 1.76 g/ml. Find 1.76 on the side scale (density, g/ml) and follow the line across until it intersects the curve for 43 000 rpm which, in this case will have to be interpolated. Then follow the line from the point to the bottom scale to determine the radius of the tube at this point...in this example it is 8.055 cm. Next, refer to figure 3-4 and find 8.05 cm on the side scale – follow the line across from this point until it intersects the curve; you'll find that the 8.05 cm radius corresponds to 2.33 ml of fluid. This means that there will be 2.33 ml of gradient above the band and 3.37 ml below the band; therefore, measuring from the top of the meniscus, the particles will be located at 41% of the fluid column.

To locate the position of a band of particles with the same density (1.76 g/ml) that were run at 5°C, use figure 3-3. You will find that the band is located at a radius of 7.95 cm, which on figure 3-4, corresponds to 1.71 ml of fluid, meaning there is 1.71 ml above the band and 3.99 ml below the band. Again, measuring from the top of the meniscus, the particles will now be located 30% of the fluid column.

Critical Speed

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 instrument frame. Mass imbalance will contribute to increased vibration intensity at the critical speed. Avoid operating the rotor at the critical speed, which is 750 rpm for the TV-1665 Rotor. Operation at the critical speed will have a detrimental effect on centrifuge component life. Read the CAUTION.



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

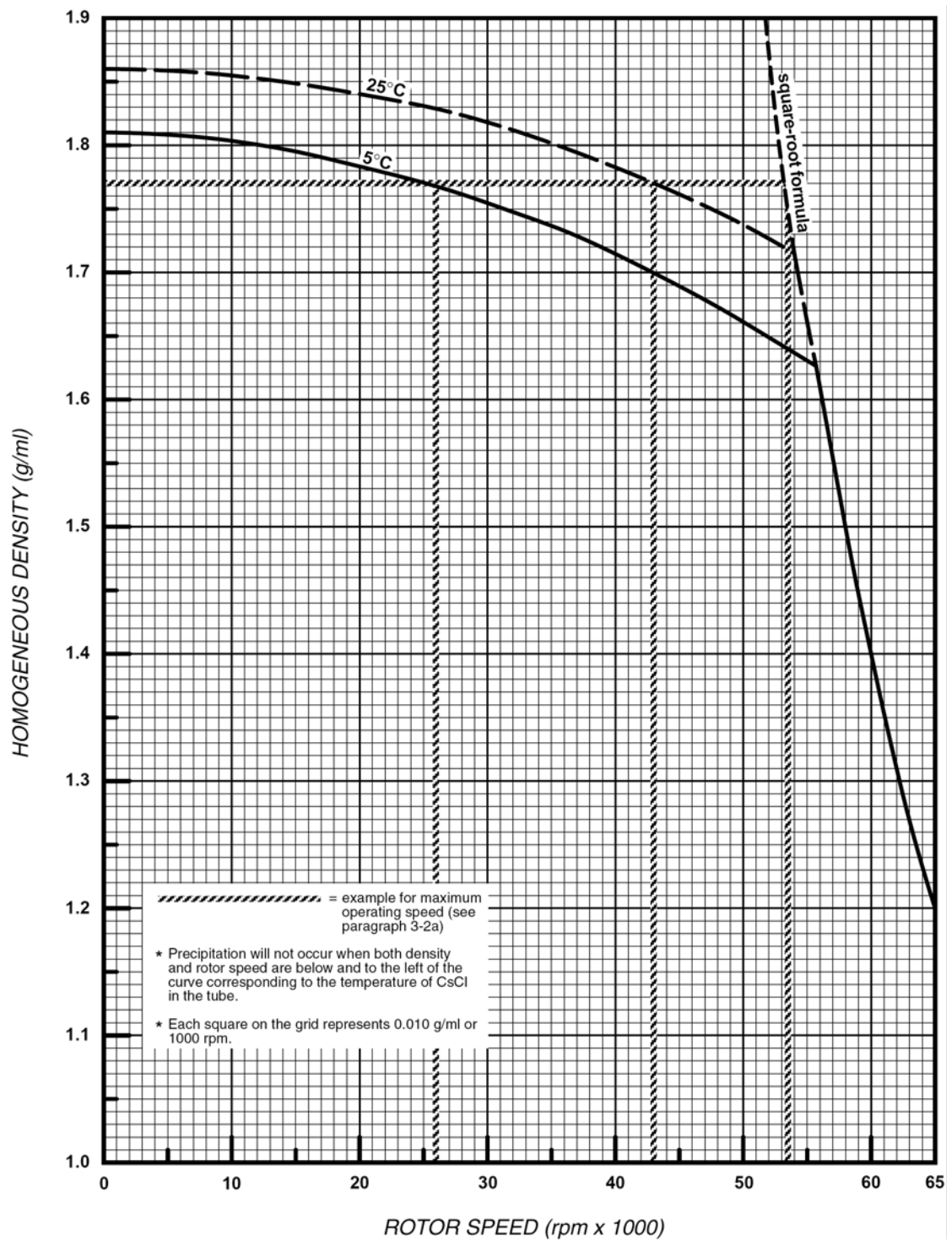


Figure 3-1. CsCl Precipitation Curves for TV-1665 Rotor

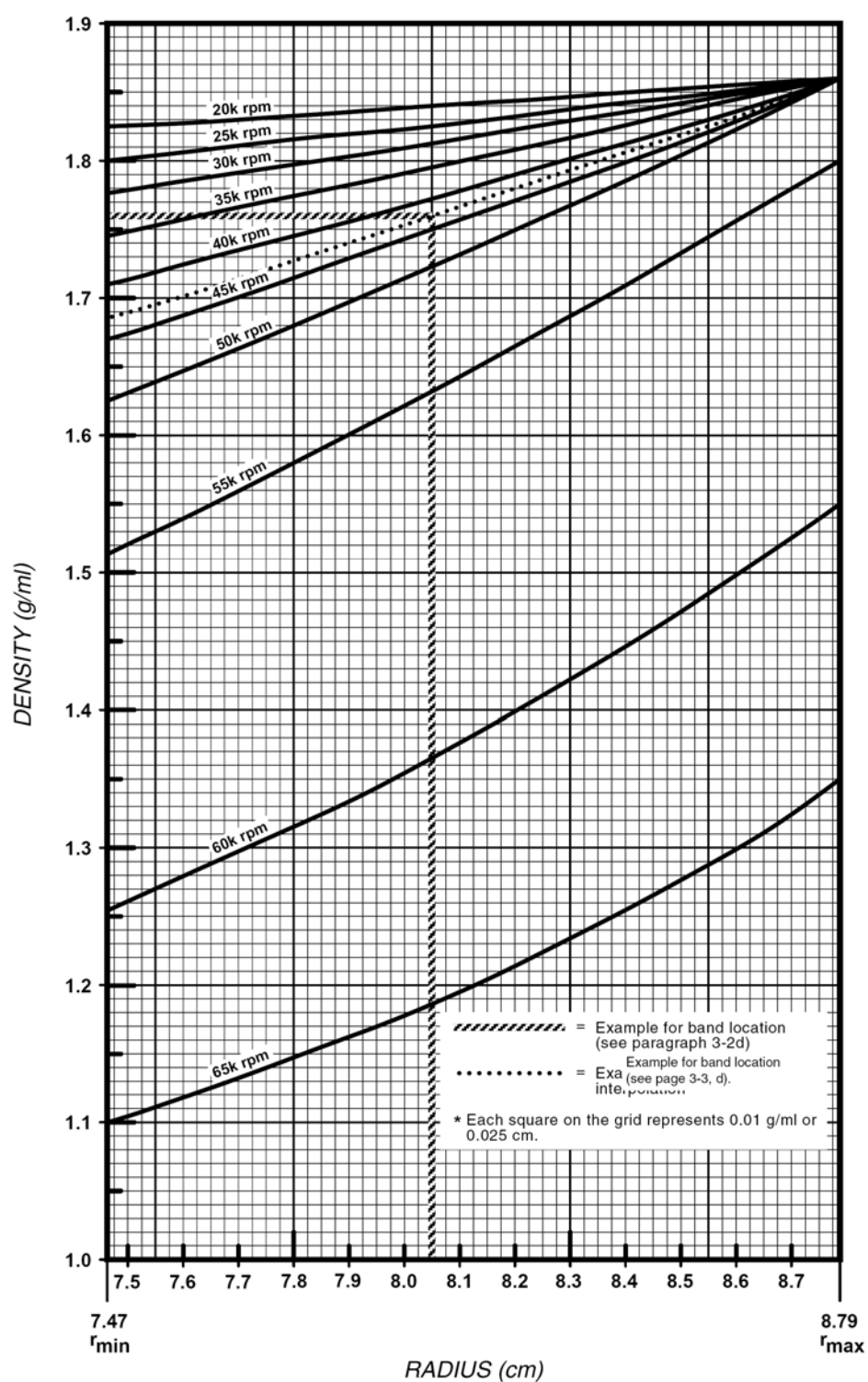


Figure 3-2. CsCl Density Gradient Shapes at Equilibrium (25°C)

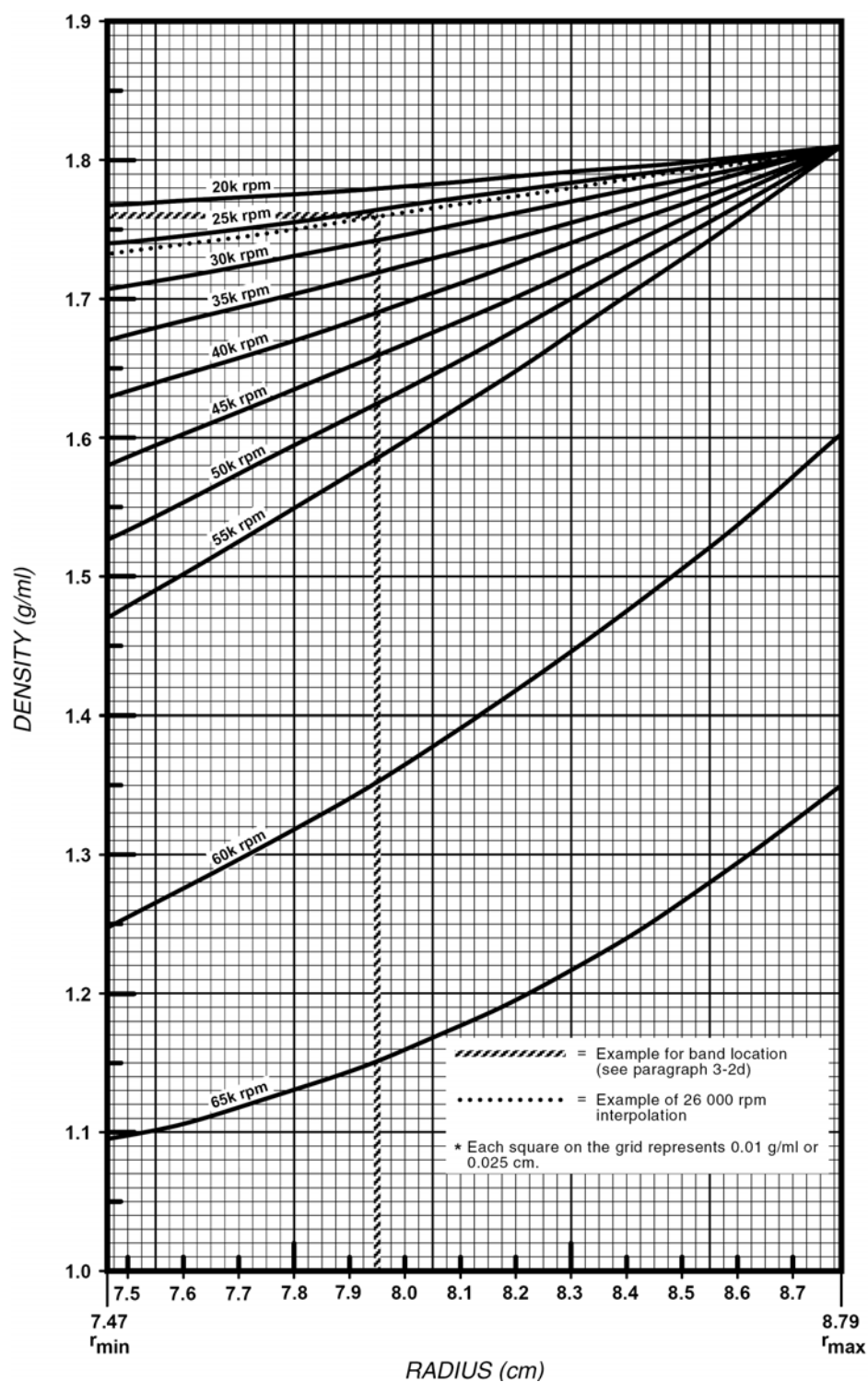


Figure 3-3. CsCl Density Gradient Shapes at Equilibrium (5°C)

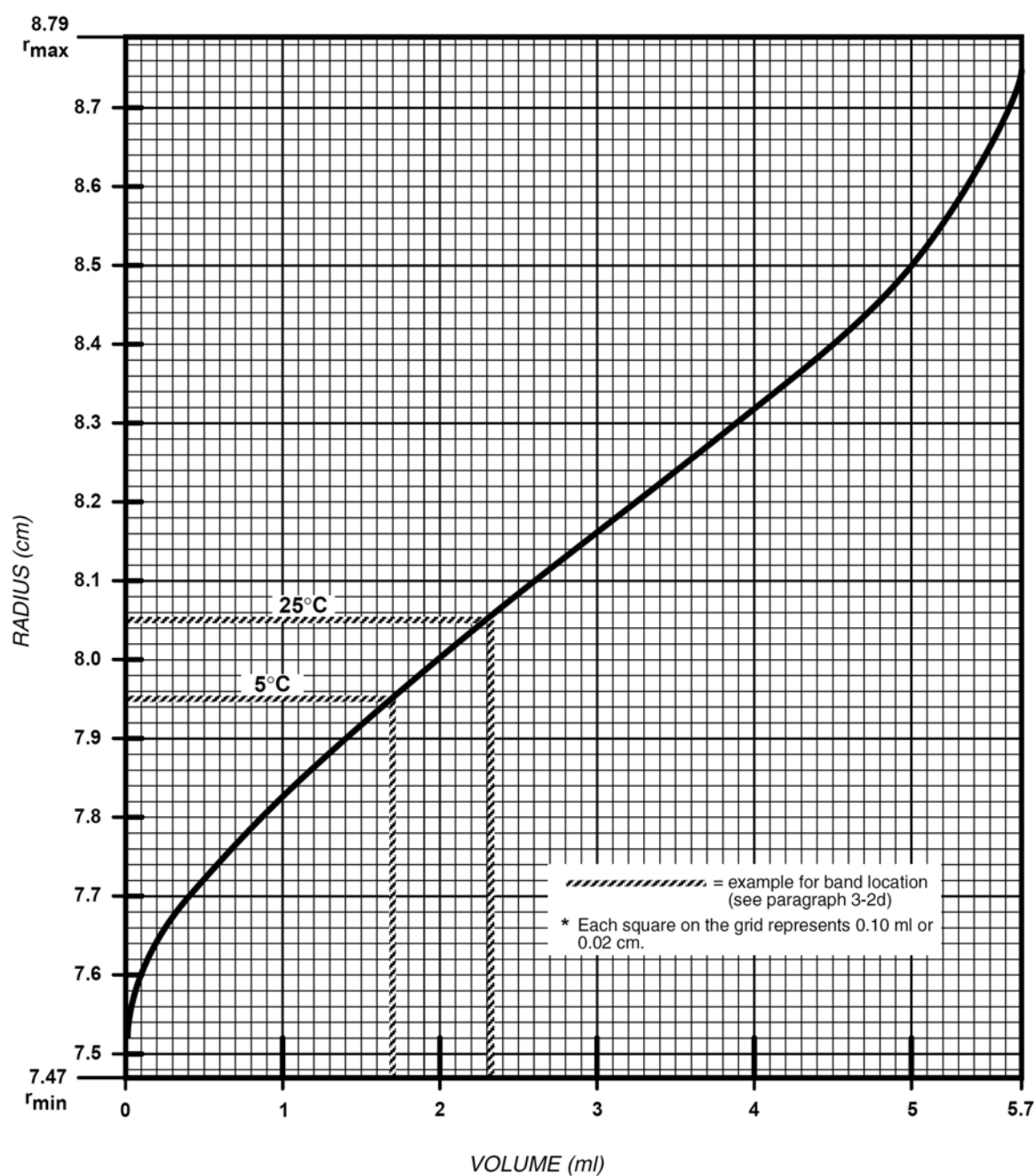


Figure 3-4. Band Location after Reorientation

CARE and MAINTENANCE

This chapter provides instructions on how to clean, decontaminate, and maintain your rotor. Always maintain the rotor in the recommended manner. Do not use rotors that show signs of corrosion or cracking.

Contents

- “Rotor Balancing” on page 4-2
- “Rotor Loading and Sealing” on page 4-3
- “Rotor Installation” on page 4-5
- “Acceleration and Deceleration” on page 4-5
- “Tube Removal” on page 4-5
- “Tube Trimmer Accessory (for use with Optional Tubes)” on page 4-6
- “Centrifuge/Rotor Log Book” on page 4-6

Rotor Balancing



WARNING The stresses that this rotor withstands during centrifugation eventually weaken the rotor body, increasing the possibility of rotor failure. For your safety, we recommend that this rotor be withdrawn from service after it has been used for 5000 runs. Failure to do so can cause rotor failure with subsequent sample loss and damage to the rotor and/or centrifuge. Also, if the material being processed is hazardous, the loss of sample can result in personal injury.

Always balance the rotor according to the following criteria:

- k. observe the CAUTION on the Safety Information Page in the front of this manual.
- l. pairs of tubes containing a sample fluid of identical specific gravity must be balanced to within 0.5 gram and placed in opposing rotor compartments.
- m. when using less than a full complement of sixteen tubes, the rotor can be operated at any speed up to its maximum speed with two, four, six, eight, ten, twelve, or fourteen samples; however, opposing pairs of tubes must be positioned as shown in figure 4-1.
- n. if an uneven number of samples is to be run, the odd sample must be counterbalanced with a tube that contains a solution of the same specific gravity.



CAUTION When the rotor is operated with two, four, six, eight, ten, twelve, or fourteen samples placed in opposing tube compartments, the remaining tube compartments must be empty. DO NOT put rotor caps (or body caps) in empty compartments.

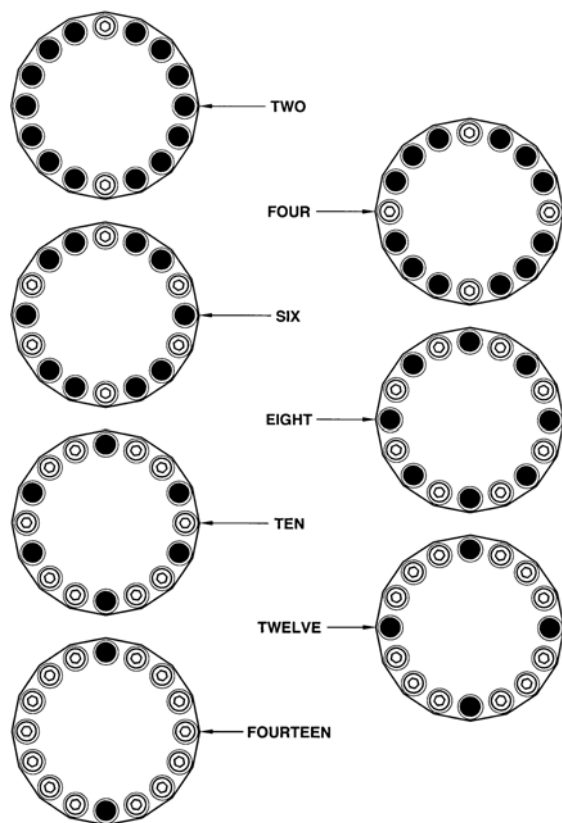


Figure 4-1. Rotor Balancing

Rotor Loading and Sealing

To be sure that each tube and tube compartment is properly sealed for operation, these instructions must be carefully followed.

If necessary, precool the rotor, rotor body caps, and tube plugs to the same temperature. Refer to the Thermo Fisher Scientific Ultracentrifuge Instruction Manual for precooling instructions.

Prepare samples according to the instructions on page 2-3, then load and seal the rotor as follows:

Using ULTRACRIMP® Tubes and Sealing System



CAUTION Inspect the counterbore area of each tube compartment before every operation — be sure there are no nicks or scratches and that the area is clean.

1. Place the rotor in the rotor holding fixture (Catalog No. 52540). Gently put filled tubes into the tube compartments, balancing the rotor as explained on page 4-1.
2. Apply a light coat of lubricant (Catalog No. 61556) to each rotor cap (Catalog No. 03991).
3. Place a rotor cap in each compartment that contains a filled tube.



CAUTION Do not put a rotor cap in an empty tube compartment. Rotor caps should only be installed in compartments that contain a filled tube.

4. Hand tighten each rotor cap.



CAUTION Do not undertighten or overtighten the rotor caps. Always use a torque value not less than 180 in lbs (20.3 N•m) or greater than 200 in lbs (22.6 N•m).

5. Using torque wrench (Catalog No. 52580) with the 7/16 inch socket (Catalog No. 52882), tighten each rotor cap to 180 in lbs (20.3 N•m).

Using Optional Sealing Assembly

1. Place the rotor in the rotor holding fixture with compartment #1 or #9 facing you.



CAUTION When using Catalog No. 03127 tubes, each one must contain 4.4 ml of solution to prevent it from collapsing or leaking during centrifugation.

2. Gently put the filled tubes into the the rotor tube compartments.
3. Place a tube plug into the top of each tube in the rotor.



CAUTION To ensure a proper seal use only white tube plugs (Catalog No. 52522) with polyallomer tubes only.

4. Apply a thin coat of lubricant (Catalog No. 61556), to the threads of the rotor body caps, then place a body cap into each tube compartment containing a filled tube.



CAUTION Do not put a rotor cap in an empty tube compartment. Rotor caps should only be installed in compartments that contain a filled tube.

5. Using the body cap wrench (Catalog No. 52363), tighten each body cap firmly into the rotor body.

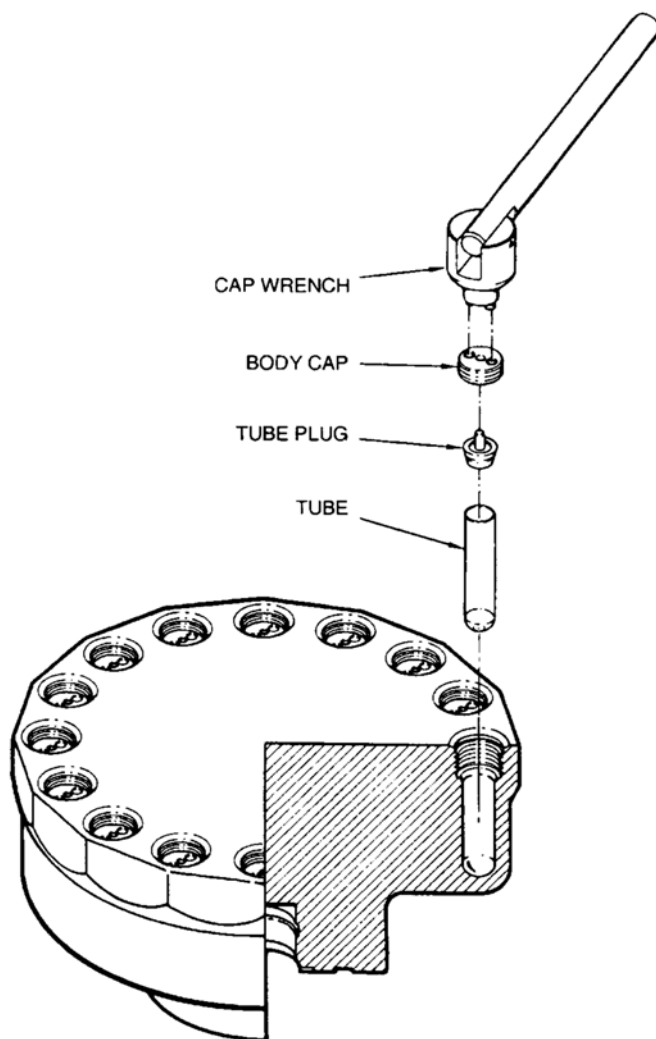


Figure 4-2. Optional Sealing Assembly

Rotor Installation

Note Whenever you carry the rotor after it has been loaded, hold it vertically with both hands underneath it; the rotor must always be moved slowly and carefully so the gradient will not be disturbed.

To install the rotor in the centrifuge, remove it from the rotor holding fixture and carefully lower it onto the drive adapter in the centrifuge rotor chamber. The rotor will snap in place on the drive adapter. To make sure the rotor is fully seated, pull up on it gently — if there is a small amount of resistance, it is properly seated.

Perform the run as explained in the ultracentrifuge instruction manual.

Acceleration and Deceleration

When using the TV-1665 for density gradient separations, the automatic rate controller, the REOGRAD mode must be used for slow acceleration and slow deceleration. For instructions on the use of these controls, refer to the individual ultracentrifuge instruction manual.

Tube Removal

To remove the tubes from the rotor:

a. ULTRACRIMP® Tubes

1. Place the rotor in the rotor holding fixture.
2. Remove the rotor caps from the rotor using the torque wrench with the adapter.
3. Remove tubes from the rotor. Because the tubes expand slightly during centrifugation, you may have to use the ULTRACRIMP® Tube Removal Tool (Catalog No. 12816), pliers, or a hemostat to grasp the tube and gently pull it from the rotor.

Note You may notice that the inner side wall of a tube may appear slightly flattened after centrifugation. This is a normal effect of centrifugation and should not be cause for any concern.

4. Unload tubes according to the instructions given in the ULTRACRIMP® Tube Sealing System Instruction Manual.
5. Clean the rotor caps according to the procedure on page 6-1.

b. Optional Tubes (Catalog No. 03127)

1. Place the rotor in the rotor holding fixture.
2. Remove the rotor body caps using the body cap wrench.
3. Remove tubes and tube plugs:

Polyallomer tubes with white tube plugs:

4 CARE and MAINTENANCE

Tube Trimmer Accessory (for use with Optional Tubes)

The groove in the plug causes the plug to interlock with the tube during centrifugation; therefore, the tube can be removed from the rotor with the plug in it. Take hold of the top of the plug and slowly pull the tube out of the rotor. Then, to remove the plug from the tube, gently rock the plug until it pops out.

4. Clean all of the sealing assembly components according to the procedure on page 6-1.

Tube Trimmer Accessory (for use with Optional Tubes)

The rim of the optional tubes (Catalog No. 03127) will be deformed by the sealing assembly during operation. This may cause a problem of leaking when the tubes are then used with certain density gradient fractionators. A tube trimmer is available (see Table 1-3) to correct this problem. After the tube has been removed from the rotor,

insert it into the trimmer. The deformed portion of the tube will extend above the top of the trimmer. Use a razor blade and very carefully cut it away from the rest of the tube.

Centrifuge/Rotor Log Book

An Ultraspeed Centrifuge/Rotor Log Book is supplied with each TV-1665 Rotor so that you can record all data necessary to meet the warranty stipulation that if a defective ultraspeed centrifuge rotor (or ultracentrifuge) is returned to Thermo Fisher Scientific it must be accompanied by an up-to-date history.

Each time the TV-1665 Rotor is used, record the run in the log book as shown in figure 4-3, 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 4-1. Sample Centrifuge/Rotor Log Sheet

TECHNICAL NOTES

Contents

- “Relative Centrifugal Force (RCF) Determination” on page 5-2
- “Calculation of Sedimentation Time in Aqueous (Non-gradient) Solutions” on page 5-6
- “Calculation of Sedimentation Time in Gradient Solutions” on page 5-6

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 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 5-1 shows the minimum, average, and maximum radii of the TV-1665 Rotor. Table 5-1 gives the RCF value at each radius at speeds from 20 000 to 65 000 rpm (in increments of 500 rpm). The RCF value at any other speed can be calculated by using the given formula.

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

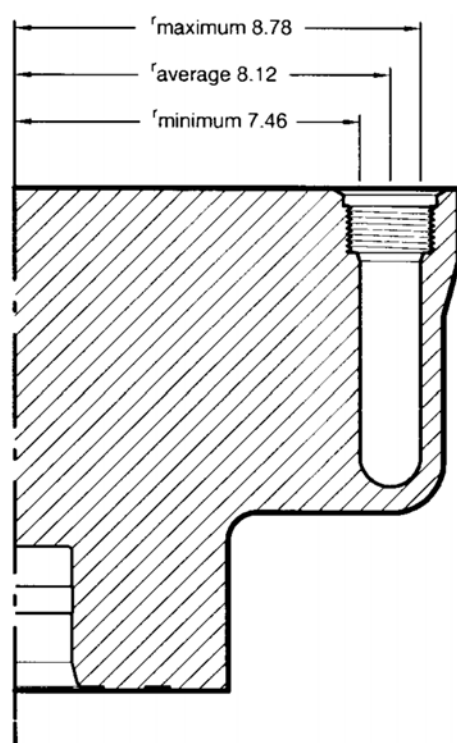


Figure 5-2. TV-1665 Rotor Radii

Table 5-6. TV-1665 Rotor: RCF Values and K Factors *

Speed (rpm)	Outer Row			K Factors
	r _{max} 8.78 cm	RCF r _{avg} 8.12 cm	r _{min} 7.46 cm	
20 000	39 229	36 280	33 331	103
20 500	41 215	38 117	35 019	98.1
21 000	43 250	39 999	36 748	93.5
21 500	45 334	41 926	38 518	89.2
22 000	47 467	43 899	40 331	85.2
22 500	49 649	45 917	42 185	81.4
23 000	51 880	47 981	44 081	77.9
23 500	54 161	50 089	46 018	74.6
24 000	56 490	52 243	47 997	71.6
24 500	58 868	54 443	50 018	68.7
25 000	61 295	56 688	52 080	66.0
25 500	63 772	58 978	54 184	63.4
26 000	66 297	61 313	56 330	61.0
26 500	68 871	63 694	58 517	58.7
27 000	71 495	66 121	60 746	56.5
27 500	74 167	68 592	63 017	54.5
28 000	76 889	71 109	65 329	52.6
28 500	79 659	73 671	67 683	50.7
29 000	82 479	76 279	70 079	49.0
29 500	85 348	78 932	72 516	47.4
30 000	88 265	81 630	74 995	45.8
30 500	91 232	84 374	77 516	44.3
31 000	94 248	87 163	80 078	42.9
31 500	97 313	89 997	82 682	41.5
32 000	100 426	92 877	85 328	40.3
32 500	103 589	95 802	88 015	39.0
33 000	106 801	98 773	90 744	37.9
33 500	110 062	101 789	93 515	36.7
34 000	113 372	104 850	96 327	35.7
34 500	116 731	107 956	99 181	34.6
35 000	120 139	111 108	102 077	33.6

5 TECHNICAL NOTES

Relative Centrifugal Force (RCF) Determination

Table 5-6. TV-1665 Rotor: RCF Values and K Factors*

Speed (rpm)	Outer Row			K Factors
	$r_{\max}$ 8.78 cm	RCF r_{avg} 8.12 cm	$r_{\min}$ 7.46 cm	
35 500	123 596	114 305	105 014	32.7
36 000	127 102	117 548	107 993	31.8
36 500	130 657	120 836	111 014	30.9
37 000	134 261	124 169	114 076	30.1
37 500	137 915	127 547	117 180	29.3
38 000	141 617	130 971	120 326	28.5
38 500	145 368	134 441	123 513	27.8
39 000	149 168	137 955	126 742	27.1
39 500	153 018	141 515	130 013	26.4
40 000	156 916	145 121	133 325	25.8
40 500	160 864	148 771	136 679	25.1
41 000	164 860	152 467	140 075	24.5
41 500	168 906	156 209	143 512	23.9
42 000	173 000	159 996	146 991	23.4
42 500	177 144	163 828	150 512	22.8
43 000	181 336	167 705	154 074	22.3
43 500	185 578	171 628	157 678	21.8
44 000	189 869	175 596	161 323	21.3
44 500	194 208	179 609	165 011	20.8
45 000	198 597	183 668	168 740	20.4
45 500	203 035	187 773	172 510	19.9
46 000	207 522	191 922	176 322	19.5
46 500	212 057	196 117	180 176	19.1
47 000	216 642	200 357	184 072	18.7
47 500	221 276	204 643	188 009	18.3
48 000	225 959	208 974	191 988	17.9
48 500	230 691	213 350	196 009	17.5
49 000	235 472	217 772	200 071	17.2
49 500	240 302	222 239	204 175	16.8
50 000	245 182	226 751	208 321	16.5
50 500	250 110	231 309	212 508	16.2
51 000	255 087	235 912	216 737	15.8

Table 5-6. TV-1665 Rotor: RCF Values and K Factors*

Speed (rpm)	Outer Row			K Factors
	$r_{\max}$ 8.78 cm	RCF r_{avg} 8.12 cm	$r_{\min}$ 7.46 cm	
51 500	260 113	240 560	221 007	15.5
52 000	265 188	245 254	225 319	15.2
52 500	270 620	250 300	229 981	14.7
53 000	275 486	254 777	234 069	14.7
53 500	280 708	259 607	238 506	14.4
54 000	285 980	264 482	242 985	14.1
54 500	291 300	269 403	247 506	13.9
55 000	296 670	274 369	252 068	13.6
55 500	302 088	279 380	256 672	13.4
56 000	307 556	284 436	261 317	13.1
56 500	313 072	289 538	266 004	12.9
57 000	318 638	294 686	270 733	12.7
57 500	324 253	299 878	275 504	12.5
58 000	329 916	305 116	280 316	12.3
58 500	335 629	310 399	285 170	12.0
59 000	341 391	315 728	290 065	11.8
59 500	347 202	321 102	295 003	11.6
60 000	353 061	326 521	299 982	11.4
60 500	358 970	331 986	305 002	11.3
61 000	364 928	337 496	310 064	11.1
61 500	370 935	343 052	315 168	10.9
62 000	376 991	348 652	320 314	10.7
62 500	383 096	354 298	325 501	10.6
63 000	389 250	359 990	330 730	10.4
63 500	395 453	365 727	336 000	10.2
64 000	401 705	371 509	341 312	10.1
64 500	408 007	377 336	347 666	9.9
65 000	414 357	383 209	352 062	9.8

* These values do not take the thickness of the tube into consideration.

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 r_{minimum} and r_{maximum}) 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 on the next page)

$S_{20,w}$ = the sedimentation coefficient for the particle of interest in water at 20°C as expressed in Svedbergs¹

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

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

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 TV-1665 Rotor at speeds from 20 000 rpm to 65 000 rpm (in increments of 500 rpm) are listed in Table 5-1.

Example: The TV-1665 Rotor has a K factor of 9.8 at 65 000 rpm. If the particles to be sedimented have a sedimentation coefficient of 10S, the estimated run time required at maximum speed will be:

$$t = \frac{9.8}{10S} \text{ 0.98 hours} = 59 \text{ minutes}$$

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 density gradient can be calculated using the following formula:

$$t = \frac{K^1}{S_{20,w}}$$

where:

¹ The sedimentation coefficient (S) in seconds, for a particle in a centrifugal field is defined by the equation $S = (dx/dt) [1/(\omega^2 x)]$; 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 $S_{20,w}$.

t = sedimentation time in hours

K^1 = the clearing factor for the rotor (the value of K^1 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 Svedbergs¹

Table 5-2 gives K^1 factors for the TV-1665 Rotor when operated at maximum speed (that is, 65 000 rpm) with particles ranging in density from 1.1g/cm³ to 1.5g/cm³. In this case, the K^1 factors are based on the use of a 5% - 20% (w/w) linear sucrose density gradient at 4°C.

Table 5-7. K^1 Factors for the TV-1665 Rotor (at maximum speed)

Particle Density (g/cm ³)	K^1 Factor (at 65 000 rpm)
1.1	66
1.2	34
1.3	30
1.4	28
1.5	17

DESCRIPTION

This chapter provides instructions on how to clean, decontaminate, and maintain your rotor. Always maintain the rotor in the recommended manner. Do not use rotors that show signs of corrosion or cracking.

Contents

- “Corrosion” on page 6-2
- “Cleaning and Decontamination” on page 6-2
- “Overspeed Decal Replacement” on page 6-3 “Storage” on page 6-3
- “Inspection” on page 6-3
- “Service Decontamination Policy” on page 6-4

Corrosion

The TV-1665 rotor body is made from titanium, making it more resistant to corrosion than an aluminum rotor; however, it should be maintained and kept clean the same as an aluminum rotor. Proper care will lessen the chances of rotor failure and significantly prolong the useful life of the rotor.

Corrosion commonly refers to chemical reactions at the surface (that is, rusting or pitting) recognized by the growing areas of visible deterioration. On the other hand, stress corrosion attacks the inside of the metal as well; barely detectable surface cracks grow inward, weakening the part without visible warning. Stress corrosion applies to most commonly used alloys, even the corrosion-resistant alloys have been found susceptible.

Stress corrosion is thought to be initiated by certain combinations of stress and chemical reaction. The most common chemical causing harmful effects is chloride, whether in a solution (for example, ammonium salts) or as a subtle form as sodium chloride in hand perspiration. If the rotor is not kept clean and chemicals remain on the rotor body, corrosion will result. Also, any moisture left on the rotor for an extended period of time can initiate corrosion. Therefore, it is important to keep the rotor clean and to dry it thoroughly after use.

In general, conditions for corrosion are present in all rotor applications;

proper care and maintenance will minimize its effects. Observe all WARNINGS and CAUTIONS found on the Safety Information Page in the front of this manual.

Cleaning and Decontamination

These procedures are for general cleaning purposes only. If the rotor or any components are exposed to a contaminant, they must be decontaminated first, then washed.

Observe all WARNINGS and CAUTIONS found on the Safety Information Page in the front of this manual.

Cleaning

Wash the rotor body and sealing assembly components with warm water and mild soap or detergent at least once a week or, ideally, after each use. It is particularly important that the rotor is washed immediately after any spills have occurred. Most laboratory chemicals can be removed with a lukewarm, 1% solution of a mild, non-alkaline detergent such as a mild dishwashing liquid. Rinse the rotor well, inside and out. After rinsing, dry the rotor thoroughly with a soft absorbent cloth or an air blast.

Do not use strong laboratory detergents to clean the rotor surface. Use a bristle brush to loosen encrusted material only if necessary; be careful not to scratch the rotor surface.

Decontamination

Ethylene oxide, a 2% glutaraldehyde solution, or ultraviolet radiation are the recommended methods of sterilization; however, the titanium rotor body of the TV-1665 can be autoclaved at temperatures up to 121°C. Do not autoclave the ULTRACRIMP® rotor caps or the optional multipiece sealing assembly rotor body caps.

For general radioactive decontamination, use a solution of equal parts of 70% ethanol, 10% SDS, and water. Follow this with ethanol rinses, then deionized water rinses, and dry with a soft absorbent cloth. Dispose of all wash solutions in proper radioactive waste containers.



WARNING Do not autoclave the ULTRACRIMP® rotor caps or optional sealing assembly components. If any of these parts are subjected to a temperature above 100°C, they should not be used. Most commercially available radioactive decontamination solutions are not compatible with aluminum.

Overspeed Decal Replacement

Before replacing the decal, be sure that the rotor is dry and at room temperature; this ensures that the new decal adheres properly.

To replace the decal:

5. Remove the existing decal from the bottom of the rotor; be careful not to scratch the rotor surface.
6. Clean the adhesive from the rotor surface using acetone or 3M General Adhesive Remover #8984.
7. Wipe the surface dry with a clean, soft cloth.

Note Check that the new decal has the correct number of black segments for the rotor being used. The decal for the TV-1665 should have 14 black segments.

8. Peel the paper backing off the new decal. Fit the decal into the recess in the bottom of the rotor. Be sure the decal is properly centered, then press the decal firmly into place.

Storage

Rotors should be stored upside down, without rotor body sealing caps, so air can circulate. This will help prevent moisture from gathering and settling at the bottom of the tube compartments.

Inspection

Periodically, inspect the rotor body and sealing assembly components for signs of: stress, including cracks, tears, and abrasions; wear (particularly the hex nut and threads of the rotor body caps); corrosion or deformation. If such problems are found, contact Thermo Fisher Scientific for information on factory inspection or replacement.

Service Decontamination Policy



WARNING Because of the characteristics of the samples likely to be processed in this centrifuge, biological or radioactive contamination may occur. Always be aware of this possibility, and take normal precautions. Use appropriate decontamination procedures should exposure occur.

If a centrifuge or rotor that has been used with radioactive or pathogenic material requires servicing by Thermo Fisher Scientific personnel, either at the customer's laboratory or at a Thermo Fisher Scientific facility, comply with the following procedures to ensure the safety of all personnel:

1. Clean the centrifuge or rotor to be serviced of all encrusted material and decontaminate it (see Maintenance Section of centrifuge or rotor instruction manual) prior to servicing by the Thermo Fisher Scientific representative or returning to the Thermo Fisher Scientific facility. There must be no radioactivity detectable by survey equipment.

The Thermo Fisher Scientific Product Guide contains descriptions of commonly used decontamination methods and a chart showing method compatibility with various materials. The centrifuge or rotor instruction manual contains specific guidance about cleaning and decontamination methods appropriate for the product it describes.

Clean and decontaminate your centrifuge or rotor as follows:

For ultraspeed centrifuges:

- a. Remove rotor from the rotor chamber.
- b. Decontaminate door and rotor chamber using an appropriate method.

For rotors:

Remove tubes, bottles, and adapters from the rotor and decontaminate rotor using an appropriate method. If tubes or rotor caps are stuck in the rotor, or the rotor lid is stuck, notify Thermo Fisher Scientific representative; be prepared with the name and nature of the sample so the Thermo Fisher Scientific Chemical Hazards Officer can decide whether to authorize the rotor's return to a Thermo Fisher Scientific facility.

2. Complete and attach Decontamination Information Certificate (in the back of your rotor or instrument manual) to the centrifuge or rotor before servicing or return to Thermo Fisher Scientific facility. If

Certificate is not available, attach a written statement verifying decontamination (what was contaminant and what decontamination method was used).

If the centrifuge or rotor must be returned to a Thermo Fisher Scientific facility:

1. Contact your Thermo Fisher Scientific representative to obtain a Return Service Order Number (RSO No.); be prepared with the name and serial number of the centrifuge or rotor and the repairs required.
2. Send item(s), with the RSO No. clearly marked on the outside packaging, to the address obtained from your Thermo Fisher Scientific representative.

Note United States federal regulations require that parts and instruments must be decontaminated before being transported.

If a centrifuge or rotor to be serviced does not have a Decontamination Information Certificate attached, and in Thermo Fisher Scientific's opinion presents a potential radioactive or biological hazard, the Thermo Fisher Scientific representative will not service the equipment until proper decontamination and certification is complete. If Thermo Fisher Scientific receives a centrifuge or rotor at its Service facilities which, in its opinion, is a radioactive or biological hazard, the sender will be contacted for instructions as to the disposition of equipment. Disposition costs will be borne by the sender.

Decontamination Information Certificates are included with these instructions. Additional certificates are available from the local Account Representative or Field Service Engineer. In the event these certificates are not available, a written statement certifying that the unit has been properly decontaminated and outlining the procedures used will be acceptable.

Note The Field Service Engineer will note on a Customer Service Repair Report if decontamination was required and, if so, what the contaminant was and what procedure was used. If no decontamination was required, it will be so stated.

Chemical Compatibility Chart

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®, CCLEARCRIMP®	POLYALLUMER	POLYCARBONATE	POLYESTER, GLASS THERMOSET	POLYETHERIMIDE	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	M	S	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

A Chemical Compatibility Chart

CHEMICAL	MATERIAL	ALUMINUM	ANODIC COATING for ALUMINUM	BUNA N	CELLULOSE ACETATE BUTYRATE	POLYURETHANE ROTOR PAINT	COMPOSITE Carbon Fiber/Epoxy	DELRI [®]	ETHYLENE PROPYLENE	GLASS	NEOPRENE	NORYL [®]	NYLON	PET [®] , POLYCLEAR [®] , CLEARCRIMP [®] , CCCCLEARCRIMP [®]	POLYALLUMER	POLYCARBONATE	POLYESTER, GLASS THERMOSET	POLYETHERIMIDE	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	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	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	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	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	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	S	M	S	S	S
Chloroform	U	U	U	U	S	S	M	U	S	U	U	M	U	M	U	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	U	S	S	S	S	M	U
Diethyl Ketone	S	-	U	U	-	-	M	-	S	U	-	S	-	M	U	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	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	-	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	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	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®, CQCLEARCRIMP®	POLYALLUMER	POLYCARBONATE	POLYESTER, GLASS THERMOSET	POLYETHERIMIDE	POLYETHYLENE	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

A Chemical Compatibility Chart

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®, CCCCLEARCRIMP®	POLYALLUMER	POLYCARBONATE	POLYESTER, GLASS THERMOSET	POLYETHERIMIDE	POLYETHYLENE	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	M	S	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	M	S	S	S	S
Oils (Petroleum)		S	S	S	-	-	-	S	U	S	S	S	S	U	U	M	S	M	U	U	S	S	U	S	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	U	M	S	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	U	M	U	S	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	DELIRIN®	ETHYLENE PROPYLENE	GLASS	NEOPRENE	NORYL®	NYLON	PET®, POLYCLEAR®, CLEARCRIMP®, CQCLEARCRIMP®	POLYALLUMER	POLYCARBONATE	POLYESTER, GLASS THERMOSET	POLYETHERIMIDE	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	S	S	S	S	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	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	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	S	S
Sucrose, Alkaline	M	S	S	-	S	S	S	-	S	S	S	S	S	S	S	U	S	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	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	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	M	S	S	S	S	U	S	S	M	S
Nitric Acid (95%)	U	-	U	U	-	U	U	-	-	U	U	U	U	U	M	U	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	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	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	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	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	S	S	M	M	S	S	S
Tetrahydrofuran	S	S	U	U	S	U	U	M	S	U	U	S	U	U	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	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	U	M	U	
Trichloroethane	S	-	U	-	-	-	M	U	-	U	-	S	U	U	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	U	U	S	U	-	U	-	S
Trisodium Phosphate	-	-	-	S	-	-	M	-	-	-	-	-	-	-	S	-	-	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	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	S	S
Urea	S	-	U	S	S	S	S	-	-	-	-	S	S	S	S	M	S	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	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	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	U	M	U	M	U	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	S	U	S	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	S	S
Citric Acid (10%)	M	S	S	M	S	S	M	S	S	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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Portugal	+34 932 23 09 18
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Switzerland	+41 44 454 12 12
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UK / Ireland	+44 870 609 9203
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China	+86 21 6865 4588
	+86 10 8419 3588

India	+91 22 6716 2200
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Japan	+81 45 453 9220
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Other Asian Countries	+852 2885 4613
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Latin America	+1 866 984 3766
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Other Countries	+49 6184 90 6940
	+33 2 2803 2180
