Thermo Fisher Scientific

TZ-28

Instruction Manual

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Table of contents

This manual is a guide for the use of

Thermo Scientific TZ-28 Zonal Rotor in the Ultracentrifuge

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.

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 compartment load exceeds the maximum allowable compartment load specified. See Chapter 2.

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

CAUTION

Do not expose 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 the rotor at the critical speed, as this will have a detrimental effect on centrifuge component life. See Chapter 2, Operation.

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

Do not operate the rotor unless it is properly seated on the drive spindle and locked in place. See Chapter 2, Operation.

Always maintain the rotor in the recommended manner. The rotor, seals, and all accessories must be clean and inspected prior to each run: do not use rotors showing signs of corrosion or cracking. See Chapter 3, Care and Maintenance.

DESCRIPTION

This manual provides the information you will need to operate and maintain your TZ-28 Zonal Rotor when used in your Thermo Scientific Ultracentrifuge. If you require additional information regarding operation or maintenance, please contact Thermo Fisher Scientific for assistance. In the United States, call Thermo Fisher Scientific toll-free 1-866-9THERMO; outside the United States, contact the nearest Thermo Fisher Scientific office (see back cover) 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/centrifuge .

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Rotor Description

The TZ-28 Rotor consists of a rotor body, septa, rotor cover, and feed adapter. The rotor body and cover are machined from a titanium forging for strength and corrosion resistance. The rotor body is painted black for surface protection and temperature regulation. The Valoxo septa is inserted into the rotor body to divide the rotor into six sector-shaped compartments. The rotor cover is fitted with a large O-ring that seals the rotor body during operation.

This manual describes assembly and operation of the TZ-28 Rotor for use in Thermo Fisher Scientific Ultracentrifuges. The TZ-28 can also be adapted for use in Thermo Fisher Scientific Refrigerated Superspeed Centrifuges. To operate the TZ-28 Rotor in Thermo Fisher Scientific Refrigerated Superspeed Centrifuges refer to Instruction Manual, Cat. No. 49618 and the Rotors, Tubes, Bottles, and Adapters Product Guide for additional kits and accessories required for superspeed centrifuge operation.

Ultracentrifuge Conversion Kit, Catalog No. 12271

The Ultracentrifuge Conversion Kit adapts the TZ-28 Rotor for use in the ultracentrifuge. This kit consists of a drive adapter, tapered adapter, distributor body, holddown plate, sealing cover and overspeed decal. The drive adapter and tapered adapter allow the TZ-28 Rotor to be installed in the ultracentrifuge, while the distributor body and holddown plate allow equal distribution of the gradient and sample to the six sector-shaped compartments. The sealing cover permits operation in a vacuum and the overspeed decal provides overspeed protection. Refer to Table 4-1 for a complete list of parts supplied in this kit. O-rings of Viton A and Buna N are used in the rotor assembly and components of the Ultracentrifuge Conversion Kit where an airtight seal is required

Rotor Specifications

Table 1-1. Rotor Specifications

Rotor Type	Zonal
Maximum Speed	28 000 rpm*
Relative Centrifugal Force (RCF) at Maximum Speed:	
- $r_{minimum}$ (3.65cm)	31701
- $r_{maximum}$ (9.53 cm)	83 457
Total Capacity (Nominal)	1350 ml
Diameter	21.33 cm (8.40 in)
Mass (Weight)	7.80 kg (17.2 lb)
Critical Speed	800 rpm
Design Load	1350 ml at 1.2 average specific gravity
K Factor at Maximum Speed	312

*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 to speed in this manual will be designated as rpm.

Parts and Accessories

Parts supplied with the TZ-28 Rotor, Catalog No. 52358, are listed in Table 1-2. To perform the operating procedures described in this manual it is necessary to have additional accessories not supplied with the TZ-28 Rotor Assembly. Table 1-3 lists additional accessories required to run the TZ-28 Rotor in an Ultracentrifuge.

To order replacement parts and accessories, telephone 1-866-9THERMO) in the United States. Outside the United States, contact your local representative for Thermo Fisher Scientifi products. To ensure you receive the correct part for your rotor be sure to provide a description of the part, catalog number, rotor model and serial number.

Table 1-2. Accessories Supplied

Quantity	Catalog Number	Description
1	52540	Rotor Holding Fixture (including mounting screws)
	49609	Septa
	49007	Feed Adapter
	66026	Dissecting Needle
	49724	Wrench
	49026	T-Wrench Assembly
	61556	Antigalling Grease (2 oz.)
	63037	O-ring, .489 ID x .070 thk, Viton®
12	66193	O-ring, .176 ID x .070 thk, Viton®
2	65755	O-ring, 7.237 ID x .103 thk, Viton®

Rate Controller

To override the centrifuge's electronic speed control, which is programmed for fast acceration and slow deceleration, an ARC-1 Automatic Rate Controller is required on the Thermo Fisher Scientific OTD-2, OTD-50, and OTD-65 Ultracentrifuges.

Precise control of the rate acceleration and deceleration in the range of 0 rpm to 1000 rpm is critical for the function of the TZ-28 Rotor sincereorientation occurs in this period. In addition, the ARC-1 Automatic Rate Controller will prevent the refrigeration compressor and fan from starting and disturbing the gradient during the critical speed period.

Refer to Table 1-2 to determine the appropriate rate controller for your centrifuge. For proper operation of the rate controller, follow the operating instructions supplied with the rate controller and the ultracentrifuge.

Note When using the TZ-28 Rotor in a Thermo Fisher Scientific OTD-55B, OTD-65B or OTD-75B Ultracentrifuge, use the REOGRAD Mode of operation for slow acceleration and deceleration. Refer to the Ulracentrifuge Instruction Manual, Cat. No. 52844, for instructions required to set the REOGRAD Mode.

Table 1-3. Additional Accessories Required

Description	Catalog Number
Ultracentrifuge Conversion Kit	12271
Automatic Rate Controller for the OTD-2 Ultracentrifuge	52130
Automatic Rate Controller for the OTD-50/65/75 Ultracentrifuge	52270
Syringe with blunt 18 gauge needle*	

*This item is not available through Thermo Fisher Scientific products.

OPERATION

Contents

Rotor Holding Fixture

The rotor holding fixture (Catalog No. 52540) is used to hold the rotor during rotor loading and unloading procedures to prevent disturbances of the gradient. Secure the rotor holding fixture to a workbench with the two flathead screws supplied as shown in figure 2-1.

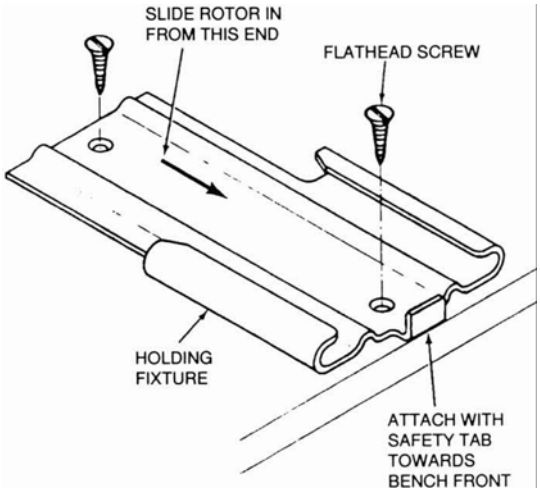

Figure 2-1. Rotor Holding Fixture Installation

Prerun Safety Check

To ensure safe performance of the rotor, the following items should be checked before every run:

- level the rotor to ensure equal dispersion of the density gradient,
- make sure the rotor spud hole is clean and free of encrusted material,
- inspect the O-rings in the rotor assembly for cracks, tears or abrasions; replace if necessary,
- remove any blockage from the lines of the septa, distributor, and holddown plate,
- lubricate the threads of the rotor body with antigalling grease,
- check the overspeed decal on the bottom of the tapered adapter for damage; replace if necessary, and
- make sure all rotor parts and accessories have been cleaned as explained in paragraph 3-2.

WARNING Failure to properly maintain your rotor can cause rotor failure with subseguent damage to your centrifuge. Also, depending on the sample being processed, rotor failure can result in biological or radioactive contamination. Therefore, every part of the rotor must be clean and should be carefully inspected before every run. If there is any sign of corrosion or cracking, the rotor should not be used.

Compartment Loads in Excess of Design Mass

There is a recommended design mass established for each rotor representing the maximum mass that can be carried in the rotor. To prevent rotor failure, the total mass should not exceed the recommended figure unless rotor speed is reduced proportionately. If the density of the solution is greater than 1.2 g/ml use the following formula to determine the reduced speed:

$$\text{Reduced Speed} = 28000 \sqrt{\frac{1.2\ \text{g/ml}}{\text{Average Fluid Density}}}$$

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 (i.e., 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 approximately 800 rpm for the TZ-28 Rotor.

CAUTION Continued operation at the critical speed will have a detrimental effect on centrifuge component life.

Relative Centrifugal Force (RCF) Determination

Relative Centrifugal Force (RCF) refers to the force during centrifu-gation 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:

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

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 2-2 represents the volume occupied by a liquid within the spinning rotor in relation to the maximum radius of the rotor, 9.531cm (3.75 inches). The points marked A, B, C, and D in figure 2-3 correspond to inflection points on the curve in figure 2-2 and may be used as a reference.

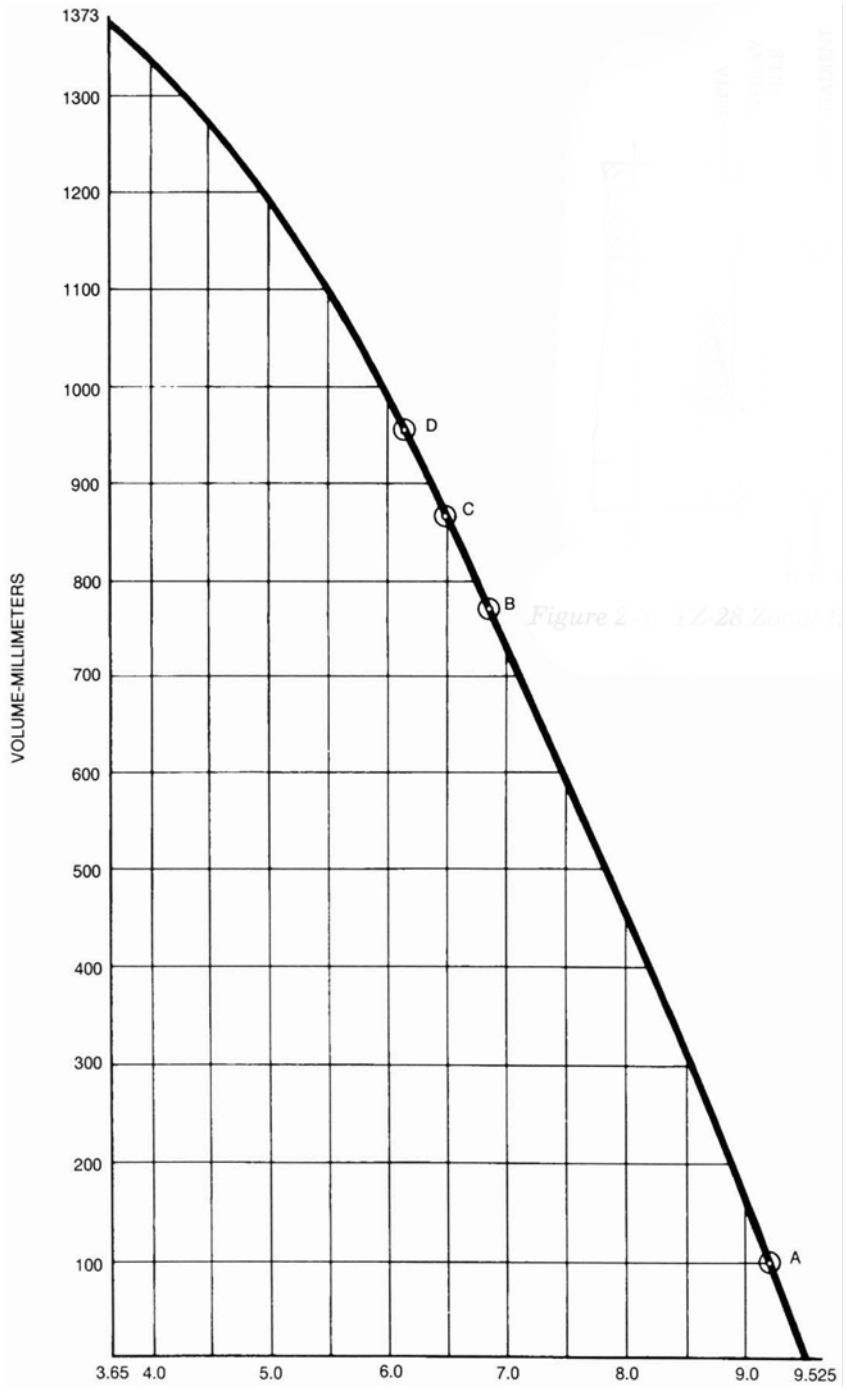

Figure 2-2. Volume vs. Radius

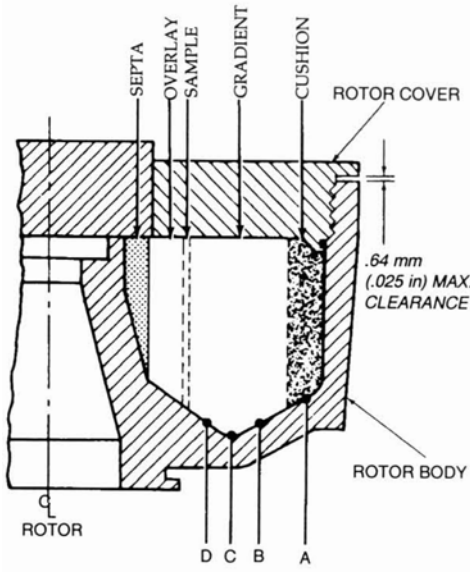

Figure 2-3. TZ-28 Zonal Rotor Cross Section

Table 2-1 list volumes along with their inside vertical surface radii. The determination of RCF can be helpful when a cushion is used since the actual forces exerted against the sample can be accurately noted. For example, if a 100 ml cushion and a 900 ml gradient were used, then the sample introduced, the forces developed on the sample at 10 000 rpm will range from 6600 at the free fluid surface of the gradient to 10 300 rpm at the interface of gradient and cushion.

Table 2-1. Tz-28 Rotor: RCF Values and K Factors

r (cm)	3.62	4.26	4.91	5.45	5.92	6.32	6.70	7.07	7.43	7.79	8.14	8.49	8.84	9.19	9.53	K
VOL (ml)	1373	1300	1200	1100	1000	900	800	700	600	500	400	300	200	100	0	Factor
Speed (rpm)	RCF															
1 000	40	50	50	60	70	70	80	80	80	90	90	100	100	100	106	979 586
1 500	91	110	120	140	150	160	170	180	190	200	200	210	220	230	240	244 897
2 000	162	190	220	240	260	280	300	320	330	350	360	380	400	410	426	108 843
2 500	253	300	340	380	410	440	470	490	520	540	570	590	620	640	665	39 183
3 000	364	430	490	550	590	640	670	710	750	780	820	850	890	920	958	27 211
3 500	495	580	670	750	810	860	920	970	1 000	1 100	1 100	1 200	1 200	1 300	1 304	19 992
4 000	647	760	880	970	1 100	1 100	1 200	1 300	1 300	1 400	1 500	1 500	1 600	1 600	1 703	15 306
4 500	819	960	1 100	1 200	1 300	1 400	1 500	1 600	1 700	1 800	1 800	1 900	2 000	2 100	2 156	12 094
5 000	1 011	1 200	1 400	1 500	1 700	1 800	1 900	2 000	2 100	2 200	2 300	2 400	2 500	2 600	2 661	9 796
5 500	1 223	1 400	1 700	1 800	2 000	2 100	2 300	2 400	2 500	2 600	2 800	2 900	3 000	3 100	3 220	8 096
6 000	1 456	1 700	2 000	2 200	2 400	2 500	2 700	2 800	3 000	3 100	3 300	3 400	3 600	3 700	3 832	6 803
6 500	1 708	2 000	2 300	2 600	2 800	3 000	3 200	3 300	3 500	3 700	3 800	4 000	4 200	4 300	4 498	5 796
7 000	1 981	2 300	2 700	3 000	3 200	3 500	3 700	3 900	4 100	4 300	4 500	4 600	4 800	5 000	5 216	4 998
7 500	2 274	2 700	3 100	3 400	3 700	4 000	4 200	4 400	4 700	4 900	5 100	5 300	5 600	5 800	5 988	4 354
8 000	2 588	3 000	3 500	3 900	4 200	4 500	4 800	5 100	5 300	5 600	5 800	6 100	6 300	6 600	6 813	3 827
8 500	2 921	3 400	4 000	4 400	4 800	5 100	5 400	5 700	6 000	6 300	6 600	6 900	7 100	7 400	7 691	3 390
9 000	3 275	3 800	4 400	4 900	5 400	5 700	6 100	6 400	6 700	7 000	7 400	7 700	8 000	8 300	8 622	3 023
9 500	3 649	4 300	4 900	5 500	6 000	6 400	6 800	7 100	7 500	7 900	8 200	8 600	8 900	9 300	9 607	2 714
10 000	4 044	4 800	5 500	6 100	6 600	7 100	7 500	7 900	8 300	8 700	9 100	9 500	9 900	10 300	10 645	2 449
10 500	4 458	5 200	6 000	6 700	7 300	7 800	8 200	8 700	9 200	9 600	10 000	10 500	10 900	11 300	11 736	2 221
11 000	4 893	5 800	6 600	7 400	8 000	8 500	9 100	9 600	10 000	10 500	11 000	11 500	12 000	12 400	12 880	2 024
11 500	5 348	6 300	7 300	8 000	8 700	9 300	9 900	10 400	11 000	11 500	12 000	12 500	13 100	13 600	14 078	1 852
12 000	5 823	6 800	7 900	8 800	9 500	10 200	10 800	11 400	12 000	12 500	13 100	13 700	14 200	14 800	15 329	1 701
12 500	6 318	7 400	8 600	9 500	10 300	11 000	11 700	12 300	13 000	13 600	14 200	14 800	15 400	16 000	16 633	1 567
13 000	6 834	8 000	9 300	10 300	11 200	11 900	12 600	13 300	14 000	14 700	15 400	16 000	16 700	17 300	17 990	1 449
13 500	7 369	8 700	10 000	11 100	12 000	12 900	13 600	14 400	15 100	15 900	16 600	17 300	18 000	18 700	19 401	1 344
14 000	7 925	9 300	10 700	11 900	13 000	13 800	14 700	15 500	16 300	17 100	17 800	18 600	19 400	20 100	20 864	1 249
14 500	8 502	10 000	11 500	12 800	13 900	14 800	15 700	16 600	17 500	18 300	19 100	19 900	20 800	21 600	22 381	1 165
15 000	9 098	10 700	12 300	13 700	14 900	15 900	16 800	17 800	19 900	20 900	21 800	22 800	23 700	24 700	23 951	1 088
15 500	9 715	11 400	13 200	14 600	15 900	17 000	18 000	19 000	19 900	20 900	21 800	22 800	23 700	24 700	25 575	1 019

Table 2-1. Tz-28 Rotor: RCF Values and K Factors

r (cm)	3.62	4.26	4.91	5.45	5.92	6.32	6.70	7.07	7.43	7.79	8.14	8.49	8.84	9.19	9.53	K
VOL (ml)	1373	1300	1200	1100	1000	900	800	700	600	500	400	300	200	100	0	Factor
Speed (rpm)	RCF															
16 000	10 351	12 200	14 000	15 600	16 900	18 100	19 200	20 200	21 300	22 300	23 300	24 300	25 300	26 300	27 251	957
16 500	11 009	12 900	14 900	16 600	18 000	19 200	20 400	21 500	22 600	23 700	24 800	25 800	26 900	27 900	28 981	900
17 000	11 686	13 700	15 900	17 600	19 100	20 400	21 600	22 800	24 000	25 100	26 300	27 400	28 500	29 700	30 764	847
17 500	12 383	14 600	16 800	18 600	20 200	21 600	22 900	24 200	25 400	26 600	27 800	29 100	30 200	31 400	32 600	800
18 000	13 101	15 400	17 800	19 700	21 400	22 900	24 200	25 600	26 900	28 200	29 500	30 700	32 000	33 200	34 490	756
18 500	13 839	16 300	18 800	20 800	22 600	24 200	25 600	27 000	28 400	29 800	31 100	32 500	33 800	35 100	36 433	716
19 000	14 597	17 200	19 800	22 000	23 900	25 500	27 000	28 500	30 000	31 400	32 800	34 300	35 700	37 000	38 428	678
19 500	15 376	18 100	20 900	23 100	25 100	26 800	28 400	30 000	31 600	33 100	34 600	36 100	37 600	39 000	40 478	644
20 000	16 174	19 000	21 900	24 300	26 400	28 200	29 900	31 600	33 200	34 800	36 400	38 000	39 500	41 000	42 580	612
20 500	16 993	20 000	23 000	25 600	27 800	29 700	31 400	33 200	34 900	36 600	38 200	39 900	41 500	43 100	44 736	583
21 000	17 832	21 000	24 200	26 800	29 100	31 100	33 000	34 800	36 600	38 400	40 100	41 800	43 600	45 300	46 944	555
21 500	18 691	22 000	25 400	28 100	30 500	32 600	34 600	36 500	38 400	40 200	42 000	43 900	45 700	47 400	49 207	530
22 000	19 571	23 000	26 500	29 500	32 000	34 200	36 200	38 200	40 200	42 100	44 000	45 900	47 800	49 700	51 522	506
22 500	20 470	24 100	27 800	30 800	33 500	35 700	37 900	40 000	42 000	44 100	46 000	48 000	50 000	52 000	53 500	484
23 000	21 390	25 100	29 000	32 200	35 000	37 300	39 600	41 800	43 900	46 000	48 100	50 200	52 200	54 300	56 312	463
23 500	22 330	26 200	30 300	33 600	36 500	39 000	41 300	43 600	45 800	48 100	50 200	52 400	54 500	56 700	58 787	443
24 000	23 291	27 400	31 600	35 100	38 100	40 700	43 100	45 500	47 800	50 100	52 400	54 600	56 900	59 100	61 315	425
24 500	24 271	28 500	32 900	36 500	39 700	42 400	44 900	47 400	49 800	52 200	54 600	56 900	59 300	61 600	63 897	408
25 000	25 272	29 700	34 300	38 000	41 300	44 100	46 800	49 300	51 900	54 400	56 800	59 300	61 700	64 100	66 531	392
25 500	26 293	30 900	35 700	39 600	43 000	45 900	48 600	51 300	54 000	56 600	59 100	61 700	64 200	66 700	69 219	377
26 000	27 334	32 100	37 100	41 100	44 700	47 700	50 600	53 400	56 100	58 800	61 500	64 100	66 800	69 400	71 960	362
26 500	28 396	33 400	38 500	42 700	46 400	49 600	52 500	55 400	58 300	61 100	63 900	66 600	69 400	72 100	74 755	349
27 000	29 477	34 600	40 000	44 400	48 200	51 500	54 500	57 500	60 500	63 400	66 300	69 200	72 000	74 800	77 602	336
27 500	30 579	35 900	41 500	46 000	50 000	53 400	56 600	59 700	62 800	65 800	68 800	71 800	74 700	77 600	80 503	324
28 000	31 701	37 300	43 000	47 700	51 800	55 300	58 700	61 900	65 100	68 200	71 300	74 400	77 400	80 500	83 457	312

Calculation of Sedimentation in Aqueous (Non-Gradient) Solutions

The time required to sediment a particle in water at 20°C through the maximum rotor path length (i.e., the distance between $r_{minimum}$ and $r_{maximum}$ can be estimated 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 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 TFT-80.2 Rotor,at speeds from 20 000 rpm to 80 000 rpm (in increments of 500 rpm), are listed in Table 2-1.

[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.

Example: The TZ-28 Rotor has a K factor of 312 at the maximum permitted speed (28 000 rpm). If the particles to be sedi-mented have a sedimentation coefficient of 100S, the estimated run time required at maximum speed will be:

$$t = \frac{312}{100S} \quad 3.12 \text{ hours} = 3 \text{ hours, } 7 \text{ minutes}$$

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.

Chemical Compatibility

The critical components of the TZ-28 Rotor that are apt to come in contact with solution are: rotor body and rotor cover (titanium), septa (Valox®), holddown plate (aluminum), feed adapter and distributor body (Delrin®), drive adapter and tapered adapter (stainless steel) and O-rings (Viton® of Buna N).

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

Rotor Assembly, Loading and Operation

a. Rotor Assembly and Precooling

Note The tapered adapter and drive adapter are shipped as an assembly and must be disassembled before assembling the rotor.
If your desired application requires precooling of the rotor gradient and sample, be sure to precool your gradient and sample separately. Follow the instructions below to precool your rotor in the ultracentrifuge. If desired, you can precool your rotor to the required temperature in a refrigerator then assemble the rotor following steps 1 through 11 below and proceed to step b. Rotor Loading. Use figures 2-5 and 2-6 for parts location and identification.

1. Insert the tapered adapter (Catalog No. 52496), into the bottom of the rotor body, no alignment is required (see figure 2-4)

Table 2-2. TZ-28 Adapter Assembly (key to figure 2-4)

Item	Quanty	Catalog Number	Description
1	1	52496	Tapered Adapter
2	1	52418	Drive Adapter
3	3	60912	Socket Head Screw (8-32 x 3/8 long)
-	1	51363	Overspeed Decal*

* Overspeed decal is located on bottom of rotor.

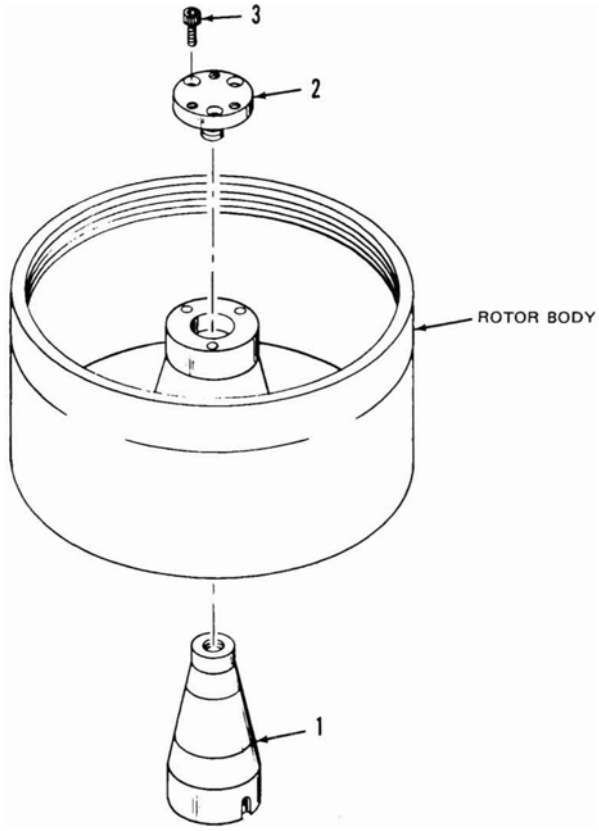

Figure 2-4. Adapter assembly

2. Thread the drive adapter (Catalog No. 52418) into the tapered adapter and turn it until the screw holes are aligned with those in the rotor body. Insert the three socket head screws (Catalog No. 60912) into the corresponding three holes in the drive adapter. Use the T-wrench (Catalog No. 49026) to loosely righted the screws.
3. From underneath the rotor body, use the tapered adapter wrench (Catalog No. 52497) to tighted the tapered adapter (turning clockwise).
4. Firmly tighted the three socket head screws in the drive adapter (step 2).
5. Slide the rotor into the rotor holding fixture.
6. Using the dissecting needle (Catalog No. 66026) suplied, carefully remove the O-rings in the rotor assembly. Inspect each of the O-rings for cracks, tears of abrasions; replace if necessary. Lubricate each O-ring with a light film of vacuum grease (Catalog No. 65937), then reinsert each O-ring into its respective part.
7. Place the septa into the rotor body using a twisting motion.
8. Lubricate the threads of the rotor cover at several places around the circumference with antigalling grease (Catalog No. 61556). Place the rotor cover onto the rotor body, then turn it clockwise until it drops onto the threads of the rotor body. Turn the cover counterclockwise until tight (this will spread the grease over the threads). Use wrench assembly (Catalog No. 49724) to securely tighted the cover.

CAUTION Before running the TZ-28 Rotor in the ultracentrifuge, make sure the rotor cover is properly seated. Clearance between the rotor body and cover (see figure 2-3) should not be greater than 0.64mm(0.025 inches). Operating the rotor with the cover not properly seated can cause rotor failure with subsequent damage to your ultrcentrifuge.

9. Use both hands to remove the rotor assembly from the rotor holding fixture and carefully lower it onto the drive spindle.
10. Check that the rotor is levelby placing a spirit level on the flat surface of the rotor cover (this will ensure equal dispersion of the gradient during operation).
11. Place the distributor body (Catalog No. 52425) in position through the hole in the rotor cover. Slowly rotate the distributor body to engage the guide pins, located on the bottom of the distributor body, with the corresponding holes in the septa.
12. Place the holddown plate (Catalog No. 52416) on the distributor body (the top of the holddown plate can be identified by the three large screw holes). Align the three screw holes of the holddown plate with the corresponding holes in the distributor body. Insert the three socket head screws (Cat. No. 62987) throught both parts. Turn the assembly (holddown plate, distributor body and septa) while pressing down firmly on one of the screws until it aligns with the corresponding threaded hole of the rotorbody and drops into place. Use the T-wrench to alternately tighted the screws until they are firmly and evenly tightened.
13. If required, precool the rotor in a refrigerator or cold room.

b. Rotor Loading

1. With the rotor at rest and the ultracentrifuge door open, connect the silicone tubing from a peristaltic pump to the feed adapter (Catalog No. 49007). Insert the feed adapter into the center of the distributor body.
2. Check that all lines are loading gradient properly. Turn the peristaltic pump on, then squeeze the silicone tubing near the feed adapter to create a back pressure. When the tubing is released the fluid should purge the air from all loading lines resulting in an even flow of fluid through all channels. Repeat this prodecure to ensure all lines are loaded evenly.
3. Load the gradient into the rotor using the peristaltic pump, light end first. The gradient must flow smoothly through all loading lines or it will be distributed unevenly between the six compartments of the septa.
4. When all the gradient is loaded, remove the feed adapter (including silicone tubing) from the distributor body.
5. Use a syringe with a blunt 18 gauge needle to load equal amounts of sample into each of the six holes in the holddown plate.

CAUTION Always run the TZ-28 Rotor with a full fluid load (1350 ml). Failure to run the rotor with less than a full load may cause damage to the ulrtracentrifuge and/or rotor due to the shifting mass of the fluid and may cause the septa to disintegrate. If enough sample is not available an overlay should be used to increase the rotor contents to 1350 ml.

6. Place the sealing cover (Catalog No. 52417) over the distributor body. Insert the three socket head screws (Catalog No. 66329) into the sealing cover and align with the distributor body. Use the T-wrench to alternately tighten the screws.
7. Close the centrifuge door and perform the run as explained in the ultracentrifuge instruction manual.

c. Acceleration and Deceleration

1. Acceleration - Acceleration should be at a slow, smooth rate, taking from five (5) to ten (10) minutes to reach 1000 rpm. Follow the instructions supplied with the Automatic Rate Controller.
2. Centrifugation - When the rotor speed reaches 1000 rpm, use normal operating procedures for the centrifuge and automatic rate controller to complete the desired run.
3. Deceleration - Use normal deceleration to 1000 rpm. Below 1000 rpm deceleration should be at a slow, smooth rate taking from five (5) to ten (10) minutes to go from 1000 rpm to 0 rpm. For slow deceleration, refer to the instruction manual supplied with your Thermo Fisher Scientific Ultracentrifuge.

d. Unloading and Disassembling the Rotor

Note Once the rotor has stopped spinning, be careful not to bump or jar the centrifuge. Any disturbance may remix the delicate separations.

1. At the end of the run, carefully open the centrifuge door.
2. Use the T-wrench to remove the three socket head screws from the sealing cover. Remove the sealing cover.
3. Relubricate the feed adapter O-ring (Catalog No. 63037) with vacuum grease (Catalog No. 65937).
4. Connect the silicone tubing from the peristaltic pump to the feed adapter. Then, insert the feed adapter into the center of the distributor body.
5. Before unloading the rotor, check that all lines unload evenly and smoothly as follows:
   a. Set the speed control of the peristaltic pump to a higher rate than normal.
   b. Turn the peristaltic pump on, then squeeze the silicone tubing near the feed adapter to create a vacuum. Release the tubing (when the tubing is released there should be a rush of bubbles up through the feed adapter as the feed lines clear). No more bubbles should appear in the effluent from the distributor body and all lines should unload at the same rate.
   c. Reset the speed control of the peristaltic pump to its normal unloading rate.

CAUTION The density gradient being pumped from the rotor must flow smoothly through all feed lines so the gradient will unload evenly. If the gradient does not unload evenly, there will be significant loss in the resolution obtained during centrifugation.

Note ccasionally, with very viscous solutions of 55% w/w sucrose or higher, small bubbles will appear in the effluent after the above procedure is completed. To eliminate this problem, reduce the unloading rate until the viscous end of the gradient (or cushion) has been pumped from the rotor. Then, reset the unloading rate of the peristaltic pump to its normal rate.

6. Unload the rotor not exceeding 75 ml/minute.
7. After the gradient has been unloaded from the rotor, remove the feed adapter from the distributor body.
8. Carefully lift the rotor out of the ultracentrifuge chamber and place it in the rotor holding fixture. Remove the three socket head screws that secure the holddown plate in place. Remove the holddown plate, distributor and rotor cover.
9. Remove the septa from the rotor body.
10. Clean and store the rotor as explained in paragraph 3-2 of this manual.

Table 2-3. TZ-28 Rotor Assembly (key to figure 2-5)

Item	Quanity	Catalog Number	Description
1	1	52418	Drive Adapter
2	1	49609*	Septa
3	12	66193*	O-ring, .176 ID x .070 , CS, Viton®
4	2	66308	O-ring, 1.739 ID x .070, CS, Buna N
5	1	52425	Distributor Body
6	2	64578	O-ring, 2.609 ID x .139, CS, Buna N
7	12	61289	O-ring, .312 ID x .070, CS, Buna N
8	1	52416	Holddown Plate
9	3	62987	Socket Head Screw, 8-32 x 1-1/8 long
10	2	65755*	O-ring, 7.237 ID x .103, CS, Viton A
11	1	63037*	O-ring, .489 ID x .070, CS
12	1	49007*	Feed Adapter
13	2	66330	O-ring, .676 IS x .070, CS
14	1	52417	Sealing Cover
15	3	66329	Socket Head Screw, 8-32 x 7/16 long

* Parts indicated by an asterisk (*) are supplied with the TZ-28 Rotor Assembly, Catalog No. 52358. All other parts supplied in the Ultracentrifuge Conversion Kit, Catalog No. 12271.

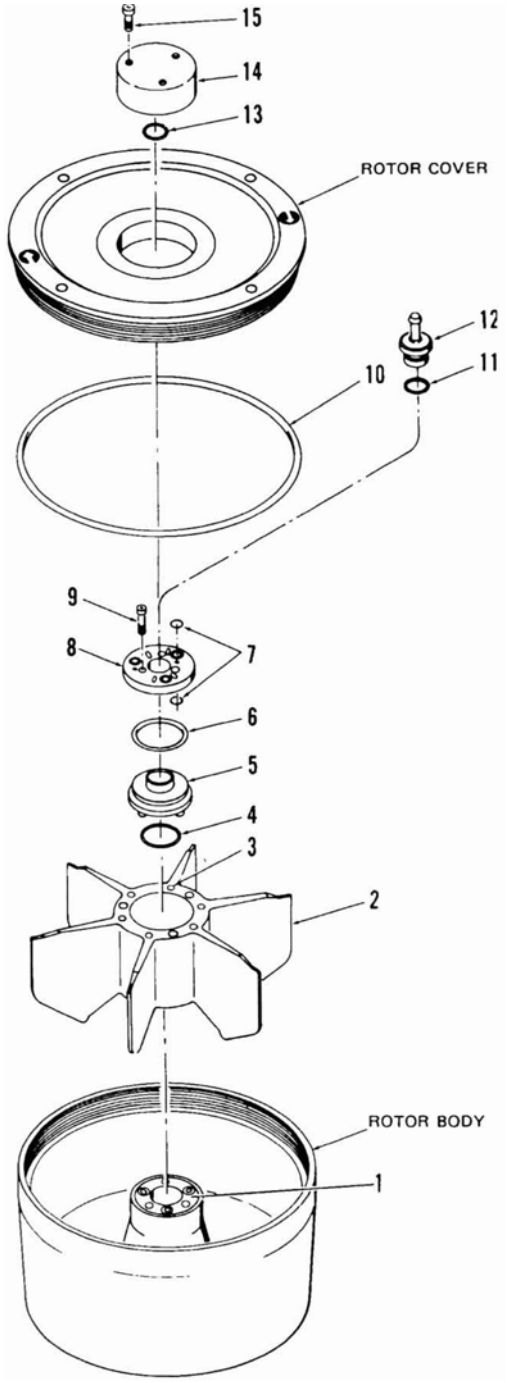

Figure 2-5. Figure 2-5. TZ-28 Rotor Assembly

Table 2-4. Rotor Accessories (key to figure 2-6)

Item	Quanity	Catalog Number	Description
1		49724*	Wrench**
2		49026	T-wrench**
3		51363	Overspeed Decal, 28 000 rpm***
4		66026	Dissecting Needle**

Table 2-4. Rotor Accessories (key to figure 2-6)

Item	Quanity	Catalog Number	Description
5		52497	Tapered Adapter Wrench Assembly***
6		52540	Rotor Holding Fixture (including mounting screws)**

* Assemble wrench handle by overlapping parts a and b as shown in figure 2-6.

** Supplied with the TZ-28 Rotor Assembly, Catalog No. 542358.

*** Supplied with the Ultracentrifuge Conversion Kit, Catalog No. 12271.

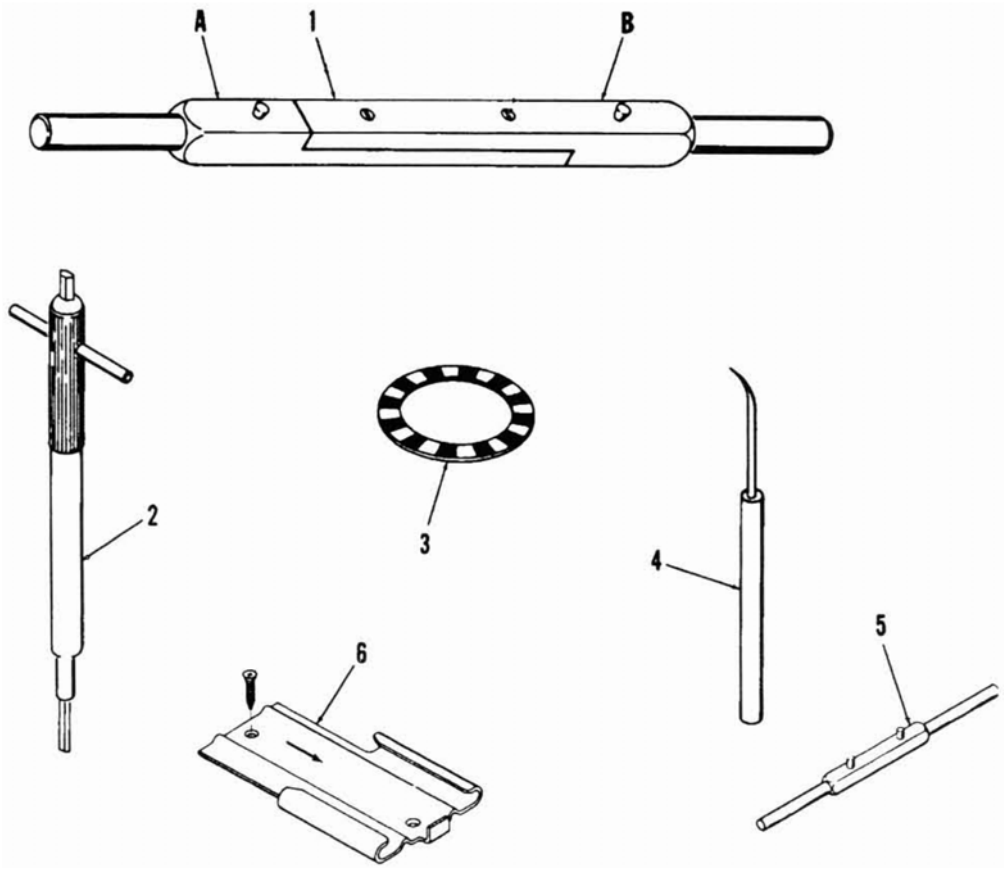

Figure 2-6. TZ-28 Accessories

Centrifuge/Rotor Log

An Ultracentrifuge Rotor Log Book is supplied with the TZ-28 Rotor so that the user can easily record all data necessary to meet the warranty stipulation that any defective rotor returned to Thermo Fisher Scientific must be accompanied by an up-to-date history of the rotor.

Use the rotor log book to record the run when the TZ-28 Rotor is used in an ultracentrifuge. The information may be recorded else where, however, it must include all data as shown in Figure 2-7, Sample Rotor Log Sheet.

Note If the TZ-28 Rotor is used in a Thermo Fisher Scientific Refrigerated Superspeed Centrifuge it is not necessary to record the run data.

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 2-7. Sample Centrifuge/Rotor Log Sheet

MAINTENANCE

Contents

Corrosion

The TZ-28 rotor body and cover are made from titanium. Although titanium is more resistant to corrosion than aluminum, care should always be used in the maintenance of all rotor parts. 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 (i.e., rusting or pitting) recognized by 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 such as ammonium salts or as subtle a form as hand perspiration. If the rotor is not kept clean and chemicals remain on the rotor, corrosion will result. Also, any moisture left on the rotor for an extended period of time can initiate corrosion; therefore, it is important the rotor is thoroughly washed and dried after use.

In general, conditions for corrosion are present in all rotor applications; proper care and maintenance will minimize its effects.

Cleaning

a. Washing

1. Rotor Body and Cover

   Wash the rotor body and cover with warm water and a mild soap or detergent at least once a week, or ideally, after each use. It is particularly important to wash the rotor 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 and parts well, inside and out. After rinsing, dry thoroughly with a soft absorbant cloth or an air blast.

2. Septa, Distributor Body and Holddown Plate

   To prevent clogging of all feed lines, fill a polyetheylene bottle with water then place the tip of the bottle into each feed line and flush clean.

b.Decontamination

Ethylene oxide, a 2% glutaraldehyde solution, or ultraviolet radiation are the recommended methods of sterilization; however, the rotor body, rotor cover, septa, drive adapter, and tapered adapter may be autoclaved at temperatures up to 120°C. Do not autoclave the distributor body or the holddown plate. For general radioactive decontamination, use a solution of equal parts 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.

c. Storage

Rinse and dry the rotor body, then store with cover removed upside-down and slightly tilted so air can circulate. This will prevent moisture from settling in the bottom of the rotor body.

Periodically lubricate O-rings with vacuum grease.

Overspeed Decal Replacement

Before replacing the decal, be sure the rotor is dry and at room temperature; if it is not, the new decal will not adhere properly.

To replace the decal:

1. Remove the existing decal from the bottom of the rotor being careful not to scratch the rotor surface.
2. Clean the adhesive from the rotor surface using either acetone or 3M General Adhesive Remover #8984.
3. Wipe the surface dry with a clean, soft cloth.
4. 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 in place.

Service Decontamination Policy

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 procedure to ensure the safety of all personnel:

- Clean the centrifuge and/or rotor to be serviced of all encrusted material and decontaminate it prior to servicing by the Thermo Fisher Scientific representative. There must be no radioactivity detectable by survey equipment.
- Complete and attach Decontamination Information Certificate (in the back of your rotor or instrument manual) to the centrifuge or rotor before servicing or returning to Thermo Fisher Scientific facility. If Certificate is not available, attach a written statement varifying decontamination (what was contaminant and what decontamination method was used).

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 disposition of the equipment. Disposition costs will be borne by the sender.

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

Note The Service Representative 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®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

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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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