

Instructions For Use

Type 70 Ti Fixed-Angle Rotor

For Use in Beckman Coulter
Class H, R, and S Preparative
Ultracentrifuges



PN L5-TB-030BA
February 2014



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Type 70 Ti Fixed-Angle Rotor
PN L5-TB-030BA (February 2014)

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Revision History

This document applies to the latest software listed and higher versions. When a subsequent software version changes the information in this document, a new issue will be released.

Issue BA, 002/14

The following sections have changed subsequent to revision AY:

- *Available Tubes and Bottles for the Type 70 Ti Rotor*
- *Thinwall Tubes*
- *Thickwall Tubes*

Safety Notice

Read all product manuals and consult with Beckman Coulter-trained personnel before attempting to use this equipment. Do not attempt to perform any procedure before carefully reading all instructions. Always follow product labeling and manufacturer's recommendations. If in doubt as to how to proceed in any situation, contact your Beckman Coulter Representative.

Alerts for Warning, Caution, Important, and Note

WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

CAUTION indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

IMPORTANT IMPORTANT is used for comments that add value to the step or procedure being performed. Following the advice in the Important adds benefit to the performance of a piece of equipment or to a process.

NOTE NOTE is used to call attention to notable information that should be followed during installation, use, or servicing of this equipment.

Safety Information for the Type 70 Ti Rotor

This rotor was developed, manufactured, and tested for safety and reliability as part of a Beckman Coulter ultracentrifuge/rotor system. Its safety or reliability cannot be assured if used in a centrifuge not of Beckman Coulter's manufacture or in a Beckman Coulter ultracentrifuge that has been modified without Beckman Coulter's approval.

Handle body fluids with care because they can transmit disease. No known test offers complete assurance that such fluids are free of micro-organisms. Some of the most virulent—Hepatitis (B and C) viruses, HIV (I–V), atypical mycobacteria, and certain systemic fungi—further emphasize the need for aerosol protection. Handle other infectious samples according to good laboratory procedures and methods to prevent spread of disease. Because spills may generate aerosols, observe proper safety precautions for aerosol containment. Do not run toxic, pathogenic, or radioactive materials in this rotor without taking appropriate safety precautions. Biosafe containment should be used when Risk Group II materials (as identified in the World Health Organization *Laboratory Biosafety Manual*) are handled; materials of a higher group require more than one level of protection.

Safety Notice

Safety Information for the Type 70 Ti Rotor

The rotor and accessories are not designed for use with materials capable of developing flammable or explosive vapors. Do not centrifuge such materials in nor handle or store them near the ultracentrifuge.

Although rotor components and accessories made by other manufacturers may fit in the Type 70 Ti rotor, their safety in this rotor cannot be ascertained by Beckman Coulter. Use of other manufacturers' components or accessories in the Type 70 Ti rotor may void the rotor warranty and should be prohibited by your laboratory safety officer. Only the components and accessories listed in this publication should be used in this rotor.

Make sure that filled containers are loaded symmetrically into the rotor and that opposing tubes are filled to the same level with liquid of the same density. Make sure that cavities in use have the proper spacers inserted (if applicable) before installing the rotor lid.

If disassembly reveals evidence of leakage, you should assume that some fluid escaped the rotor. Apply appropriate decontamination procedures to the centrifuge and accessories.

Never exceed the maximum rated speed of the rotor and labware in use. Refer to the section on [Run Speeds](#), and derate the run speed as appropriate.

Do not use sharp tools on the rotor that could cause scratches in the rotor surface. Corrosion begins in scratches and may open fissures in the rotor with continued use.

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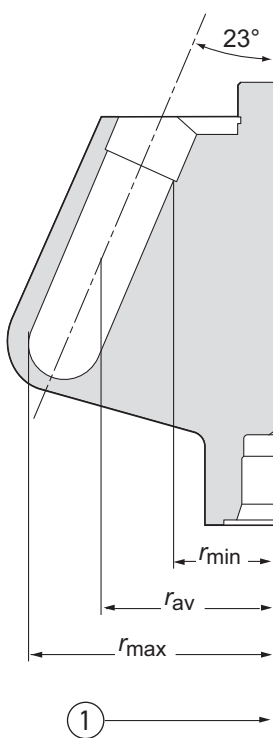
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Type 70 Ti Fixed-Angle Rotor

Specifications



1. 1. Axis of Rotation

Maximum speed 70,000 RPM

Density rating at maximum speed 1.2 g/mL

Relative Centrifugal Field^a at maximum speed

At r_{\max} (91.9 mm) $504,000 \times g$

At r_{av} (65.7 mm) $361,000 \times g$

At r_{\min} (39.5 mm) $217,000 \times g$

k factor at maximum speed 44

Conditions requiring speed reductions see [Run Speeds](#)

Number of tube cavities 8

Available tubes see [Table 1](#)

Nominal tube dimensions (largest tube) 25 × 89 mm

Nominal tube capacity (largest tube) 39 mL

Nominal rotor capacity 312 mL

Approximate acceleration time to maximum speed
(fully loaded) 8 1/2 min

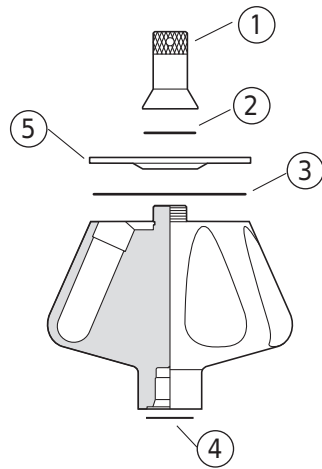
Approximate deceleration time from maximum speed
(fully loaded) 7 min

Weight of fully loaded rotor 9 kg (20 lb)

Rotor material titanium

a. Relative Centrifugal Field (RCF) is the ratio of the centrifugal acceleration at a specified radius and speed (rw^2) to the standard acceleration of gravity (g) according to the following formula: $RCF = \omega^2 r / g$ — where r is the radius in millimeters, ω is the angular velocity in radians per second ($2 \pi \text{ RPM} / 60$), and g is the standard acceleration of gravity (9807 mm/s^2). After substitution: $RCF = 1.12r (\text{RPM}/1000)^2$

Description



1. Handle (337924)
2. Handle O-Ring (011757)
3. Lid O-Ring (870612)
4. Overspeed Disk (335585)
5. Lid (337923)

Beckman Coulter Type 70 Ti rotors are manufactured in a facility that maintains certifications to both ISO 9001:2008 and ISO 13485:2003. They are for use with the specified Beckman Coulter ultracentrifuges. The rotors were developed, manufactured, and tested for safety and reliability as part of a Beckman Coulter ultracentrifuge/rotor system. Their safety or reliability cannot be assured if used in an ultracentrifuge not of Beckman Coulter's manufacture or in a Beckman Coulter ultracentrifuge that has been modified without Beckman Coulter's approval.

The Type 70 Ti is a fixed-angle rotor designed to centrifuge up to eight tubes at a 23-degree angle to the axis of rotation. Used in Beckman Coulter class H, R, and S preparative ultracentrifuges, the rotor develops centrifugal forces sufficient for applications including pelleting of small particles, and purification of viruses and subcellular organelles using sucrose gradients. Up to 312 mL of sample and gradient can be centrifuged per run.

The rotor is made of titanium and is finished with black polyurethane paint. The aluminum lid and handle are anodized for corrosion resistance. The handle is interchangeable with the Type 70.1 Ti rotor handle but no others. O-rings made of Buna N rubber in the lid and handle maintain atmospheric pressure inside the rotor during centrifugation, if they are properly lubricated. The lid is a patented design that seats on the rotor body so that centrifugal force aids sealing. Four small holes in the lid provide a temporary vent, preventing pressure build-up and extrusion of the large lid O-ring in the event of leakage. Because of the weight of the rotor, drive pins are not required in the rotor drive hub cavity.

For overspeed protection, a photoelectrical detector in the ultracentrifuge monitors the overspeed disk on the rotor bottom and shuts down the run if speeds exceeding 70,000 RPM are detected.

See the Warranty at the back of this manual for warranty information.

Preparation and Use

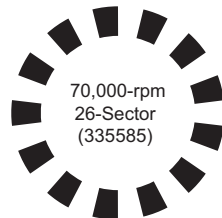
*Specific information about the Type 70 Ti rotor is given here. Information common to this and other rotors is contained in *Rotors and Tubes for Preparative Ultracentrifuges* (publication LR-1M), which should be used together with this manual for complete rotor and accessory operation.*

NOTE Although rotor components and accessories made by other manufacturers may fit in the Type 70 Ti rotor, their safety in this rotor cannot be ascertained by Beckman Coulter. Use of other manufacturers' components or accessories in the Type 70 Ti rotor may void the rotor warranty and should be prohibited by your laboratory safety officer. Only the components and accessories listed in this publication should be used in this rotor.

Prerun Safety Checks

Read the [Safety Notice](#) section at the front of this manual before using the rotor.

- 1 Make sure that the rotor and lid are clean and show no signs of corrosion or cracking.
- 2 Make sure the 26-sector (70,000 RPM) overspeed disk is properly attached to the rotor bottom. If the disk is missing or damaged, replace it according to the instructions in *Rotors and Tubes*.



- 3 Verify that only the tubes and bottles listed in [Table 1](#) are being used.
 - 4 Check the chemical compatibilities of all materials used (refer to *Chemical Resistances*, publication IN-175).
-

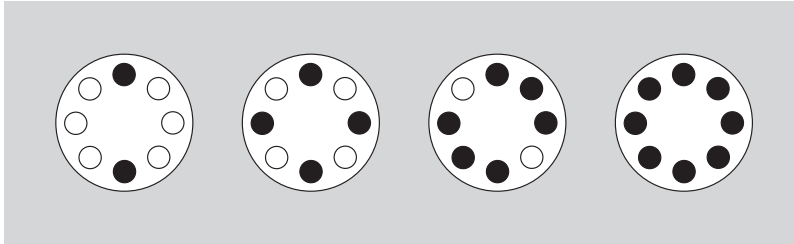
Rotor Preparation

For runs at other than room temperature refrigerate or warm the rotor beforehand for fast equilibration.

- 1 Be sure that metal threads in the rotor are clean and lightly but evenly lubricated with Spinkote lubricant (306812).
Also ensure that O-rings are lightly but evenly coated with silicone vacuum grease.

- 2 Load the filled containers symmetrically into the rotor.
(Refer to *Tubes, Bottles, and Accessories* on page 10 for information about containers).
If fewer than eight tubes are being run, they must be arranged symmetrically in the rotor (see *Figure 1*).
Opposing tubes must be filled to the same level with liquid of the same density.

Figure 1 Arranging Tubes in the Rotor

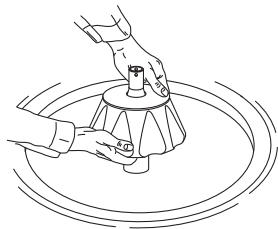


NOTE Two, four, six, or eight tubes can be centrifuged per run if they are arranged in the rotor as shown.

- 3 Complete loading by placing the correct spacers (if required) over the tubes.
NOTE Place filled tubes in at least two opposing cavities. Make sure that cavities in use also have the proper spacers inserted (if applicable) before installing the rotor lid. See page 10 for special installation instructions for thinwall tubes (344367) with crimp-lock caps.
- 4 Put the lid in place and tighten as firmly as possible.

Operation

- 1 Carefully lower the rotor straight down onto the drive hub.



- 2 Refer to the applicable instrument instruction manual for ultracentrifuge operation.

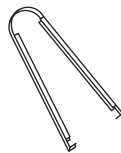
- 3 For additional operating information, see the following:
 - [Run Times](#), page 14, for using k factors to adjust run durations.
 - [Run Speeds](#), page 15, for information about speed limitations.
 - [Selecting CsCl Gradients](#), page 16, for methods to avoid CsCl precipitation during centrifugation.

Removal and Sample Recovery

 **CAUTION**

If disassembly reveals evidence of leakage, you should assume that some fluid escaped the rotor. Apply appropriate decontamination procedures to the ultracentrifuge and accessories.

- 1 Remove the rotor from the centrifuge by lifting it straight up and off the drive hub.
- 2 Remove the rotor lid.
- 3 Use the appropriate removal tool (listed in the [Supply List](#)) to remove the spacers and tubes.



Quick-Seal Tube Removal Tool (361668)

Tubes, Bottles, and Accessories

The Type 70 Ti rotor uses the tubes, bottles, and accessories listed in [Table 1](#). Be sure to use only those items listed, and to observe the maximum speed limits and fill volumes shown. (Maximum fill volume is the maximum amount that can be centrifuged in the container listed.) Refer to *Chemical Resistances* for information on the chemical compatibilities of tube, bottle, and accessory materials.

Table 1 Available Tubes and Bottles for the Type 70 Ti Rotor^a

| Tube | | | | Required Accessory | | Max Speed/ RCF/ k factor |
|------------|-----------------------------------|-----------------|----------------------|---|---------------------|---|
| Dimensions | Description | Part Number | Max Fill Volume | Description | Part Number | |
| 25 × 89 mm | Quick-Seal Ultra-Clear | 344326 (pkg/50) | 39 mL | red aluminum spacer | 342699 | 70,000 RPM 504,000 × g 44 |
| 25 × 89 mm | Quick-Seal polypropylene | 342414 (pkg/50) | 39 mL | red aluminum spacer | 342699 | 70,000 RPM 504,000 × g 44 |
| 25 × 89 mm | Ultra-clear | 344058 (pkg/50) | 38.5 mL ^b | red aluminum cap | 331151 | 60,000 RPM 371,000 × g 59 |
| 25 × 89 mm | Thinwall polypropylene | 326823 (pkg/50) | 38.5 mL ^b | red aluminum cap | 331151 | 60,000 RPM 371,000 × g 59 |
| 25 × 89 mm | Stainless steel | 301112 | 38.5 mL | aluminum cap | 302133 | 40,000 RPM ^c 165,000 × g 135 |
| 25 × 83 mm | Thinwall polypropylene | 344367 (pkg/50) | 38.5 mL | titanium/aluminum cap | 337927 ^d | 70,000 RPM 504,000 × g 43 |
| 25 × 83 mm | Quick-Seal polypropylene bell-top | 344623 (pkg/50) | 33 mL | plastic spacer | 344635 | 70,000 RPM 504,000 × g 38 |
| 26 × 77 mm | OptiSeal bell-top ^e | 361625 (pkg/56) | 32.4 mL | amber polyetherimide (PEI) spacer | 361669 (pkg/2) | 70,000 RPM 504,000 × g 44 |
| 25 × 89 mm | Thickwall polypropylene | 355642 (pkg/25) | 30 mL | blue aluminum cap | 338906 | 60,000 RPM 371,000 × g 59 |
| | | | 16.5 mL | none | — | 20,000 RPM 41,200 × g 535 |
| 25 × 89 mm | Thickwall polycarbonate | 355631 (pkg/25) | 30 mL | blue aluminum cap | 338906 | 60,000 RPM 371,000 × g 60 |
| | | | 16.5 mL | none | — | 45,000 RPM ^f 208,000 × g 106 |
| 25 × 64 mm | Quick-Seal Ultra-Clear bell-top | 344323 (pkg/50) | 27 mL | polyphenylene oxide (PPO) floating spacer | 343448 | 70,000 RPM 504,000 × g 31 |

Table 1 Available Tubes and Bottles for the Type 70 Ti Rotor^a (Continued)

| Tube | | | | Required Accessory | | Max Speed/ RCF/ k factor |
|------------|---------------------------------------|---|----------------------|---|---------------------|--|
| Dimensions | Description | Part Number | Max Fill Volume | Description | Part Number | |
| 25 × 64 mm | Quick-Seal polypropylene bell-top | 343665 (pkg/50) | 27 mL | polyphenylene oxide (PPO) floating spacer | 343448 | 70,000 RPM 504,000 × g 31 |
| 25 × 89 mm | Polycarbonate bottle and cap assembly | 355618 (assembly) 355654 (bottle only) | 26.3 mL ^g | — aluminum cap | — 355619 | 60,000 RPM ^h 371,000 × g 59 |
| 25 × 38 mm | Quick-Seal Ultra-Clear bell-top | 344324 (pkg/50) | 15 mL | polyphenylene oxide (PPO) floating spacer | 343448 | 70,000 RPM 504,000 × g 24 |
| 25 × 38 mm | Quick-Seal polypropylene bell-top | 343664 (pkg/50) | 15 mL | polyphenylene oxide (PPO) floating spacer | 343448 | 70,000 RPM 504,000 × g 24 |
| 16 × 76 mm | Ultra-clear | 344085 (pkg/50) | 13.5 mL | acetal (POM) adapter | 303307 | 40,000 RPM 151,000 × g 104 |
| | | | | aluminum cap | 330860 | |
| 16 × 76 mm | Thinwall polypropylene | 326814 (pkg/50) | 13.5 mL | acetal (POM) adapter | 303307 | 40,000 RPM 151,000 × g 104 |
| | | | | aluminum cap | 330860 | |
| 16 × 76 mm | Thickwall polypropylene | 355640 (pkg/25) | 13.5 mL | acetal (POM) adapter | 303307 | 40,000 RPM 151,000 × g 104 |
| | | | | aluminum cap ⁱ | 338907 | |
| 16 × 76 mm | Thickwall polycarbonate | 355630 (pkg/25) | 13.5 mL | acetal (POM) adapter | 303307 | 40,000 RPM 151,000 × g 104 |
| | | | | aluminum cap ⁱ | 338907 | |
| 13 × 64 mm | Ultra-clear | 344088 (pkg/50) | 6.5 mL | acetal (POM) adapter | 303392 | 45,000 RPM 102,000 × g 69 |
| | | | | cap assembly | 346256 ⁱ | |
| 13 × 64 mm | Thinwall polypropylene | 326820 (pkg/50) | 6.5 mL | acetal (POM) adapter | 303392 | 45,000 RPM 102,000 × g 69 |
| | | | | cap assembly | 346256 ⁱ | |
| 13 × 64 mm | Thickwall polypropylene | 355644 (pkg/25) | 4 mL | adapter | 303392 | 45,000 RPM 102,000 × g 69 |
| 13 × 64 mm | Thickwall polycarbonate | 355645 (pkg/25) | 4 mL | adapter | 303392 | 45,000 RPM 102,000 × g 69 |

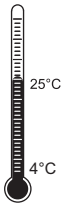
Table 1 Available Tubes and Bottles for the Type 70 Ti Rotor^a (Continued)

| Tube | | | | Required Accessory | | Max Speed/ RCF/ k factor |
|------------|-----------------|-------------|-----------------|--------------------|-------------|---|
| Dimensions | Description | Part Number | Max Fill Volume | Description | Part Number | |
| 13 × 64 mm | Stainless steel | 301099 | 6.5 mL | adapter | 303392 | 30,000 RPM ^c 78,900 × <i>g</i> 155 |
| | | | | cap | 303113 | |

- Use only the items listed here.
- Nominal volume—in operation, fill as completely as possible.
- For solution densities of 2.0 g/mL and below; above 2.0, further speed reductions are required. Refer to publication L5-TB-072 when centrifuging stainless steel tubes
- Specially designed cap; do not use any other cap with this tube.
- Includes disposable plastic plugs.
- 50,000 RPM for 4 hours or less.
- Minimum fill level is 16.0 mL.
- 50,000 RPM if filled below maximum volume.
- Tube cap is optional.
- Cap assembly includes neoprene gasket (344672) and stem (346246).

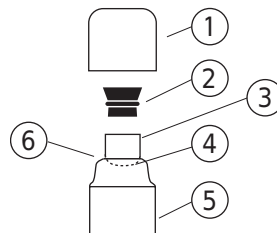
Temperature Limits

- Plastic tubes and bottles have been centrifuge tested for use at temperatures between 4 and 25°C. For centrifugation at other temperatures, pretest tubes under anticipated run conditions.
- If plastic containers are frozen before use, make sure that they are thawed to at least 4°C prior to centrifugation.



OptiSeal Tubes

OptiSeal tubes come with plastic plugs and can be quickly and easily prepared for use. With the tube spacer in place, the *g* force during centrifugation ensures a tight, reliable seal that protects your samples.



- Spacer
- Plug
- Stem
- Meniscus
- Tube
- Base of Stem

- Place the tubes in the rack and fill each tube to the base of the stem, leaving no fluid in the stem.

NOTE Overfilling the tube can cause spillage when the plug is inserted or can compromise seal integrity. However, too much air can cause excessive tube deformation, disrupting gradients and sample bands.

- 2 Refer to *Using OptiSeal Tubes* (publication IN-189), included in each box of tubes, for detailed information on the use and care of OptiSeal tubes.

Quick-Seal Tubes



Quick-Seal tubes must be sealed prior to centrifugation. These tubes are heat sealed and do not need caps; however, spacers are required on top of the tubes when they are loaded into the rotor.

- 1 Fill Quick-Seal tubes leaving a *small* bubble of air at the base of the neck.
Do not leave a large air space—too much air can cause excessive tube deformation.
- 2 Refer to *Rotors and Tubes* for detailed information on the use and care of Quick-Seal tubes.
Quick-Seal tubes are disposable and should be discarded after a single use.

Thinwall Tubes



Thinwall polypropylene and Ultra-Clear tubes require caps for tube support. Fill the tubes as full as possible to prevent tube collapse during centrifugation. If necessary, float mineral oil (or some other low-density, immiscible liquid) on top of the tube contents to fill the tube to its maximum volume. (Do not use an oil overlay in Ultra-Clear tubes.)

Thickwall Tubes



Thickwall polypropylene and polycarbonate tubes can be run partially filled (at least half filled) with or without caps, but all opposing tubes for a run must be filled to the same level with liquid of the same density. Do not overfill capless tubes; be sure to note the reductions in fill volume and run speed shown in [Table 1](#).

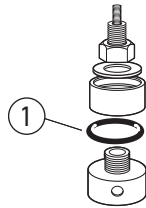
NOTE Special instructions for using thinwall tubes (344367) are provided on page 10.

Tube Caps

Thinwall tubes require caps for tube support during centrifugation; thickwall tubes and bottles can be run with or without caps (speed reduction may be required). Use only the caps listed in [Table 1](#). Refer to *Rotors and Tubes* for the use, assembly, and maintenance of caps.

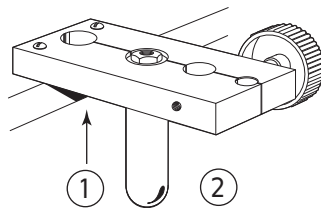
- 1 Inspect tube caps before use as described in *Rotors and Tubes*.
Replace any damaged components.
- 2 Inspect the O-rings or gaskets in the caps for cracks, nicks, or flattened areas.

Be sure that they are dry and free of lubricant during assembly.



1. O-ring or Gasket

3 Tighten aluminum caps with a hex driver while the tube is held in the tube-cap vise (305075).



1. Insert tube from bottom
2. Tube Cap Vise (305075)

4 Tighten bottle caps by hand.

Thinwall Tubes with Red-anodized Caps

These tubes must be capped. Refer to Instructions for Using Aluminum Tube Caps (publication L5-TB-060) for the use, assembly, and maintenance of these caps. Tighten the caps with a torque wrench to 13.6 N•m (120 in.-lb) for the first four runs and to 11 N•m (100 in.-lb) for subsequent runs.



Polycarbonate Bottles

The capped polycarbonate bottles may be centrifuged completely filled, or partially filled (not less than half full). Again, all opposing containers for a run must be filled to the same level. Be sure to note the reductions in run speed shown in [Table 1](#) if bottles are partially filled.

Thinwall Tubes with Crimp-Lock Caps

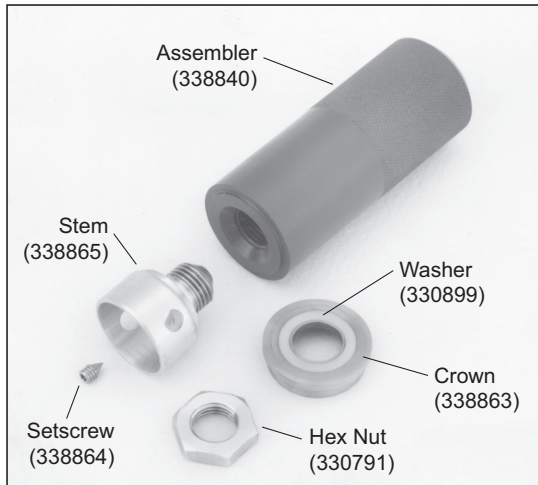
Thinwall tubes, part number 344367, must be used with the crimp-lock cap assembly. The special titanium-aluminum cap provides the added support needed for the tube to withstand centrifugation at 70,000 RPM. The 83-mm tube has a **BECKMAN** logo at its top for identification—DO NOT use any other caps with this tube. These tubes should be used only once, and MUST NOT be autoclaved before use. Assemble and use this tube and cap assembly as follows.

Assembly

Refer to [Figure 2](#) as you perform the steps below.

NOTE The tube can be destroyed during assembly if any steps are performed carelessly.

Figure 2 Crimp-Lock Titanium-aluminum Cap Parts and Assembling Tool



- 1 Screw the aluminum stem into the gray vinyl assembler.
- 2 Push the tube onto the stem until it fits flush against the assembler.
- 3 Insert the tube in the tube vise hole; seat firmly, with the tube below and the assembler on top.
- 4 Turn the vise knob to clamp the tube securely.
- 5 Unscrew the assembler and remove it.
- 6 Put the titanium crown on top of the stem, with the rim uppermost.
Make sure the crown is level and the white acetal (POM) washer is centered on the crown.
- 7 Add the aluminum hex nut; screw it down finger tight.
- 8 Tighten the hex nut with a torque wrench to 11 N•m (100 in.-lb) to collapse the tube rim.

⚠ CAUTION

Do not over-torque, or the assembly will not fit in the rotor.

- 9 Make sure that the mating surfaces of the tube and crown are smooth and even, with the entire rim of the tube folded inside the crown.

Make sure no part of the rim has been left out.

Filling and Sealing

- 1 Use a syringe to completely fill the tube through the hole in the cap.
- 2 With tube removal tool (301875), tighten the pointed setscrew firmly on the nylon insert in the filling hole, sealing the tube.

NOTE Use only pointed setscrews (338864) in these cap assemblies.

Installation

- 1 Place the capped tube in the rotor cavity.
- 2 When the crown is resting on the counterbore, push it down firmly with your thumb.
- 3 Measure the distance from the top of the cap to the outer top surface (O-ring surface) of the rotor.
This should be at least 8 mm (0.33 in.), as shown in [Figure 3](#).

Figure 3 Measuring Distance from Cap to Rotor Tray

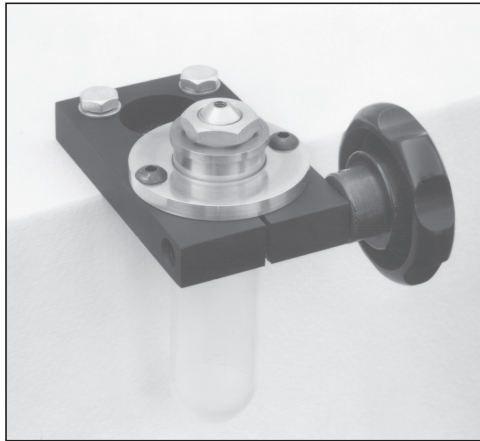


Removing Crimp-Lock Caps from Thinwall Tubes

1 To avoid spills during this process, first remove 3 or 4 mL of the supernatant through the setscrew hole, when possible.

2 Insert the tube into the tube vise.
Position it so the bottom of the crown is nearly flush with the top of the vise (see [Figure 4](#)).

Figure 4 Bottom of Crown is Nearly Flush with Vise Top



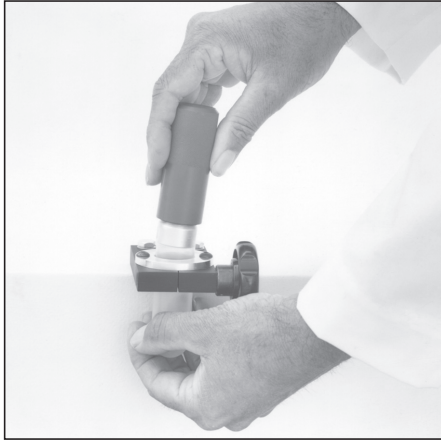
3 Use the torque wrench to remove the nut and crown.

4 Screw the gray assembler back on the stem.

5 Loosen the vise slightly so the stem can be removed.
Support the tube from below, or carefully adjust the pressure so the tube is still held firmly in the vise.

6 Using a rotary motion, pull the stem out of the tube as shown in [Figure 5](#).

Figure 5 Pulling the Stem from the Tube



Run Times

The k factor of the rotor is a measure of the rotor's pelleting efficiency. (Beckman Coulter has calculated the k factors for all of its preparative rotors at maximum rated speed and using full tubes.) The k factor is calculated from the formula

$$k = \frac{\ln(r_{\max}/r_{\min})}{\omega^2} \times \frac{10^{13}}{3600} \quad \text{EQ 1}$$

where ω is the angular velocity of the rotor in radians per second ($\omega = 0.105 \times \text{RPM}$), r_{\max} is the maximum radius, and r_{\min} is the minimum radius.

After substitution:

$$k = \frac{(2.533 \times 10^{11}) \ln(r_{\max}/r_{\min})}{\text{RPM}^2} \quad \text{EQ 2}$$

Use the k factor in the following equation to estimate the run time t (in hours) required to pellet particles of known sedimentation coefficient s (in Svedberg units, S).

$$t = \frac{k}{s} \quad \text{EQ 3}$$

Run times can be estimated for centrifugation at less than maximum speed by adjusting the k factor as follows:

$$k_{\text{adj}} = k \left(\frac{70,000}{\text{actual run speed}} \right)^2 \quad \text{EQ 4}$$

Run times can also be estimated from data established in prior experiments using a different rotor if the k factor of the previous rotor is known. For any two rotors, a and b:

$$\frac{t_a}{t_b} = \frac{k_a}{k_b}$$

EQ 5

Run Speeds

The centrifugal force at a given radius in a rotor is a function of speed. Comparisons of forces between different rotors are made by comparing the rotors' relative centrifugal fields (RCF). When rotational speed is adjusted so that identical samples are subjected to the same RCF in two different rotors, the samples are subjected to the same force. The RCF at a number of rotor speeds is provided in [Table 2](#).

Do not select rotational speeds that exceed the limits in [Table 1](#). In addition, speeds must be reduced under the following circumstances:

1. If nonprecipitating solutions more dense than 1.2 g/mL are centrifuged, the maximum allowable run speed must be reduced according to the following equation:

$$\text{reduced maximum speed} = 70,000 \text{ RPM} \sqrt{\frac{1.2 \text{ g/mL}}{\rho}}$$

EQ 6

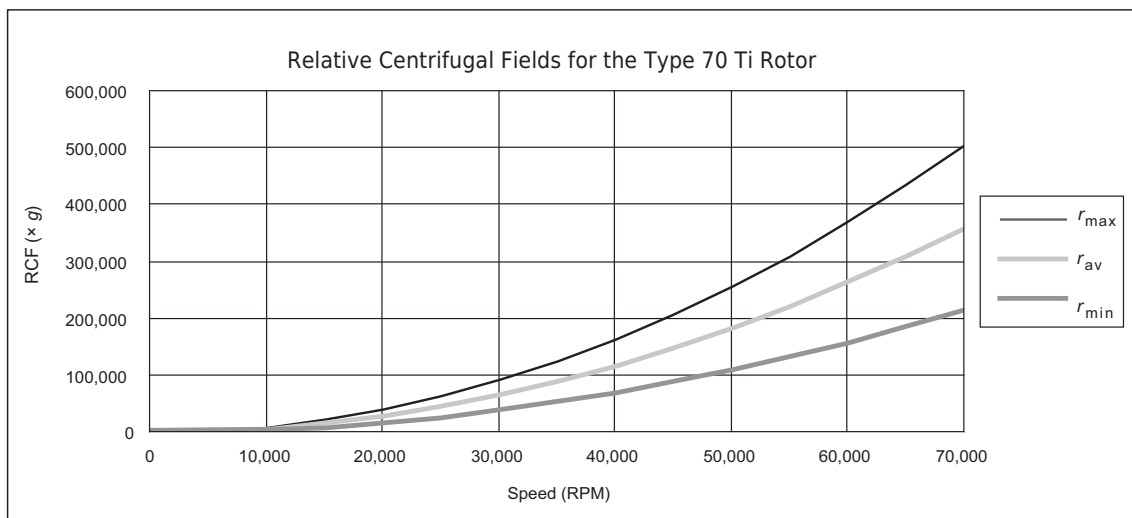
where ρ is the density of the tube contents. This speed reduction will protect the rotor from excessive stresses due to the added tube load. *Note, however, that the use of this formula may still produce maximum speed figures that are higher than the limitations imposed by the use of certain tubes or adapters (see [Table 1](#)).* In such cases, use the lower of the two speeds.

2. *Further speed limits must be imposed when CsCl or other self-forming-gradient salts are centrifuged, as equation (6) does not predict concentration limits/speeds that are required to avoid precipitation of salt crystals. Solid CsCl has a density of 4 g/mL, and if precipitated during centrifugation may cause catastrophic rotor failure and instrument damage. [Figure 6](#) and [Figure 7](#), together with the description and examples below, show how to reduce run speeds when using CsCl gradients.*

Table 2 Relative Centrifugal Fields for the Type 70 Ti Rotor^a

| Rotor Speed (RPM) | Relative Centrifugal Field ($\times g$) | | | k Factor ^b |
|-------------------|---|-----------------------|------------------------|-----------------------|
| | At r_{max} (91.9 mm) | At r_{av} (65.7 mm) | At r_{min} (39.5 mm) | |
| 70,000 | 505,000 | 361,000 | 217,000 | 44 |
| 65,000 | 435,000 | 311,000 | 187,000 | 51 |
| 60,000 | 371,000 | 265,000 | 159,000 | 60 |
| 55,000 | 311,000 | 223,000 | 134,000 | 71 |
| 50,000 | 257,000 | 184,000 | 111,000 | 86 |
| 45,000 | 208,000 | 149,000 | 89,600 | 106 |
| 40,000 | 165,000 | 118,000 | 70,800 | 134 |
| 35,000 | 126,000 | 90,100 | 54,200 | 175 |
| 30,000 | 92,600 | 66,200 | 39,800 | 238 |
| 25,000 | 64,300 | 46,000 | 27,700 | 342 |
| 20,000 | 41,200 | 29,400 | 17,700 | 535 |
| 15,000 | 23,200 | 16,600 | 9,950 | 951 |

- Entries in this table are calculated from the formula $RCF = 1.12r (RPM/1000)^2$ and then rounded to three significant digits.
- Calculated for all Beckman Coulter preparative rotors as a measure of the rotor's relative efficiency in pelleting sample in water at 20°C.



Selecting CsCl Gradients

Precipitation during centrifugation would alter density distribution, and this would change the position of the sample bands. Curves in [Figure 6](#) and [Figure 7](#) are provided up to the maximum rated

speed of the rotor, but note also that *tubes or bottles must never be centrifuged faster than the limits in Table 1.*

NOTE The curves in [Figure 6](#) and [Figure 7](#) are for solutions of CsCl salt dissolved in distilled water only. If other salts are present in significant concentrations, the overall CsCl concentration may need to be reduced.

Rotor speed is used to control the slope of a CsCl density gradient, and must be limited so that CsCl precipitation is avoided. Speed and density combinations that intersect on or below the curves in [Figure 6](#) ensure that CsCl will not precipitate during centrifugation in the Type 70 Ti rotor. Curves are provided at two temperatures: 20°C (black curves) and 4°C (gray curves)

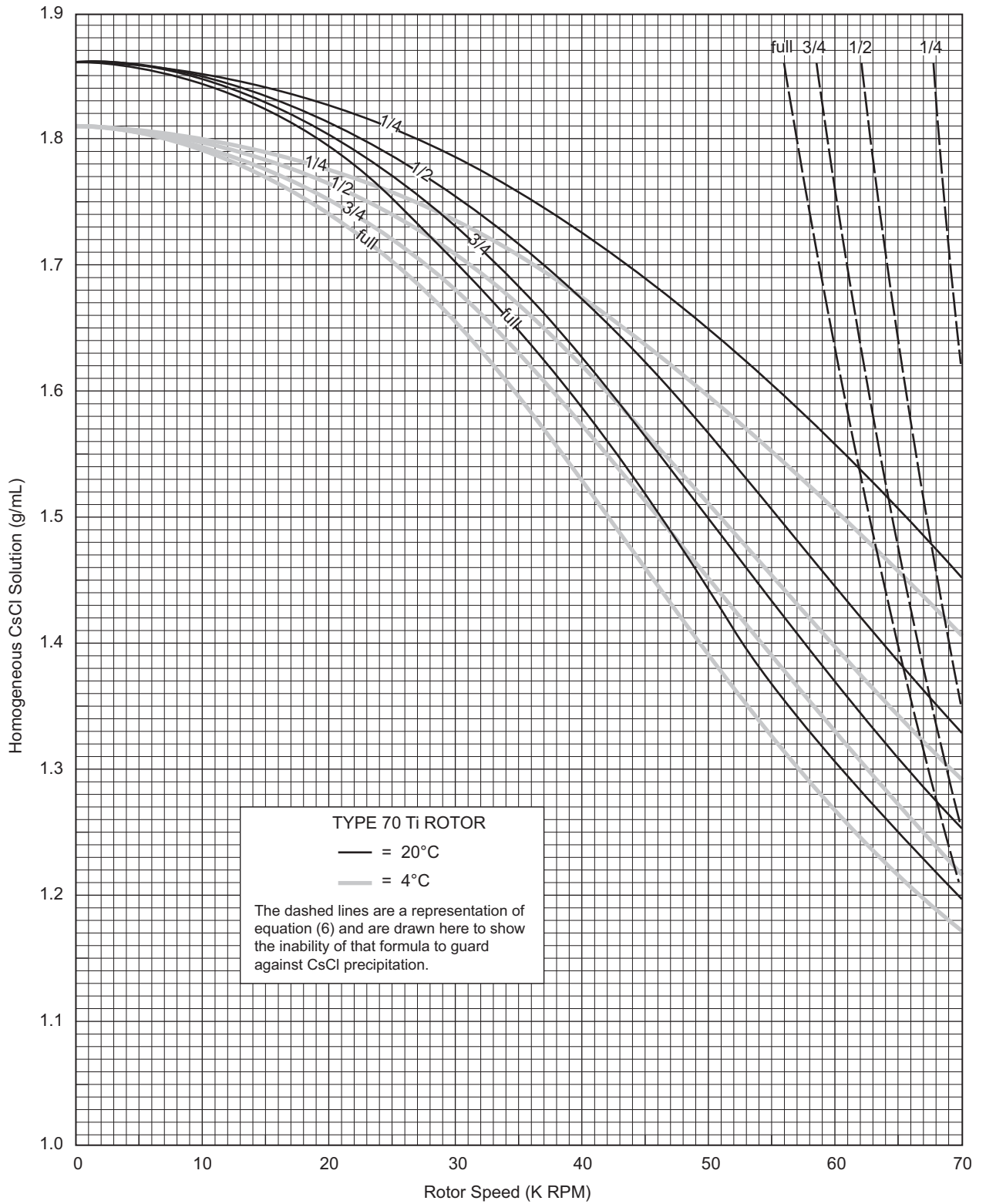
The reference curves in [Figure 7](#) show gradient distribution at equilibrium. Each curve in [Figure 7](#) is within the density limits allowed for the Type 70 Ti rotor: each curve was generated for a single run speed using the maximum allowable homogeneous CsCl densities (one for each fill level) that avoid precipitation at that speed. (The gradients in [Figure 7](#) can be generated from step or linear gradients, or from homogeneous solutions. But the total amount of CsCl in solution must be equivalent to a homogeneous solution corresponding to the concentrations specified in [Figure 6](#).) [Figure 7](#) can also be used to approximate the banding positions of sample particles.

Adjusting Fill Volumes

[Figure 6](#) and [Figure 7](#) show that several fill volumes are possible in a tube. If a tube is partially filled with gradient solution, float mineral oil (or some other low-density, immiscible liquid) on top of the tube contents to fill the tube to its maximum volume. (Do not use an oil overlay in Ultra-Clear tubes.) Note that for a given CsCl density, as the fill level decreases the maximum allowable speed increases. Partial filling may be desirable when there is little sample or when you wish to shorten the run time.

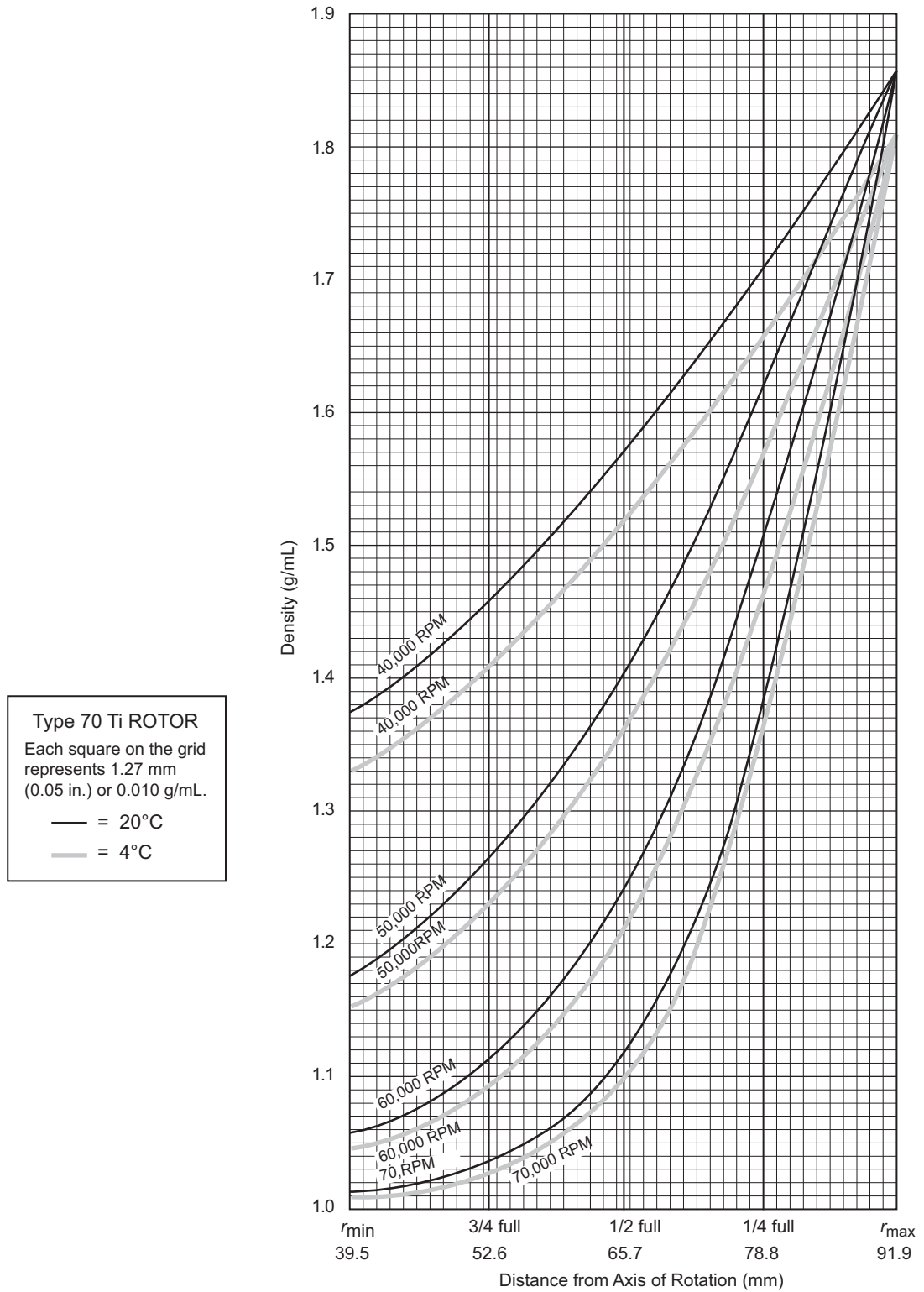
For example, a half-filled tube of 1.44-g/mL homogeneous CsCl solution at 20°C may be centrifuged at 60,000 RPM (see [Figure 6](#)). The segment of the 60,000-RPM curve ([Figure 7](#)) from the half-filled line to 1.86 g/mL at the tube bottom represents this gradient. The same solution in a quarter-filled tube may be centrifuged no faster than 54,000 RPM. (Gradient curves not shown in [Figure 7](#) can be interpolated.) A tube full of the 1.44-g/mL CsCl solution may be centrifuged no faster than 50,000 RPM.

Figure 6 Precipitation Curves for the Type 70 Ti Rotor*



* Using combinations of rotor speeds and homogeneous CsCl solution densities that intersect on or below these curves ensures that CsCl will not precipitate during centrifugation.

Figure 7 CsCl Gradients at Equilibrium for the Type 70 Ti Rotor*

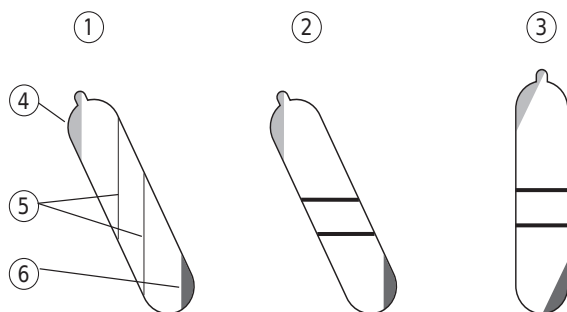


* Centrifugation of homogeneous CsCl solutions at the maximum allowable speeds (from Figure 6) results in gradients presented here.

Typical Examples for Determining CsCl Run Parameters

Example A:

Knowing homogeneous CsCl solution density (1.57 g/mL) and approximate particle buoyant densities (1.6 and 1.7 g/mL), at 20°C, where will particles band?



- | | |
|---------------------|------------------------|
| 1. At Speed | 4. Floating Components |
| 2. At Rest in Rotor | 5. Bands |
| 3. Upright | 6. Pelleted Material |

1 In [Figure 6](#) find the curve that corresponds to the desired run temperature (20°C) and fill volume (half full).

The maximum allowable rotor speed is determined from the point where this curve intersects the homogeneous CsCl density (50,000 RPM).

2 In [Figure 7](#), sketch in a horizontal line corresponding to each particle's buoyant density.

3 Mark the point in the figure where each particle density intersects the curve corresponding to the selected run speed and temperature.

Particles will band at these locations across the tube diameter at equilibrium during centrifugation.

In this example, particles will band about 81 and 85 mm from the axis of rotation, about 4 mm of centerband-to-centerband separation at the rotor's 23-degree tube angle. When the tube is removed from the rotor and held upright (vertical and stationary), there will be about 4.35 mm of centerband-to-centerband separation. This interband distance, d_{up} , can be calculated from the formula:

$$d_{up} = \frac{d_{\theta}}{\cos \theta}$$

EQ 7

where d_{θ} is the interband distance when the tube is held at an angle, θ , in the rotor.

Example B:

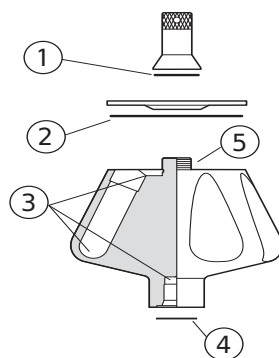
Knowing particle buoyant densities (1.70 and 1.65 g/mL), how do you achieve good separation?

- 1 In [Figure 7](#), sketch in a horizontal line corresponding to each particle's buoyant density.
- 2 Select the curve at the desired temperature (20°C) and tube volume (full) that gives the best particle separation.
- 3 Note the run speed along the selected curve (40,000 RPM).
- 4 From [Figure 6](#), select the maximum homogeneous CsCl density (in this case, 1.585 g/mL) that corresponds to the temperature and run speed established above.
These parameters will provide the particle-banding pattern selected in Step 2.

In this example, particles will band at about 73 and 78 mm from the axis of rotation (about 5 mm apart). When the tube is held upright there will be about 5.42 mm of center-of-band to center-of-band separation.

Care and Maintenance

Maintenance



1. Handle O-ring (011757)
2. Lid O-ring (870612)
3. Check for Corrosion
4. Overspeed Disk (335585)
5. Threads

NOTE Do not use sharp tools on the rotor that could cause scratches in the rotor surface. Corrosion begins in scratches and may open fissures in the rotor with continued use.

- 1 Periodically (at least monthly) inspect the rotor, especially inside cavities, for rough spots or pitting, white powder deposits (frequently aluminum oxide), or heavy discoloration.
If any of these signs are evident, do not run the rotor.
- 2 Regularly lubricate the metal threads in the rotor with a thin, even coat of Spinkote lubricant.

Failure to keep these threads lubricated can result in damaged threads.

- 3 Regularly apply silicone vacuum grease (335148) to the O-rings.
Replace O-rings about twice a year or whenever worn or damaged.
- 4 Regularly inspect the overspeed disk (335585).
If it is scratched, damaged, or missing, replace it according to the instructions in *Rotors and Tubes*.
- 5 Refer to *Chemical Resistances* for the chemical compatibilities of rotor and accessory materials.
Your Beckman Coulter representative provides contact with the Field Rotor Inspection Program and the rotor repair center.

Cleaning

Wash the rotor and rotor components immediately if salts or other corrosive materials are used or if spillage has occurred. Do not allow corrosive materials to dry on the rotor.

Under normal use, wash the rotor frequently (at least weekly) to prevent buildup of residues.

- 1 Remove the O-rings before washing.
- 2 Wash the rotor and lid in a mild detergent, such as Solution 555 (339555), that won't damage the rotor.
Dilute the detergent with water (10 parts water to 1 part detergent).



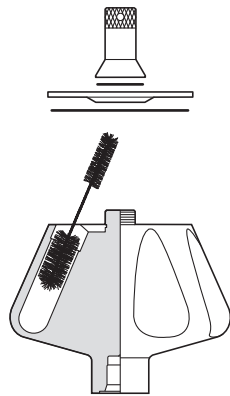
NOTE Do not wash rotor components in a dishwasher. Do not soak in detergent solution for long periods, such as overnight.

The Rotor Cleaning Kit (339558) contains two plastic-coated brushes and two quarts of Solution 555 for use with rotors and accessories.

- 3 Thoroughly rinse the cleaned rotor and components with distilled water.
- 4 Air-dry the rotor and lid upside down.
Do not use acetone to dry the rotor.
- 5 Apply a thin, even coat of silicone vacuum grease to the lid O-ring before replacing it in the groove in the outer rim of the lid.

Also apply silicone vacuum grease to the handle O-ring before reassembly.

- 6 Clean metal threads every 6 months, or as necessary.
 - a. Use a brush and concentrated Solution 555.
 - b. Dilute the detergent with water (10 parts water to 1 part detergent).
 - c. Rinse and dry thoroughly, then lubricate lightly but evenly with Spinkote to coat all threads.



- 7 Periodically remove the O-rings and wipe clean as necessary.
 - a. Clean the O-ring grooves with a cotton-tipped swab.
 - b. Reapply a light film of silicone vacuum grease.

Decontamination



If the rotor (and/or accessories) becomes contaminated with radioactive material, it should be decontaminated using a solution that will not damage the anodized surfaces. Beckman Coulter has tested a number of solutions and found two that do not harm anodized aluminum: RadCon Surface Spray or IsoClean Solution (for soaking),* and Radiacwash.†

NOTE IsoClean can cause fading of colored anodized surfaces. Use it only when necessary and remove it promptly from surfaces.

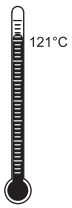
* In U.S., contact Nuclear Associates (New York); in Eastern Europe and Commonwealth States, contact Victoreen GmbH (Munich); in South Pacific, contact Gammasonics Pty. Ltd. (Australia); in Japan, contact Toyo Medic Co. Ltd. (Tokyo).

† In U.S., contact Biodex Medical Systems (Shirley, New York); internationally, contact the U.S. office to find the dealer closest to you.

While Beckman Coulter has tested these methods and found that they do not damage components, no guarantee of decontamination is expressed or implied. Consult your laboratory safety officer regarding the proper decontamination methods to use.

If the rotor or other components are contaminated with toxic or pathogenic materials, follow appropriate decontamination procedures as outlined by your laboratory safety officer.

Sterilization and Disinfection



- The rotor and all rotor components, except those made of polyphenylene oxide (PPO), can be autoclaved at 121°C for up to an hour. Remove the lid from the rotor and place the rotor, lid, and spacers in the autoclave upside down.
- Ethanol (70%) or hydrogen peroxide (6%) may be used on all rotor components, including those made of plastic. Bleach (sodium hypochlorite) may be used, but may cause discoloration of anodized surfaces. Use the minimum immersion time for each solution, per laboratory standards.



Ethanol is a flammability hazard. Do not use it in or near operating ultracentrifuges.

While Beckman Coulter has tested these methods and found that they do not damage the rotor or components, no guarantee of sterility or disinfection is expressed or implied. When sterilization or disinfection is a concern, consult your laboratory safety officer regarding proper methods to use.

Refer to publication IN-192 (included with each box of tubes or bottles) for tube and bottle sterilization and disinfection procedures. *Quick-Seal and thinwall open-top tubes are disposable and should be discarded after a single use.*

Storage

When the rotor is not in use, store it in a dry environment (not in the instrument) with the lid removed to allow air circulation so moisture will not collect in the tube cavities.

Returning a Rotor

Before returning a rotor or accessory for any reason, prior permission must be obtained from Beckman Coulter, Inc. A return authorization form is necessary and may be obtained from your local Beckman Coulter sales office. The return form should contain the following information:

- rotor type and serial number,
- history of use (approximate frequency of use),
- reason for the return,
- original purchase order number, billing number, and shipping number, if possible,

- name and email address of the person to be notified upon receipt of the rotor or accessory at the factory,
- name and email address of the person to be notified about repair costs, etc.

To protect our personnel, it is the customer's responsibility to ensure that all parts are free from pathogens and/or radioactivity. Sterilization and decontamination must be done before returning the parts. Smaller items (such as tubes, bottles, etc.) should be enclosed in a sealed plastic bag.

*All parts must be accompanied by a note, plainly visible on the outside of the box or bag, stating that they are safe to handle and that they are not contaminated with pathogens or radioactivity. **Failure to attach this notification will result in return or disposal of the items without review of the reported problem.***

Use the address label printed on the return form when mailing the rotor and/or accessories.

Customers located outside the United States should contact their local Beckman Coulter office.

Supply List

See the Beckman Coulter *Ultracentrifuge Rotors, Tubes & Accessories* catalog (BR-8101, available at www.beckmancoulter.com), call Beckman Coulter Customer Service at 1-800-742-2345 (U.S.A. or Canada), or contact your local Beckman Coulter office for detailed information on ordering parts and supplies. For your convenience, a partial list is given below.

Replacement Rotor Parts

| Description | Part Number |
|-----------------------------|-------------|
| Type 70 Ti rotor assembly | 337922 |
| Rotor lid | 337923 |
| Rotor handle | 337924 |
| Handle O-ring | 011757 |
| Lid O-ring | 870612 |
| Overspeed disk (70,000 RPM) | 335585 |

Other

NOTE For MSDS information, go to the Beckman Coulter website at www.beckmancoulter.com.

| Description | Part Number |
|--|-----------------------------|
| Tubes, bottles, and accessories | see Table 1 |
| OptiSeal tube rack assembly | 361646 |
| Quick-Seal Cordless Tube Topper kit, 60 Hz | 358312 |

Type 70 Ti Fixed-Angle Rotor
Supply List

| Description | Part Number |
|--|-------------|
| Quick-Seal Cordless Tube Topper kit, 50 Hz (Europe) | 358313 |
| Quick-Seal Cordless Tube Topper kit, 50 Hz (Great Britain) | 358314 |
| Quick-Seal Cordless Tube Topper kit, 50 Hz (Australia) | 358315 |
| Quick-Seal Cordless Tube Topper kit, 50 Hz (Canada) | 367803 |
| Tube Topper rack (16-mm dia. tubes) | 348124 |
| Special tool kit for the Type 70 Ti rotor includes: | 338841 |
| Torque wrench | 858121 |
| Socket adapter for 20-mm (3/4-in. hex nuts | 858122 |
| Socket for 20-mm (3/4-in.) hex nuts | 858123 |
| Socket for 11-mm (7/16-in.) hex nuts | 870432 |
| Tube/cap vise | 338835 |
| Tube cap assembler | 338840 |
| Removal tool (capped tubes) | 301875 |
| Tube Cap vise | 305075 |
| Removal tool (floating spacer) | 338765 |
| Removal tool (polycarbonate bottles) | 878133 |
| Removal tool (Quick-Seal tubes) | 361668 |
| Handle tool | 356959 |
| Spinkote lubricant (2 oz) | 306812 |
| Silicone vacuum grease (1 oz) | 335148 |
| Rotor Cleaning Kit | 339558 |
| Solution 555 (1 qt) | 339555 |
| Rotor cleaning brush | 339379 |
| Centering tool (for replacing overspeed disk) | 331325 |

Beckman Coulter, Inc.

Ultracentrifuge Rotor Warranty

All Beckman Coulter ultracentrifuge Fixed Angle, Vertical Tube, Near Vertical Tube, Swinging Bucket, and Airfuge rotors are warranted against defects in materials or workmanship for the time periods indicated below, subject to the Warranty Conditions stated below.

| | |
|--|------------------------|
| Preparative Ultracentrifuge Rotors | 5 years — No Proration |
| Analytical Ultracentrifuge Rotors | 5 years — No Proration |
| ML and TL Series Ultracentrifuge Rotors | 5 years — No Proration |
| Airfuge Ultracentrifuge Rotors | 1 year — No Proration |
| For Zonal, Continuous Flow, Component Test, and Rock Core Ultracentrifuge Rotors, see separate warranty. | |

1. This warranty is valid for the time periods indicated above from the date of shipment to the original Buyer by Beckman Coulter or an authorized Beckman Coulter representative.
2. This warranty extends only to the original Buyer and may not be assigned or extended to a third person without written consent of Beckman Coulter.
3. This warranty covers the Beckman Coulter Centrifuge Systems only (including but not limited to the centrifuge, rotor, and accessories) and Beckman Coulter shall not be liable for damage to or loss of the user's sample, non-Beckman Coulter tubes, adapters, or other rotor contents.
4. This warranty is void if the Beckman Coulter Centrifuge System is determined by Beckman Coulter to have been operated or maintained in a manner contrary to the instructions in the operator's manual(s) for the Beckman Coulter Centrifuge System components in use. This includes but is not limited to operator misuse, abuse, or negligence regarding indicated maintenance procedures, centrifuge and rotor classification requirements, proper speed reduction for the high density of certain fluids, tubes, and tube caps, speed reduction for precipitating gradient materials, and speed reduction for high-temperature operation.
5. Rotor bucket sets purchased concurrently with or subsequent to the purchase of a Swinging Bucket Rotor are warranted only for a term co-extensive with that of the rotor for which the bucket sets are purchased.
6. This warranty does not cover the failure of a Beckman Coulter rotor in a centrifuge not of Beckman Coulter manufacture, or if the rotor is used in a Beckman Coulter centrifuge that has been modified without the written permission of Beckman Coulter, or is used with carriers, buckets, belts, or other devices not of Beckman Coulter manufacture.
7. Rotor parts subject to wear, including but not limited to rotor O-rings, VTi, NVT, TLV, MLN, and TLN rotor tube cavity plugs and gaskets, tubing, tools, optical overspeed disks, bearings, seals, and lubrication are excluded from this warranty and should be frequently inspected and replaced if they become worn or damaged.
8. Keeping a rotor log is not mandatory, but may be desirable for maintenance of good laboratory practices.

Repair and Replacement Policies

1. If a Beckman Coulter rotor is determined by Beckman Coulter to be defective, Beckman Coulter will repair or replace it, subject to the Warranty Conditions. A replacement rotor will be warranted for the time remaining on the original rotor's warranty.
2. If a Beckman Coulter centrifuge is damaged due to a failure of a rotor covered by this warranty, Beckman Coulter will supply free of charge (i) all centrifuge parts required for repair (except the drive unit, which will be replaced at the then current price less a credit determined by the total number of revolutions or years completed, provided that such a unit was manufactured or rebuilt by Beckman Coulter), and (ii) if the centrifuge is currently covered by a Beckman Coulter warranty or Full Service Agreement, all labor necessary for repair of the centrifuge.
3. If a Beckman Coulter rotor covered by this warranty is damaged due to a malfunction of a Beckman Coulter ultracentrifuge covered by an Ultracentrifuge System Service Agreement, Beckman Coulter will repair or replace the rotor free of charge.
4. If a Beckman Coulter rotor covered by this warranty is damaged due to a failure of a Beckman Coulter tube, bottle, tube cap, spacer, or adapter, covered under the Conditions of this Warranty, Beckman Coulter will repair or replace the rotor and repair the instrument as per the conditions in policy point (2) above, and the replacement policy.
5. Damage to a Beckman Coulter rotor or instrument due to the failure or malfunction of a non-Beckman Coulter tube, bottle, tube cap, spacer, or adapter is not covered under this warranty, although Beckman Coulter will assist in seeking compensation under the manufacturer's warranty.

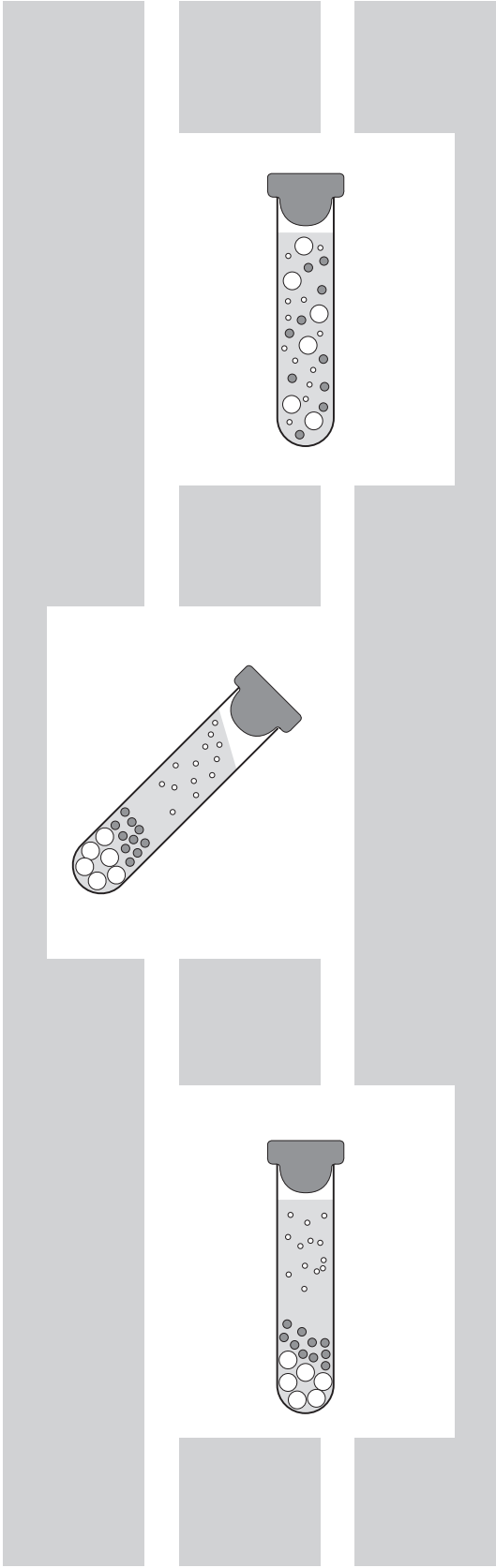
Disclaimer

IT IS EXPRESSLY AGREED THAT THE ABOVE WARRANTY SHALL BE IN LIEU OF ALL WARRANTIES OF FITNESS AND OF THE WARRANTY OF MERCHANTABILITY AND BECKMAN COULTER, INC. SHALL HAVE NO LIABILITY FOR SPECIAL OR CONSEQUENTIAL DAMAGES OF ANY KIND WHATSOEVER ARISING OUT OF THE MANUFACTURE, USE, SALE, HANDLING, REPAIR, MAINTENANCE, OR REPLACEMENT OF THE PRODUCT.

Factory Rotor Inspection Service

Beckman Coulter, Inc., will provide free mechanical and metallurgical inspection in Indianapolis, Indiana, USA, of any Beckman Coulter rotor at the request of the user. (Shipping charges to Beckman Coulter are the responsibility of the user.) Rotors will be inspected in the user's laboratory if the centrifuge in which they are used is covered by an appropriate Beckman Coulter Service Agreement. Contact your local Beckman Coulter office for details of service coverage or cost.

Before shipping, contact the nearest Beckman Coulter Sales and Service office and request a Returned Goods Authorization (RGA) form and packaging instructions. Please include the complete rotor assembly, with buckets, lid, handle, tube cavity caps, etc. A SIGNED STATEMENT THAT THE ROTOR AND ACCESSORIES ARE NON-RADIOACTIVE, NON-PATHOGENIC, NON-TOXIC, AND OTHERWISE SAFE TO SHIP AND HANDLE IS REQUIRED.



Related Documents

Rotors and Tubes for Preparative Ultracentrifuges (LR-IM)

- Rotors
- Tubes, Bottles, and Accessories
- Using Tubes, Bottles, and Accessories
- Using Fixed-Angle Rotors
- Using Swinging-Bucket Rotors
- Using Vertical-Tube and Near-Vertical Tube Rotors
- Care and Maintenance
- Chemical Resistances for Beckman Coulter Centrifugation Products
- Use of the w2t Integrator
- The Use of Cesium Chloride Curves
- Gradient Materials
- References
- Glossary

Available in hard copy or electronic pdf by request.

Rotors and Tubes CD (369668)

- Rotors and Tubes for Tabletop Preparative Ultracentrifuges
- Rotors and Tubes for J2, J6, Avanti J Series Centrifuges
- Rotors and Tubes for Preparative Ultracentrifuges
- Rotor Safety Bulletin
- Chemical Resistances for Beckman Coulter Centrifugation Products

Included with shipment of instrument.

Additional References

- Chemical Resistances for Beckman Coulter Centrifugation Products (IN-175)
- Beckman Coulter Ultracentrifuge Rotors, Tubes & Accessories catalog (BR-8101)
- Using OptiSeal Tubes (IN-189)
- Use and Care of Centrifuge Tubes and Bottles (IN-192)

Available in hard copy or electronic pdf by request.

Data Sheets

- *g*-Max System: Short Pathlengths in High Force Fields (DS-709B)

Available at www.beckmancoulter.com

www.beckmancoulter.com

