Thermo Fisher Scientific

AH-650

Instruction Manual

52274-11 March 2010

Part of Thermo Fisher Scientific

Thermo SCIENTIFIC

Release history: 52274-11 printed in March 2010.

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

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This manual is a guide for the use of

Thermo Scientific AH-650 Rotor

Data herein has been verified and is believed adequate for the intended use of the centrifuge. 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.

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

Failure to reduce 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) or heavy metals such as cesium, lead, silver, or mercury. Use of these materials with aluminum can cause a chemical reaction that initiates corrosion.

Besure to securely lock the rotor to drive before starting a centrifuge run.

Do not operate or precool a rotor at the critical speed, as this will have a detrimental effect on centrifuge component life. See Chapter 1, Description.

Do not operate centrifuge with a rotor out of balance. Operating the rotor out of balance can cause damage to the centrifuge drive assembly.

Always maintain the rotor in the recommended manner; do not use rotors showing signs of corrosion or cracking. See Chapter 3, Care and Maintenance.

Do not autoclave or expose any aluminum rotor parts to temperatures in excess of 100°C.

DESCRIPTION

This manual provides you with the information you will need to operate and maintain your Thermo Scientific Rotor. If you encounter any problem concerning either operation or maintenance that is not covered in the manual, please contact our Marketing Technical Group for assistance. In the United States, call toll free 1-866-9THERMO. Outside the United States, contact the 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 .

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Rotor Description

The AH-650 is an aluminum swinging bucket ultracentrifuge rotor that can produce up to six sets of data during a single run at speeds up to 50,000 rpm.[1] Each rotor bucket will hold a centrifuge tube having a nominal fluid capacity of 5 ml; the buckets are sealed during operation by an O-ring and an aluminum bucket cap. The buckets attach to the rotor body, each at its own numbered position. During a centrifuge run, they swing out horizontally and return to a vertical position during deceleration. A disc with alternative black and reflective segments attached to the bottom of the rotor provides overspeed protection.

Rotor Specifications

Table 1-1 provides the basic specifications for the AH-650 Rotor.

Table 1-1. Rotor Specifications

Rotor Type	Swinging Bucket
Maximum Speed *	50,000 rpm
Relative Centrifugal Force (RCF) at Maximum Speed:	
at $r_{minimum}$ (10.60 cm) at $r_{average}$ (8.44 cm) at $r_{maximum}$ (6.28 cm)	296,005 235,687 175,369
K Factor at maximum speed	53
Critical Speed	1700 rpm
Number of Buckets	6
Total Capacity (nominal)	30 ml
Total Capacity (actual) **	28.8 ml
Tube compartment diameter	1.3 cm (0.5 in)
Tube length (nominal)	5.1 cm (2 in)
Maximum compartment mass (includes bucket, tube and contents)	156.6 g
Diameter	16.5 cm (6.5 in)
Rotor weight including buckets	3.0 kg (6.7 lb)

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

** With tubes filled to within 3 mm (1/8 in) of the top.

Accessories

The parts supplied with the AH-650 Rotor ordered with complete accessories, Catalog No. 52071, are listed in Table 1-1. The AH-650 Rotor can also be purchased with basic accessories only. Catalog No. 54294, which includes all items listed in Table 1-1 except the tubes.

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

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

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

Table 1-2. Accessories Supplied

Quantity	Catalog Number	Description
4 boxes	3127	Tubes, Polyallomer 5 ml (nominal) (50/box)
1 set of 6	52072	Buckets, 5 ml
6	63713	O-rings (for rotor buckets)
1	52243	Bucket Rack
1	52258	Bucket Cap Wrench
1	51942	Rotor Storage Stand
1	65937	Vacuum Grease
1	61556	Lubricant
1	51349	Overspeed Decal, 50 000 rpm (extra)
1	52384	Ultraspeed Centrifuge/Rotor Log Book
1	52274	Instruction Manual

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

SPECIAL OPERATING CONSIDERATIONS

This chapter provides special operating considerations for Basic Operation.

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Derating Rotor Speed

Because of the stresses that the rotor body and buckets must withstand during centrifugation, it is necessary to eventually derate the maximum operating speed of the rotor. Specifically, the maximum speed of 50 000 rpm must be derated to 45 000 rpm after the rotor has been used for 1000 runs. To know when the rotor speed must be lowered, all runs should be recorded in the Ultraspeed Centrifuge/ Rotor Log Book supplied with the rotor.

Note After the maximum speed has been derated, the new lowered maximum speed should be used in all calculations and during all operations for the ensuing 1000 runs. (These runs should also be recorded in the Ultraspeed Centrifuge/Rotor Log Book). In addition, the overspeed decal on the bottom of the rotor must be replaced with a new decal (Catalog No. 51351) for the lowered speed (see page 5-3 for Overspeed Decal Replacement procedure).

WARNING After the rotor has been used for 1000 runs at the derated speed, the rotor body and any set of buckets used with it should no longer be used. Failure to do so can cause rotor failure with subsequent loss of sample and damage to the rotor and/ or centrifuge. Also, if the material being processed is hazardous, the loss of sample may result in personal injury.

Compartment Loads in Excess of Design Mass

The maximum run speed (50 000 rpm) is based on the recommended design mass that has been established for the rotor, representing the maximum mass that can be carried in each rotor bucket at top speed.

To prevent rotor failure, the total contents of each bucket, including the weight of the bucket, specimen and tube, should not exceed the recommended figure unless the rotor speed is reduced proportionately.

Strict adherence to the maximum allowable compartment mass or reduced speed is required to prevent rotor failure. Observe the WARNING on the Safety Information Page in the front of this manual.

The design mass (that is, the weight of the bucket, tube and contents) for an AH-650 bucket is 45.7 g at 50 000 rpm. This figure is based on the use of a Thermo Fisher Scientific thinwall polyallomer tube filled with liquid at 1.2 specific gravity. If the specific gravity of the solution is greater than 1.2 g, sue the following formula to determine the reduced speed:

$$\text{Reduced Speed} = 50000\ \text{rpm}\sqrt{\frac{1.2\ \text{g/ml}}{\text{Average Fluid Density}}}$$

This formula does not apply when using gradients that can precipitate (see below).

Precautions to Prevent Precipitation of Cesium Chloride

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

a. Reducing speed to prevent Precipitation

Maximum speed must be reduced for an average fluid density greater than 1.2 g/ml (square-root reduction) to prevent excessive hydraulic pressure in the bucket. Although the standard formula (see page 2-1) pertains to sucrose when material such as cesium chloride (CsCl) is used in an ultracentrifuge.

When solid, crystalline CsCl forms, it places a density of 4 g/ml at the bottom of each bucket. This density is dangerously high and can cause the rotor to fail, with subsequent sample loss. Therefore, cesium chloride solutions must be run at reduced speeds to avoid this precipitation. The allowable speed is determined by the average density of the CsCl solution and the run temperature. Saturation 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 . Figures 2-1 and 2-2 should be used to determine the maximum operating speed. Curves are given for specific average densities and various percentage fills at 5°C and 25°C that will prevent both precipitation and excessive hydraulic pressure.

Also, figures 2-1 (5°C) and 2-2 (25°C) include curves that show the standard speed (square root) reductions to avoid excessive hydraulic pressure only. The standard, square-root reduction formula cannot be used when precipitation of CsCl must be considered. For example, standard speed reduction would allow you to run a full tube of solution with a homogeneous density of 1.70 g/ml at 42 000 rpm at both the 5°C and 25°C temperature ranges. The graphs show that the highest speed you can run a cesium chloride solution of this density (1.70 g/ml) is 20 500 rpm at 5°C and 28 300 rpm at 25°C for a full tube of solution. Similarly, if you were to run a cesium chloride solution with a homogeneous density of 1.70 g/ml in a 3/4 filled tube, the highest speed you can run is 23 500 rpm at 5°C or 32 000 rpm at 25°C .

b. The Gradient Shape

The curves in figures 2-3 (5°C) and 2-4 (25°C) show the gradient shape at equilibrium for tubes filled with a CsCl solution using the homogeneous density and speeds selected from figures 2-1 and 2-2. The shape of the gradient produced in a partially-filled tube can be determined by using lines 3/4, 1/2 and 1/4 fills. For example, figure 2-1 indicates that a 3/4-filled tube with a 1.70 g/ml homogeneous CsCl solution cannot be run any faster than 23 300 rpm at 5°C. Figure 2-3 shows the gradient profile of this tube, 1.61 g/ml at the meniscus to 1.81 g/ml at the bottom of the tube. The shape of the gradient curve in figure 2-3 can be interpolated between the 20 000 rpm curve and the 25 000 rpm curve. Particle locations can be determined using the particle density and the gradient shape curves. For example, to locate a band of particles having a specific density of 1.62 g/ml in 3/4-filled tube run at 23 300 rpm at 5°C,the particles will band 0.3 ml below the 3/4-fill line of the tube (refer to figure 2-3). Similarly, figure 2-2 shows the same solution in a 3/4-filled tube cannot be run as faster than 32 000 rpm at 25°C. Figure 2-4 shows the gradient profile of this tube, 1.56 g/ml at the meniscus to 1.86 g/ml at the bottom of the tube. The shape of the gradient curve in figure 2-4 can be interpolated between the 30 000 rpm curve and the 35 000 rpm curve. To locate a band of particles having a specific density of 1.62 g/ml in a 3/4-filled tube run at 32 000 rpm at 25°C, the particles will band just below the 3.0 ml line or 0.9 ml from the 3/4-fill line of the tube (refer to figure 2-4).

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

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. Operation at the critical speed of 1700 revolutions per minute (rpm) will have a detrimental effect on centrifuge component life and therefore, should be avoided.

Chemical Compatibility

The critical components of the AH-650 Rotor apt to come in contact with solution are: rotor body (aluminum), rotor buckets (titanium), bucket caps (aluminum), O-rings (Viton®), and the material of the tubes used.

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

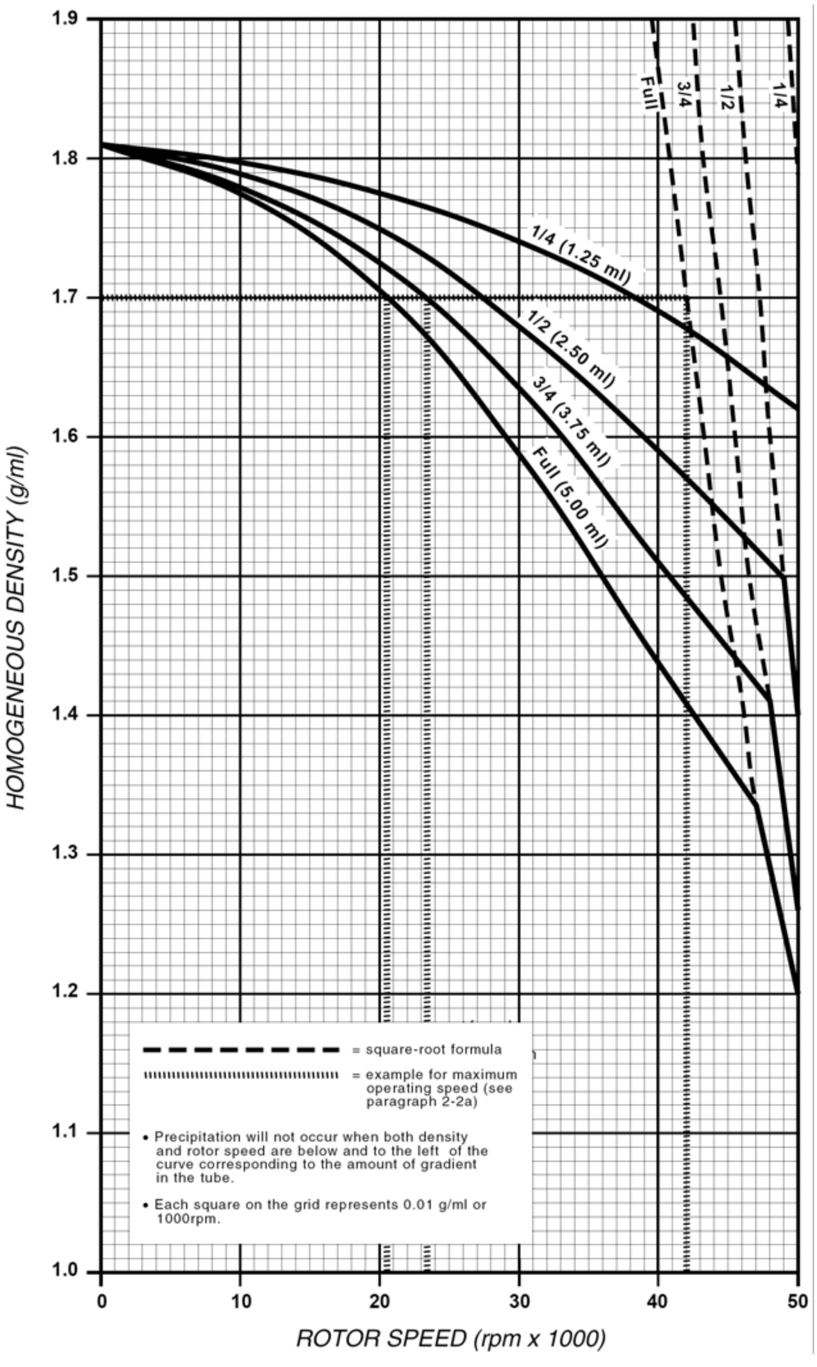


Figure 2-1. CsCl Precipitation Curve, 17 ml Buckets, 5°C

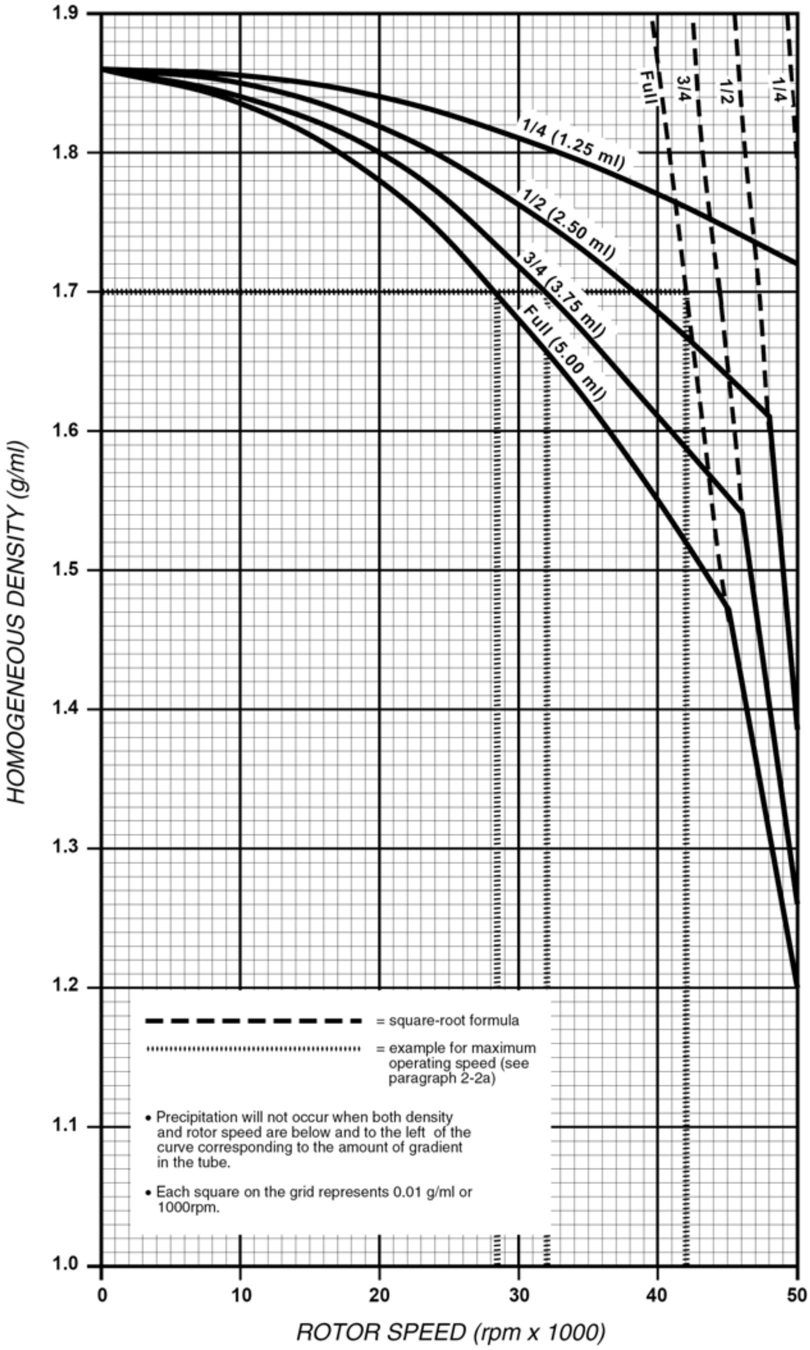


Figure 2-2. CsCl Gradients at Equilibrium, 17 ml Buckets, 5°C

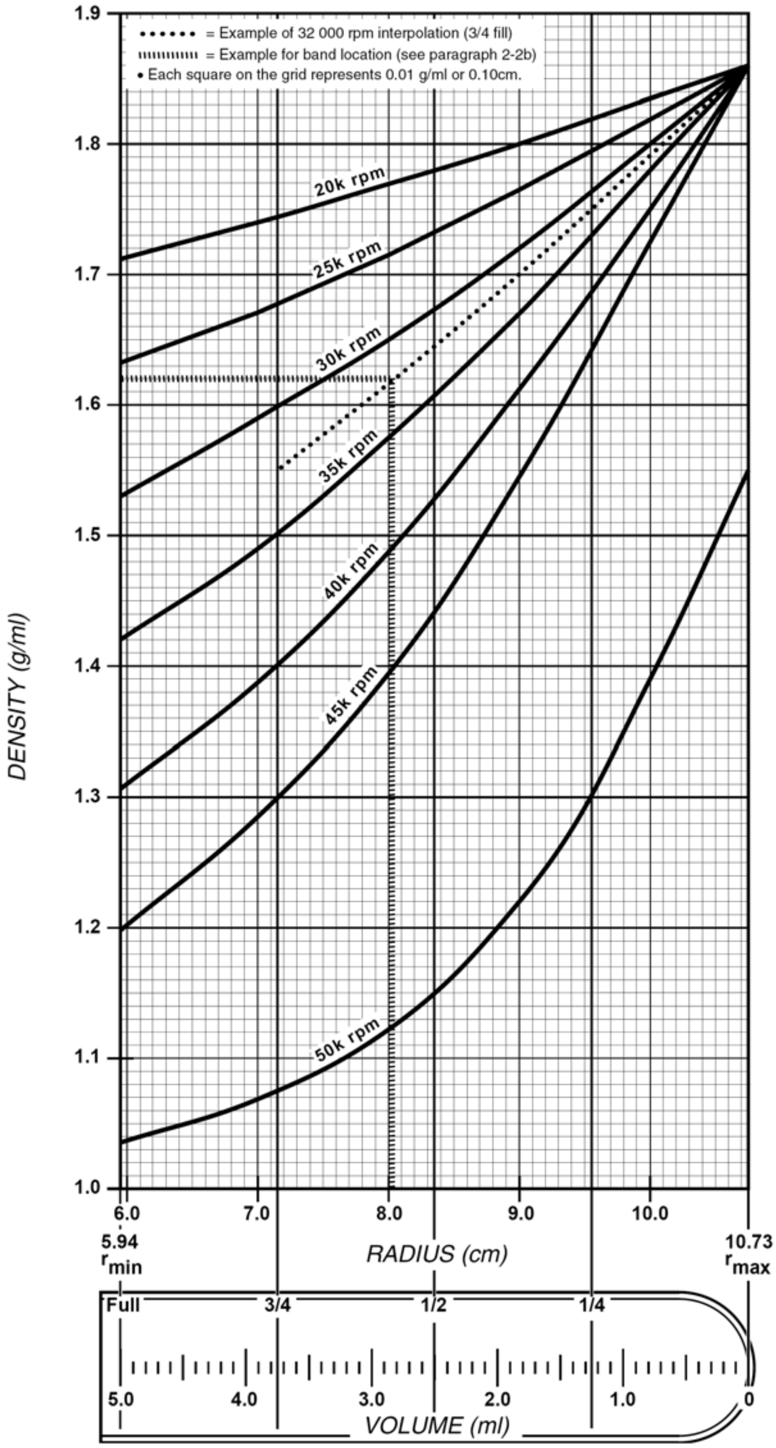


Figure 2-3. CsCl Precipitation Curve, 20 ml Buckets, 5°C

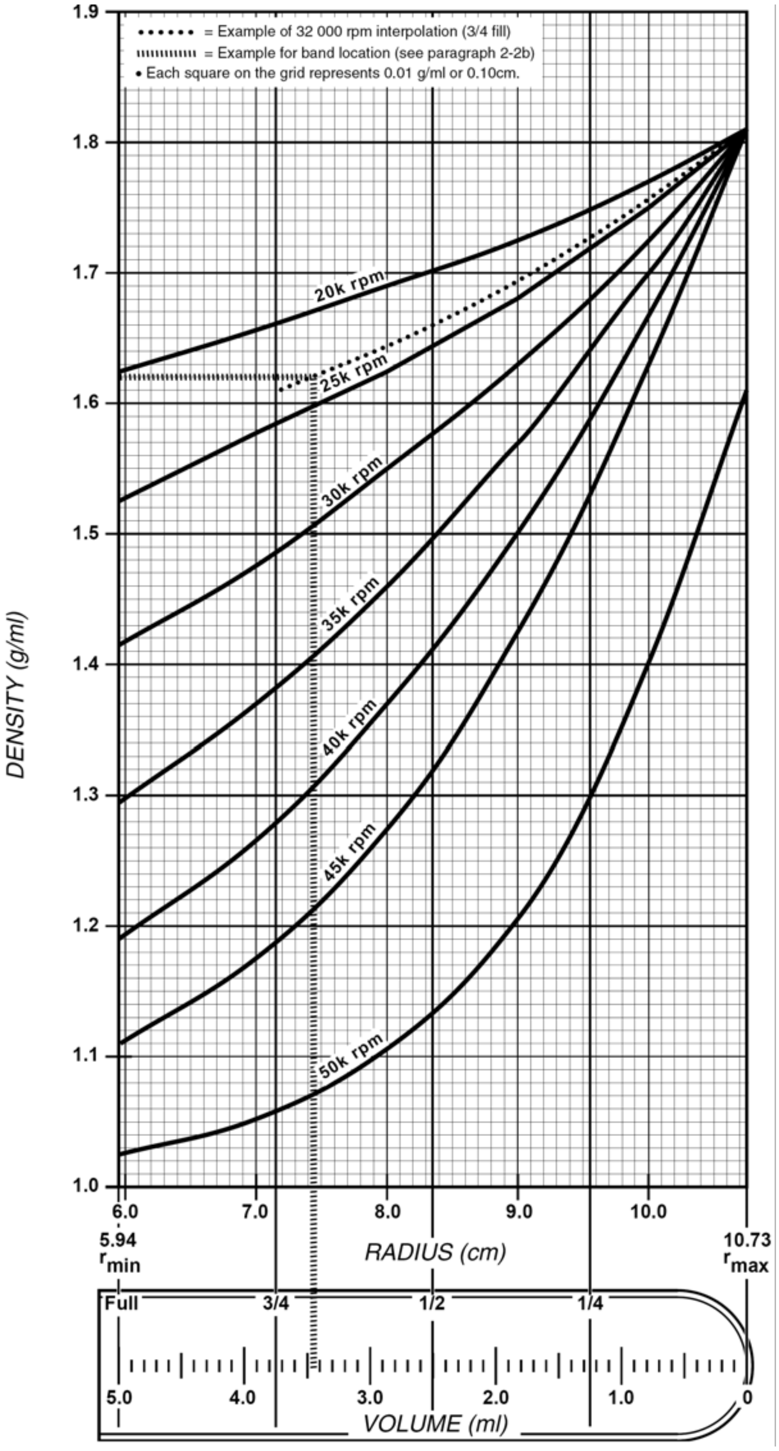


Figure 2-4. CsCl Gradients at Equilibrium, 20 ml Buckets, 5°C

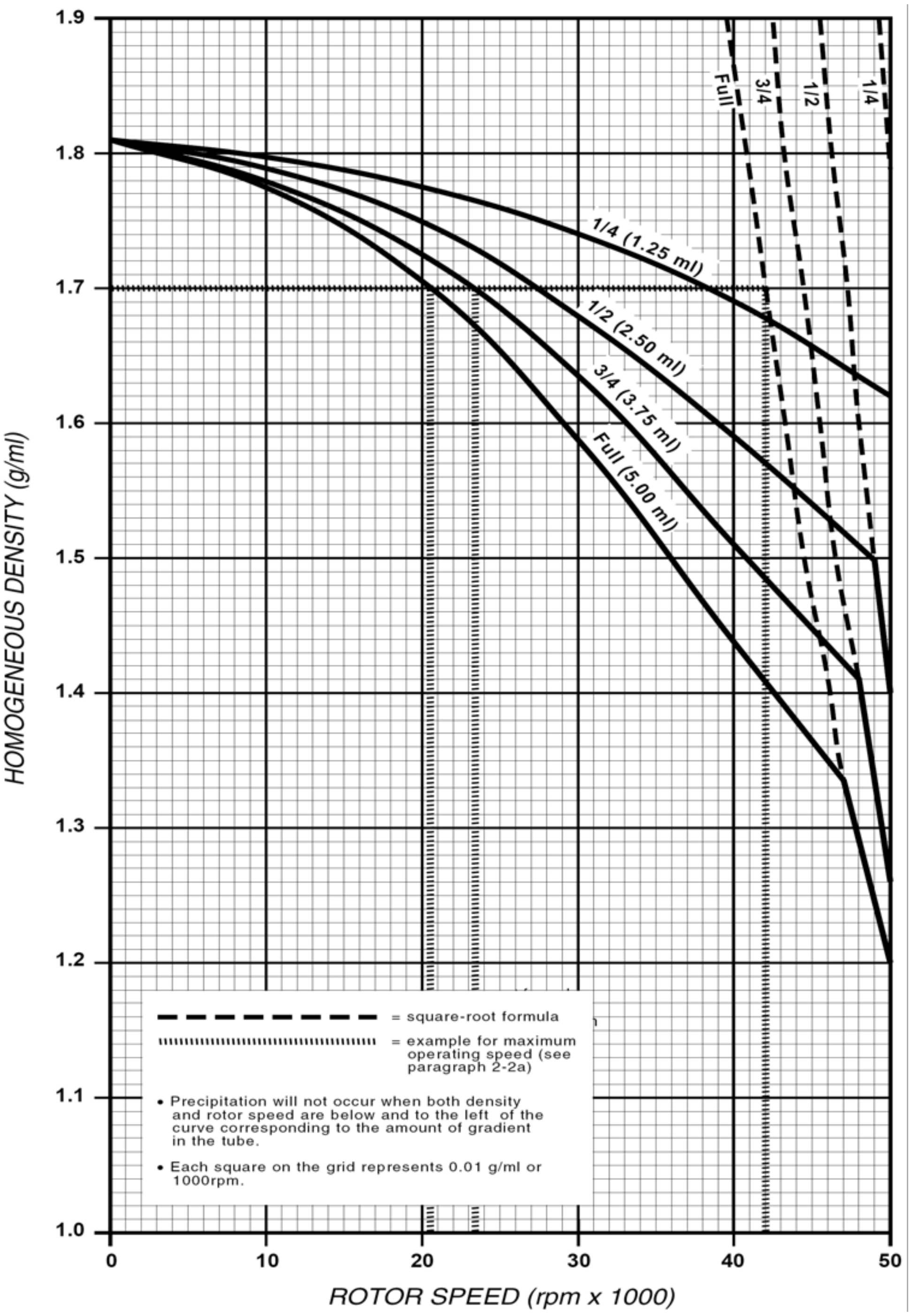
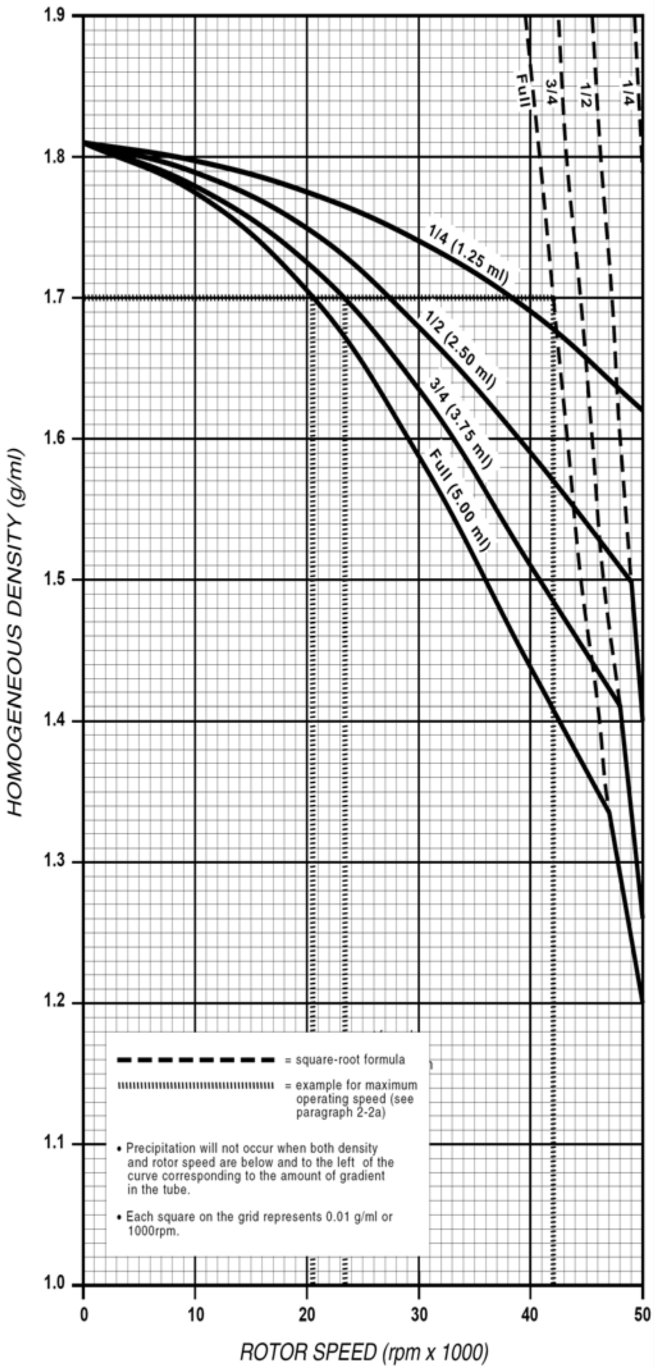


Figure 2-5. CsCl Precipitation Curve, 36 ml Buckets, 5°C


1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
HOMOGENEOUS DENSITY (g/ml)
0
10
20
30
40
50
ROTOR SPEED (rpm x 1000)
Full
3/4
1/2
1/4
1/4 (1.25 ml)
1/2 (2.50 ml)
3/4 (3.75 ml)
Full (5.00 ml)
= square-root formula
= example for maximum operating speed (see paragraph 2-2a)
• Precipitation will not occur when both density and rotor speed are below and to the left of the curve corresponding to the amount of gradient in the tube.
• Each square on the grid represents 0.01 g/ml or 1000rpm.

OPERATION

This chapter provides step-by-step operating instructions for Basic Operation.

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Prerun Safety Checks

WARNING When using a tube assembly other than those supplied by Thermo Fisher Scientific, be sure to check the top speed capability, when in doubt, do a test run for the desired application. If using a Thermo Fisher Scientific tube assembly other than those recommended for use with this rotor, refer to the Product Guide for the maximum speed of the tube. Exceeding the top speed capability of the tube assembly can result in tube breakage.

To ensure safe performance of the rotor, check the following items before every run:

a. read the Safety Information Page in the front of this manual.

b. make sure there are no burrs or scratches on the bucket and bucket seats.

c. check the centrifuge chamber, drive spindle, and mounting surface of the rotor to be sure they are clean and free of scratches and burrs.

d. make sure the buckets are properly seated on the rotor body hooks.

e. inspect the bucket cap O-ring for cracks, tears or abrasions; replace if necessary.

f. check that each bucket cap is on tight (page 3-2).

g. make sure the proper overspeed decal (18 black segments) is attached to the bottom of the rotor; if the rotor has been derated to 45 000 rpm, the decal should have 20 black segments (see page 5-3 for Overspeed Decal Replacement procedure).

h. check the chemical compatibility of all materials used (see Appendix).

i. be sure the proper environment has been selected for operation; that is, controlled ventilation or isolation, if required.

j. check the top speed capability of the tube (or bottle) being used. Read the Caution.

Rotor Precool

If samples are routinely processed around 4°C or below, the rotor can be stored in a refrigerator or cold room. If this is not possible, the rotors and buckets can easily be precooled in a Thermo Fisher Scientific Refrigerated Superspeed centrifuge. Refer to the Ultraspeed Centrifuge Instruction Manual for precooling directions. Be careful not to precool the rotor at the critical speed (see page 2-3, Critical Speed).

Tube Filling and Bucket Loading

The tubes that are supplied with the AH-650 Rotor are made of pollyallomer. They are translucent, easily cut or pierced (for sample removal), and resistant to most chemicals (see Appendix).

CAUTION When using tubes other than those supplied with this rotor, be sure to do a test run to check the top speed capability of the tubes being used.

The dimensions of each tube are 1.3 cm (diameter 5.1 cm (length) with a nominal fluid capacity of 5 ml each.

Assembly the tube and bucket as follows (see figure 3-1):

1. Before each run, apply a thin film of vacuum grease (Catalog No. 65937) to the bucket cap O-ring. Then, reapply a thin film of lubricant (Catalog No. 61556) on the threads of the bucket cap. Reinstall the greased O-ring in the bucket making sure it is seated in the groove below the threads.

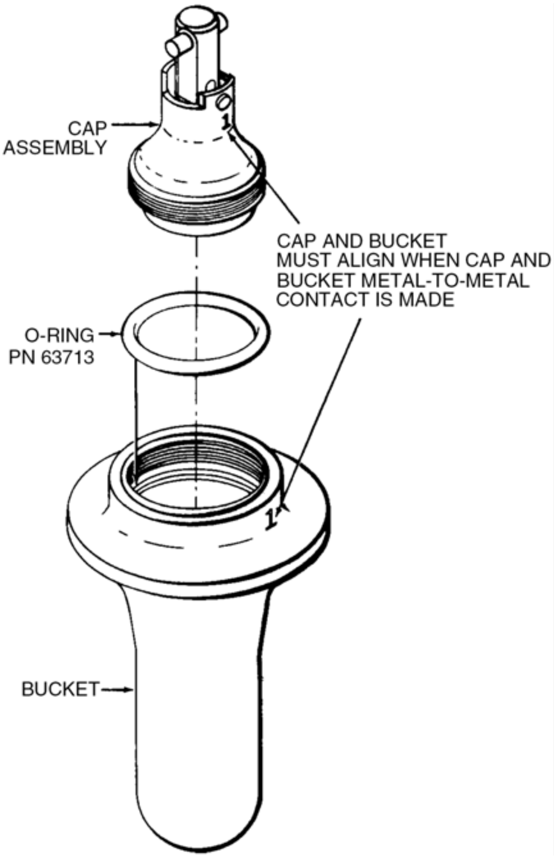

Figure 3-1. Cap and Bucket Assembly

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

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

3. Fill each tube to within 3 mm (1/8 inch) from the top to prevent the tube from collapsing during centrifugation. If the sample does not fill the tube to this level, add a light mineral oil above the sample or a dense, inert liquid below it.

4. Hold the bucket upright and insert the tube into the bucket.

5. To seal the bucket, screw the bucket cap down until metal-tometal contact is made. Bucket and cap numbers will align when the cap is tight. Each cap is numbered and must be used with its corresponding numbered bucket for proper balance.

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

Rotor Balancing

Always balance the rotor according to the following criteria:

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

b. balance pairs of tubes containing a fluid of identical specific to within 0.1 gram and place them in opposite rotor compartments.

c. when using less than a full complement of six buckets, the rotor can be operated at its maximum allowable speed with two, three, or four samples, provided opposing pairs of buckets are positioned as shown in figure 2-3. Empty buckets must be placed in the remaining positions.

CAUTION For proper rotor balance, always install empty buckets in all unused bucket positions.

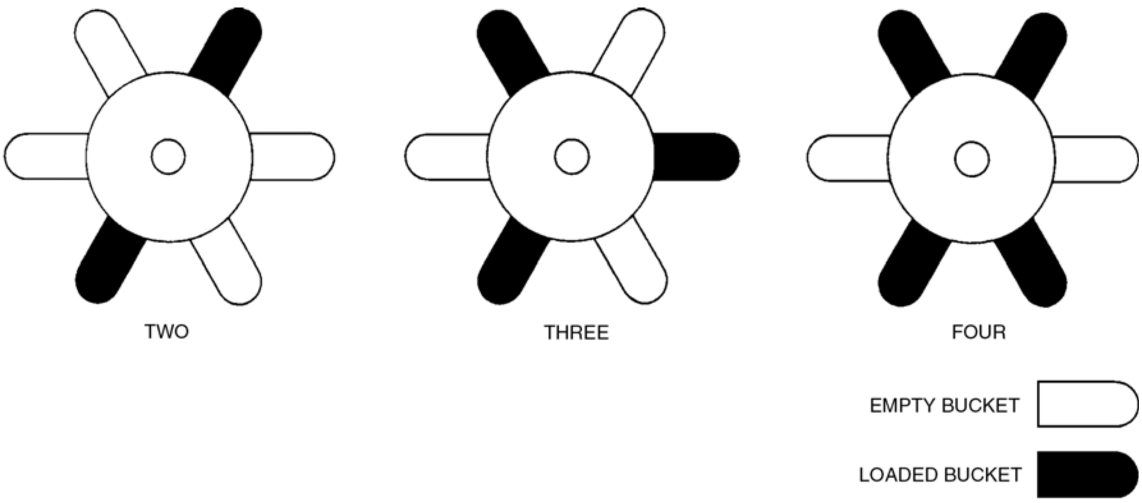

Figure 3-2. Rotor Balancing

Bucket Attachment

To attach the buckets to the rotor:

1. Hold each loaded bucket vertically with the single-digit number facing you. Gently insert it in the proper bucket position (matching number) on the rotor body.

CAUTION For maximum rotor and bucket life, you should always use the same set of buckets and bucket caps with the same rotor body. Failure to do so invalidates the rotor warranty.

Note Buckets must be attached to the rotor body at the bucket positions with the number that matches that on the bucket.

2. Gently bring the bucket down until the pin engages on the two hooks on the rotor body.

3. Check the bucket attachment by gently twisting the bucket in both directions about its vertical axis. A properly seated bucket can be moved a few degrees in each direction. Be careful not to unscrew the bucket cap.

Rotor Installation

To install the rotor in the centrifuge:

1. Carry the rotor carefully with both hands placed around the rotor body.

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

2. Lower the rotor in the chamber smoothly and vertically.
3. Be sure the rotor snaps in place on the drive adapter. Check that the rotor is properly seated by pulling it gently in an upward direction and noting a small amount of resistance.
4. When the rotor is seated, recheck the buckets to be sure they swing freely.
5. Perform the run as explained in the centrifuge instruction manual.

Centrifuge/Rotor Log

An Ultraspeed Centrifuge/Rotor Log Book is supplied with the AH-650 Rotor so that the user can easily record all data necessary to meet the warranty stipulation that any defective ultraspeed centrifuge rotor (or ultracentrifuge) returned to Sorvall must be accompanied by an up-to-date history of the rotor.

Each time the AH-650 Rotor is used, record the run in the log book. If desired, the information may be recorded elsewhere, however, it must include all data shown in Table 3-1, Sample Centrifuge/Rotor Log Sheet.

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

Figure 3-3. Sample Centrifuge/Rotor Log Sheet

Technical Notes

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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:

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

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

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

Figure 4-1 shows the minimum, average, and maximum radii of the AH-650 Rotor. Tables 4-1 gives the RCF value at each radii from 20 000 rpm to 50 000 rpm (in increments of 500 rpm). The RCF value at any other speed can be calculated by using the formula above.

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

CAUTION Do not operate this rotor unless it is symmetrically balanced. Operating the centrifuge with the rotor out of balance can cause damage to the centrifuge drive assembly.

WARNING Always reduce (derate) rotor speed of the installed rotor as instructed in this manual whenever the compartment load exceeds the maximum allowable compartment load specified. Failure to reduce rotor speed under these conditions can cause rotor failure.

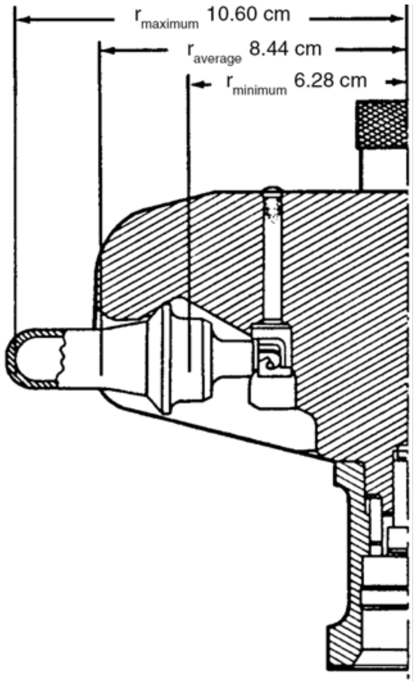

Figure 4-1. AH-650 Rotor Radii

Table 4-1. AH-650 Rotor: RCF Values and K Factors

Speed (rpm)	r_{max} 10.60 cm	r_{avg} 8.44cm	r_{min} 6.28 cm	K Factor
20 000	47 361	37 710	28 059	331
20 500	49 758	39 619	29 480	315
21 000	52 215	41 575	30 935	300
21 500	54 731	43 579	32 426	287
22 000	57 307	45 629	33 951	274
22 500	59 941	47 727	35 512	262
23 000	62 635	49 871	37 108	250
23 500	65 388	52 063	38 739	240
24 000	68 200	54 302	40 405	230
24 500	71 071	56 588	42 106	221
25 000	74 001	58 922	43 842	212
25 500	76 991	61 302	45 613	204
26 000	80 040	63 730	47 420	196
26 500	83 148	66 204	49 261	189
27 000	86 315	68 726	51 138	182
27 500	89 542	71 295	53 049	175
28 000	92 827	73 911	54 996	169
28 500	96 172	76 575	56 977	163
29 000	99 576	79 285	58 994	158

Table 4-1. AH-650 Rotor: RCF Values and K Factors

Speed (rpm)	r_{max} 10.60 cm	r_{avg} 8.44cm	r_{min} 6.28 cm	K Factor
29 500	103 039	82 043	61 046	152
30 000	106 562	84 847	63 133	147
30 500	110 143	87 699	65 255	142
31 000	113 784	90 598	67 412	138
31 500	117 484	93 544	69 604	134
32 000	121 244	95 537	71 831	129
32 500	125 062	99 578	74 093	125
33 000	128 940	102 665	76 391	122
33 500	132 877	105 800	78 723	118
34 000	136 873	108 982	81 091	115
34 500	140 928	112 211	83 493	111
35 000	145 042	115 487	85 931	108
35 500	149 216	118 810	88 404	105
36 000	153 449	122 180	90 911	102
36 500	157 741	125 598	93 454	99.4
37 000	162 092	129 062	96 032	96.7
37 500	166 503	132 574	98 645	94.2
38 000	170 972	136 133	101 293	91.7
38 500	175 501	139 739	103 976	89.4
39 000	180 089	143 392	106 694	87.1
39 500	184 737	147 092	109 448	84.9
40 000	189 443	150 840	112 236	82.8
40 500	194 209	154 634	115 060	80.7
41 000	199 034	158 476	117 918	78.8
41 500	203 918	162 365	120 812	76.9
42 000	208 861	166 301	123 740	75.1
42 500	213 864	170 284	126 704	73.3
43 000	218 925	174 314	129 703	71.6
43 500	224 046	178 391	132 737	70.0
44 000	229 226	182 516	135 806	68.4
44 500	234 466	186 688	138 910	66.9
45 000	239 764	190 906	142 049	65.4
45 500	245 122	105 172	145 223	64.0
46 000	250 539	199 485	148 432	62.6
46 500	256 015	203 846	151 677	61.3
47 000	261 550	208 253	154 956	60.0

Table 4-1. AH-650 Rotor: RCF Values and K Factors

Speed (rpm)	r_{max} 10.60 cm	r_{avg} 8.44cm	r_{min} 6.28 cm	K Factor
47 500	267 145	212 708	158 271	58.7
48 000	272 798	217 209	161 620	57.5
48 500	278 511	221 758	165 005	56.3
49 000	284 283	226 354	168 424	55.2
49 500	290 115	230 997	171 879	54.1
50 000	296 005	235 687	175 369	53.0

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 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 AH-650 Rotor at speeds from 20 000 rpm to 50 000 rpm are listed in Table 4-1.

Example: The A-650 Rotor used with sealed bottles has a K factor of 53.0 at the maximum permitted speed (50,000 rpm). If the particles to be sedimented have a sedimentation coefficient of 40 S, the estimated run time required at maximum speed will be:

$$t = \frac{53.0}{40S}\ 1.33\text{ hours} = 1\text{ hours, 20 minutes}$$

[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.

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:

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 Svedbergs[1]

Table 4-2 gives K^1 factors for the AH-650 Rotor when operated at maximum speed (that is, 52 000 rpm) with particles ranging in density from 1.1 g/cm3 to 1.9 g/cm3. The K^1 factors are based on the use of a 5% - 20% (w/w) linear sucrose density gradient at 5°C.

Table 4-2. K^1 Factor for the AH-650 Rotor (at maximum speed)

Particle Density (g/cm^3)	17 ml Bucket	K 1 Factor 20 ml Bucket	36 ml Bucket
1.1	3114	1758	2718
1.2	1722	938	1486
1.3	1526	826	1314
1.4	1444	778	1245
1.5	1400	757	1205
1.6	1369	738	1177
1.7	1348	727	1150
1.8	1333	715	1146
1.9	1320	708	1133

5

CARE and MAINTENANCE

This chapter provides care and maintenance instructions.

Contents

Corrosion

The AH-650 rotor body is made from aluminum alloy for high strength-to-weight ratio, and the buckets are made of titanium. Although aluminum corrosion resistance is good, it is not as good as stainless steel or titanium, and should be maintained and kept clean. 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 corrosionresistant 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 or buckets are not kept clean and chemicals remain on them, corrosion will result. Also, any moisture left on the buckets 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

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

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

1. Washing

   Wash the rotor body and buckets with warm water and 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 dishwashing liquid. Rinse the rotor well, inside and out. After rinsing, dry thoroughly with a soft absorbent cloth.

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

   Wash cap assemblies with a mild detergent solution, rinse and dry carefully before storing. Occasionally apply a thin film of lubricant (Catalog No. 61556) to the bucket and cap threads. This will prevent galling and permit easier cap removal.

CAUTION Do not autoclave the aluminum cap assemblies. If the rotor body or cap assemblies are subjected to temperatures above 100°C, they should not be used. Use gas or chemical sterilization, if necessary.

2. Decontamination

   Ethylene oxide, a 2% glutaraldehyde solution, or ultraviolet radiation are the recommended methods of sterilization; however, the titanium buckets of the AH-650 Rotor can be autoclaved at temperatures up to 121°C.

CAUTION Most commercially available radioactive decontamination solutions are not compatible with aluminum or titanium.

   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.

Inspection

The rotor body, buckets, and cap assemblies should be inspected periodically for signs of: stress, including cracks, tears, or brasions; wear; corrosion, indicated by pitting or scratching; or deformation.

Replace any damaged part. Contact your Thermo Fisher Scientific Service Representative for information about the inspection of rotors or about rotor replacement.

Inspect bucket O-ring regularly for cracks, tears, or abrasions; replace if necessary. Keep O-rings lightly greased using vacuum grease (Catalog No. 65937) supplied. Occasionally apply a thin film of lubricating grease (Catalog No. 61556) to the bucket and cap threads. This will prevent galling and permit easier cap removal.

Storage

Rinse and dry each bucket, then store them (with caps off) upsidedown and slightly tilted so air can circulate through the bucket. This will help prevent moisture from settling in the bottom of the bucket.

Overspeed Decal Replacement

Before replacing the decal, be sure that 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.

Note Check that the new decal has the correct number of black segments – the decal for the AH-650 Rotor should have 18 black segments or if the rotor has been derated 20 black segments.

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 on the bottom of the rotor. Be sure that 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:

1. Clean the centrifuge or rotor to be serviced of all encrusted material and decontaminate (see Maintenance Section of centrifuge or rotor instruction manual) it prior to servicing by the Thermo Fisher Scientific representative or returning it 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 Care and Maintenance Section of 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 an Equipment Return Form and return it to Thermo Fisher Scientific. Upon receipt of a completed form, a Returned Material Authorization Number (RMA Number) will be issued to you.

2. With the RMA Number clearly marked on the outside of packaging, send the items 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. Outside the United States, check local regulations.

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 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 the 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

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®
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
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

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®
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
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

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 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
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

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®
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
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

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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.

Contact Information

United States	866-9-THERMO
	+1 866 984 3766
Canada	+1 866 984 3766
Austria	+43 1 801 400
Belgium	+32 2 482 30 30
Germany	08001 536 376
	+49 6184 90 6940
France	+33 2 2803 2180
	+33 2 2803 2000
Italy	+39 02 02 95059 341
Netherlands	+31 76 571 4440
Nordic / Baltic Countries	+35 89 329 100
Russia	+7 (812) 703 42 15

Spain	+34 932 23 09 18
Portugal	+34 932 23 09 18
Switzerland	+41 44 454 12 12
UK / Ireland	+44 870 609 9203
China	+86 21 6865 4588
	+86 10 8419 3588
India	+91 22 6716 2200
Japan	+81 45 453 9220
Other Asian Countries	+852 2885 4613
Latin America	+1 866 984 3766
Other Countries	+49 6184 90 6940
	+33 2 2803 2180

CHINA
Tel.: +86 21 68 65 45 88
Tel.: +86 10 58 50 35 88

INDIA
Tel.: +91 22 55 42 94 94

JAPAN
Tel.: +81 454 53 92 20

OTHER ASIA PACIFIC COUNTRIES
Tel.: +852 28 85 46 13

AUSTRIA
Tel.:+43 (1) 80 14 00

BELGIUM
Tel.: +32 24 82 30 30

FINLAND
Tel.: +35 89 32 91 00

FRANCE
Tel.: +33 1 69 18 77 77
+33 2 28 03 20 00

GERMANY
Tel.: +49 61 84 90 69 40
+49 61 03 40 81 012

ITALY
Tel.: +39 02 95 05 91

NETHERLANDS
Tel.: +31 7 65 71 44 40

SPAIN or PORTUGAL
Tel.: +34 9 32 23 31 54

SWITZERLAND
Tel : +41 (1) 4 54 12 12

UNITED KINGDOM or IRELAND
Tel.: +44 87 06 09 92 03

Other EUROPE, MIDDLE EAST, or AFRICA
Tel.: +49 61 84 90 69 40
+33 2 28 03 20 00

RUSSIA/CIS
Tel: +7 09 52 25 11 15

UNITED STATES of AMERICA
Tel.: +1 800 522 77 46
+1 866 984 37 66

CANADA or LATIN AMERICA
Tel.: +1 800 522 77 46
+1 866 984 37 66

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