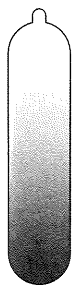
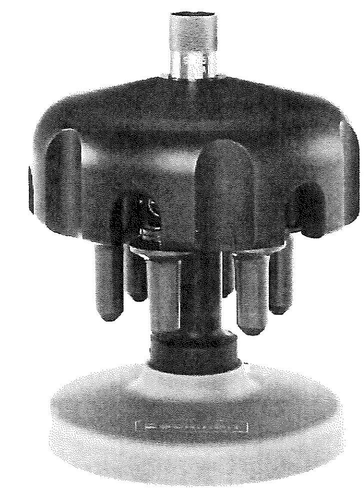
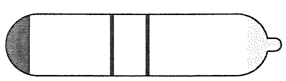
L5-TB-062AN
November 2009

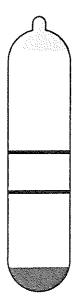
BECKMAN COULTER



SW 55 Ti Rotor

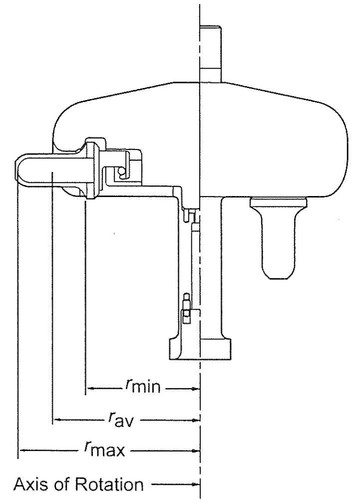






Used in Beckman Coulter Class H, R, and S Preparative Ultracentrifuges

SW 55 Ti Rotor



U.S. Pat. No. 3,393,864;
Japanese Pat. No. 739,613;
British Pat. No. 1,145,005;
German Pat. No. 1,598,174.

SPECIFICATIONS

Maximum speed	55 000 rpm
Density rating at maximum speed	1.2 g/mL
Relative Centrifugal Field* at maximum speed	
At r_{max} (108.5 mm)	368 000 × g
At r_{av} (84.6 mm)	287 000 × g
At r_{min} (60.8 mm)	206 000 × g
k factor at maximum speed	48
k' factors at maximum speed (5 to 20% sucrose gradient; 5°C)	
When particle density = 1.3 g/mL	135
When particle density = 1.5 g/mL	123
When particle density = 1.7 g/mL	118
Conditions requiring speed reductions	see RUN SPEEDS
Number of buckets	6
Available tubes	see Table 1
Nominal tube dimensions (largest tube)	13 × 51 mm
Nominal tube capacity (largest tube)	5 mL
Nominal rotor capacity	30 mL
Approximate acceleration time to maximum speed (fully loaded)	
in an Optima XL ultracentrifuge	3.5 min
in an L8M ultracentrifuge	3 min
Approximate deceleration time from maximum speed (fully loaded)	
in an Optima XL ultracentrifuge	3.5 min
in an L8M ultracentrifuge	3 min
Weight of fully loaded rotor	5 kg (11 lb)
Rotor material	titanium

* Relative Centrifugal Field (RCF) is the ratio of the centrifugal acceleration at a specified radius and speed ($r\omega^2$) to the standard acceleration of gravity (g) according to the following formula:

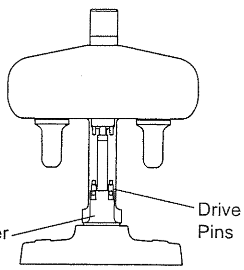
$$\text{RCF} = \frac{r\omega^2}{g}$$

where r is the radius in millimeters, ω is the angular velocity in radians per second (2π RPM /60), and g is the standard acceleration of gravity (9807 mm/s^2). After substitution:

$$\text{RCF} = 1.12\, r \left(\frac{\text{RPM}}{1000}\right)^2$$

DESCRIPTION

This Beckman Coulter rotor has been manufactured in a registered ISO 9001 or 13485 facility for use with the appropriately classified Beckman Coulter ultracentrifuge.



The SW 55 Ti, rated for 55 000 rpm, is a swinging bucket rotor designed to centrifuge up to six tubes. Used in Beckman Coulter class H, R, and S preparative ultracentrifuges, the rotor develops centrifugal forces for the separation and purification of small particles. Typical applications include separation of DNA, RNA, proteins, and subcellular particles in density gradients, and banding RNA- containing viruses in sedimentation equilibrium studies. Approximate sample volume per tube is 0.2 mL, with a gradient volume of about 4.8 mL.

The rotor body and buckets are made of titanium and finished with polyurethane paint; the rotor body is black and the buckets are red. *Do not interchange these* red *buckets with the SW 50.1 Ti* black *buckets.* A solid-film lubricant (grey in color) is applied to the bucket flange to improve the seating of the bucket into the rotor pocket. Bucket caps are anodized aluminum. The bucket and cap assemblies hook over the crossbar of the rotor hanger mechanism. O-rings, made of Buna N rubber, between each bucket and bucket cap maintain atmospheric pressure inside the buckets during centrifugation.

Drive pins in the rotor bottom prevent the rotor from slipping on the ultracentrifuge drive hub during acceleration and deceleration. Two indentations on the sides of the rotor adapter indicate their location.

For overspeed protection, a Beckman Coulter ultracentrifuge equipped with a photoelectric detector will monitor the overspeed disk on the adapter bottom and shut down the run if a speed exceeding the maximum allowable speed is detected.

Refer to the Warranty at the back of this manual for warranty information.

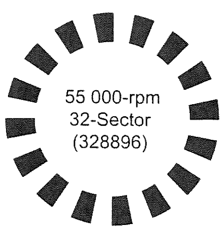
PREPARATION AND USE

Specific information about the SW 55 Ti rotor is given here. Information common to this and other rotors is contained in the manual Rotors and Tubes for Preparative Ultracentrifuges *(publication LR-IM), which should be used together with this manual for complete rotor and accessory operation.* Rotors and Tubes *is included in the literature package with this rotor manual.*

NOTE

Although rotor components and accessories made by other manufacturers may fit in the SW 55 Ti rotor, their safety in this rotor cannot be ascertained by Beckman Coulter. Use of other manufacturers' components or accessories in the SW 55 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 page at the front of this manual before using the rotor.

1. Make sure that the rotor, buckets, and bucket caps are clean and show no signs of corrosion or cracking.

2. Make sure that the rotor is equipped with the correct overspeed disk. If the disk is missing or damaged, replace it according to the instructions in *Rotors and Tubes*.

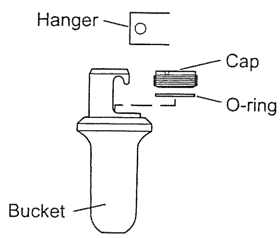
3. Check the chemical compatibilities of all materials used (refer to Appendix A in *Rotors and Tubes*).

4. Verify that the tubes and accessories being used are listed in Table 1.

ROTOR PREPARATION

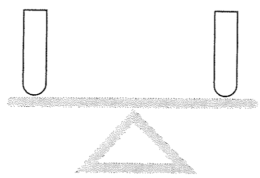
For runs at other than room temperature, refrigerate or warm the rotor beforehand for fast equilibration.

1. Load the filled containers into the buckets (see page 8 for tube and accessory information). Complete loading by placing the correct spacers and/or floating spacers (if required) over the tubes.



Ensure that bucket O-rings are lightly but evenly coated with silicone vacuum grease (335148). Do not run a bucket without an O-ring, as the bucket will leak.

3. Be sure that metal threads in the bucket caps are clean and lightly but evenly lubricated with Spinkote™ lubricant (306812). Match numbered buckets to numbered caps. Put bucket caps on the buckets and screw the caps into the buckets until there is metal-to-metal contact.



4. *Hook all buckets, loaded or empty, to the rotor.* If fewer than six 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.

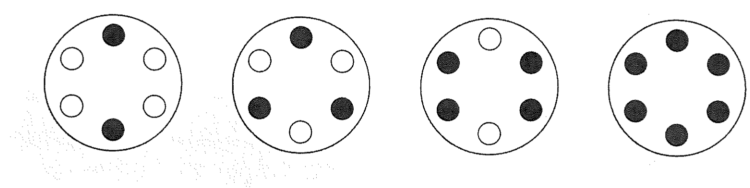
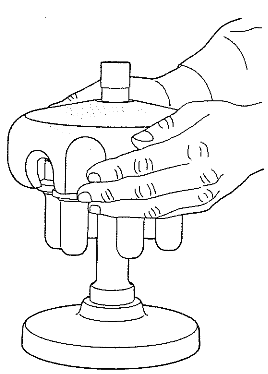


Figure 1. Arranging Tubes in the Rotor. Two, three, four, or six tubes can be centrifuged per run if they are arranged in the rotor as shown. All buckets must be attached to the rotor, whether loaded or empty.

OPERATION



Refer to Rotors and Tubes *for information on installing swinging bucket rotors.*

1. To install the rotor, carefully lift it with both hands—*do not lift the rotor by the adapter*—and place it on the drive hub. Make sure that the rotor pins are perpendicular to the drive hub pins. The pins must not rest on top of each other; turn the rotor to the right (clockwise) by hand to check for proper installation.

2. Refer to the instrument instruction manual for ultracentrifuge operation. In Model L2-50/65 ultracentrifuges, use the stabilizer level "39" for this rotor; in Models L2-65B/75B, use the level marked by three dots.

3. For additional operating information, see the following:

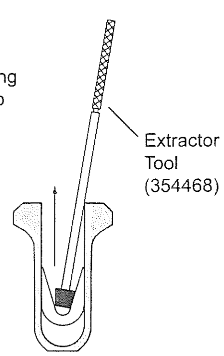
   - RUN TIMES, page 11, for using *k* factors to adjust run durations
   - RUN SPEEDS, page 12, for information about speed limitations
   - SELECTING CsCl GRADIENTS, page 14, for methods to avoid CsCl precipitation during centrifugation

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 centrifuge and accessories.

1. Remove the rotor from the instrument by lifting it straight up and off the drive hub.
2. Set the rotor on the rotor stand and carefully remove the buckets.
3. Remove the bucket caps and use the appropriate removal tool (listed in the SUPPLY LIST) to remove the spacers and tubes. If floating spacers were used, remove them with the threaded end of the floating spacer removal tool (338765).



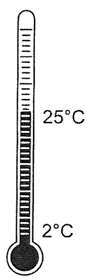
NOTE

If the conical-shaped adapters that support *k*onical tubes are difficult to remove after centrifugation, an extractor tool (354468) is available to facilitate removal.

TUBES AND ACCESSORIES

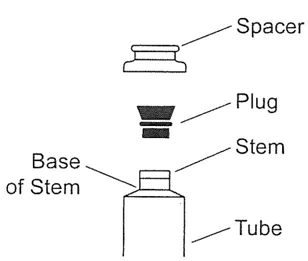
The SW 55 Ti rotor uses tubes and accessories listed in Table 1. Be sure to use only those items listed, and to observe the maximum speed limits shown. Refer to Appendix A in *Rotors and Tubes* for information on the chemical resistances of tube and accessory materials.

Temperature Limits



- Plastic tubes have been centrifuge tested for use at temperatures between 2 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 2°C prior to centrifugation.
- Stainless steel tubes can be centrifuged at any temperature.

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.

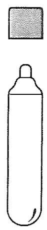
- Place the tubes in the rack and fill each tube to the base of the stem, leaving no fluid in the stem. Overfilling the tube can cause spillage when the plug is inserted or compromise seal integrity. However, too much air can cause excessive tube deformation, disrupting gradients and sample bands.
- Refer to publication IN-189 (*Using OptiSeal™ Tubes*), included in each box of tubes, for detailed information on the use and care of OptiSeal tubes.

Table 1. Beckman Coulter Tubes and Accessories for the SW 55 Ti Rotor. Use only the items listed here.

Tube			Required Accessory		Max Speed/ RCF/ *k* Factor
Dimensions and Volume	Description	Part Number	Description	Part Number	
13 × 51 mm 5 mL	Ultra Clear	344057 (pkg/50)	none	—	55 000 rpm 368 000 × *g* 48
13 × 51 mm 5 mL	thinwall polyallomer	326819 (pkg/50)	none	—	55 000 rpm 368 000 × *g* 48
13 × 51 mm 3 mL	*k*onical open-top polyallomer	358119 (pkg/50)	adapter	358153	55 000 rpm 368 000 × *g* 48
13 × 51 mm 3.2 mL	Quick-Seal *k*onical, polyallomer	358647 (pkg/50)	adapter	358153	55 000 rpm 368 000 × *g* 48
			Noryl* floating spacer	355535	
13 × 33 mm 3.3 mL	OptiSeal bell-top polyallomer	361627 (pkg/56)	Ultem spacer	361678	55 000 rpm 368 000 × *g* 48
13 × 51 mm 3.5 mL	thickwall polyallomer	349623 (pkg/25)	none	—	55 000 rpm 368 000 × *g* 48
13 × 25 mm 2 mL	Quick-Seal polyallomer	345829 (pkg/50)	Noryl floating spacer	355535	55 000 rpm 368 000 × *g* 29
13 × 51 mm 3.5 mL	thickwall polycarbonate	349622 (pkg/25)	none	—	55 000 rpm 368 000 × *g* 48
5 × 41 mm 0.8 mL	Ultra Clear	344090 (pkg/50)	adapter	356860	48 000 rpm 269 000 × *g* 64
				305527	25 000 rpm 73 200 × *g* 209

*Noryl and Ultem are registered trademarks of GE Plastics.

Quick-Seal® Tubes

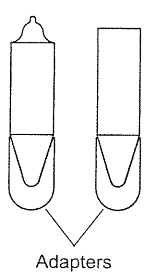


Quick-Seal tubes must be sealed prior to centrifugation. These tubes are heat sealed and do not need caps; however, spacers are required on top of the tubes when they are loaded into the rotor buckets.

- 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.
- Refer to *Rotors and Tubes* for detailed information on the use and care of Quick-Seal tubes.

Some of the tubes listed in Table 1 are part of the *g*-Max™ system. The *g*-Max system uses a combination of small bell-top Quick-Seal tubes and floating spacers (also called *g*-Max spacers). This means that you can run the shorter tubes listed in the table in the SW 55 Ti rotor without reduction in *g* force. Additional information about the *g*-Max system is available in publication DS-709.

*k*onical™ Tubes



Polyallomer *k*onical tubes, used to optimize pelleting separations, have a conical tip that concentrates the pellet in the narrow end of the tube. The narrow bottom also reduces the tube's nominal volume and minimizes gradient material requirement. The *k*onical tubes come in both open-top and Quick-Seal tube designs. Conical cavity adapters hold the tubes in the rotor buckets.

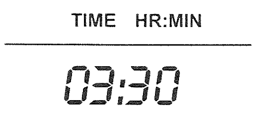
Thinwall Tubes

Thinwall polyallomer and Ultra-Clear open-top tubes should be filled as full as possible (2 or 3 mm from the tube top) for tube support. 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.) All opposing tubes for a run must be filled to the same level with liquid of the same density.

Thickwall Tubes

Thickwall polyallomer 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.

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:

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

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:

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

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*).

$$t = \frac{k}{s} \qquad (3)$$

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

$$k_{adj} = k\left(\frac{55\ 000}{\text{actual run speed}}\right)^2 \qquad (4)$$

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

$$\frac{t_a}{t_b} = \frac{k_a}{k_b} \tag{5}$$

For more information on k factors see *Use of* k *Factor for Estimating Run Times from Previously Established Run Conditions* (publication DS-719).

RUN SPEEDS

SPEED RPM/RCF

55 000 RPM

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 in excess of 55 000 rpm. In addition, speeds must be reduced under the following circumstances:

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

$$\text{reduced maximum speed} = (55\,000 \text{ rpm}) \sqrt{\frac{1.2 \text{ g/mL}}{\rho}} \tag{6}$$

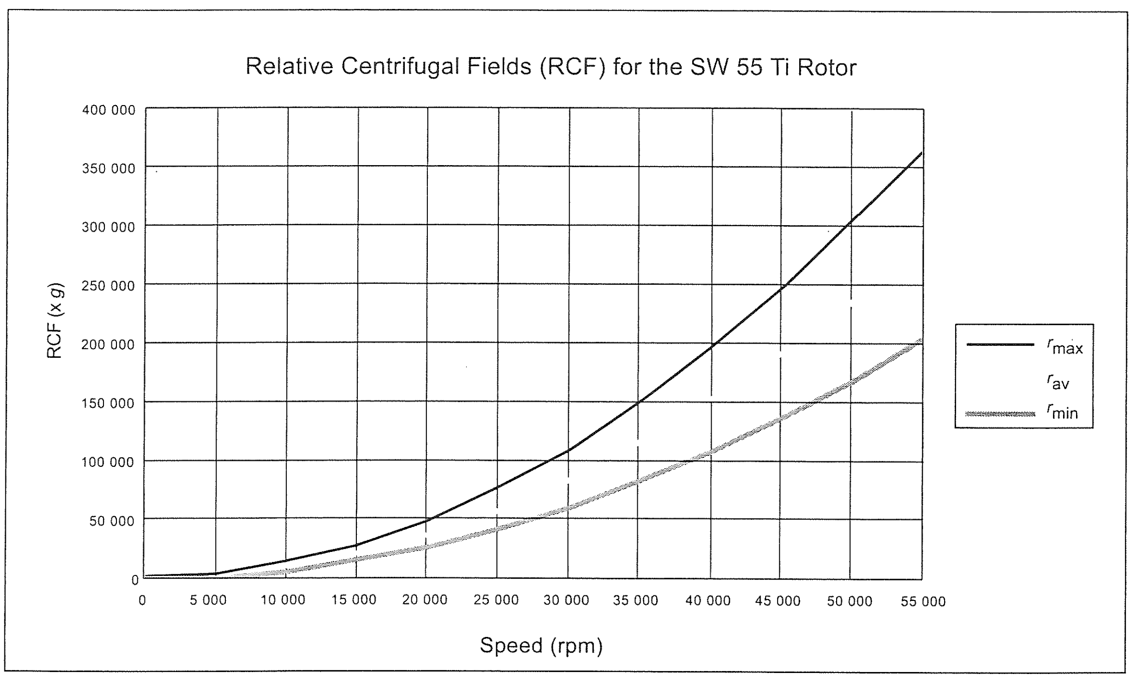
   where ρ is the density of the tube contents. This speed reduction will protect the rotor from excessive stresses due to the added tube load.

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 rotor failure. Figures 2 and 3, together with the description and examples below, show how to reduce run speeds when using CsCl gradients.

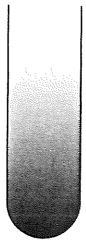
Table 2. Relative Centrifugal Fields for the SW 55 Ti Rotor. Entries in this table are calculated from the formula $RCF = 1.12r\,(RPM/1000)^2$ and then rounded to three significant digits.

Rotor Speed (rpm)	Relative Centrifugal Field (× *g*)			*k* Factor*
	At r_{max} (108.5 mm)	At r_{av} (84.6 mm)	At r_{min} (60.8 mm)	
55 000	368 000	287 000	206 000	48
50 000	304 000	237 000	170 000	59
45 000	246 000	192 000	138 000	72
40 000	194 000	152 000	109 000	92
35 000	149 000	116 000	83 400	120
30 000	109 000	85 300	61 300	163
25 000	76 000	59 200	42 600	235
20 000	48 600	37 900	27 200	367
15 000	27 300	21 300	15 300	652
10 000	12 200	9 480	6 810	1 467

*Calculated for all Beckman Coulter preparative rotors as a measure of the rotor's relative pelleting efficiency, in water at 20°C.



SELECTING CsCl GRADIENTS



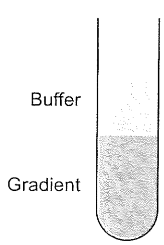
Rotor speed is used to control the slope of a CsCl density gradient, and must be limited so that CsCl precipitation is avoided. Speed and density combinations that intersect on or below the curves in Figure 3 ensure that CsCl will not precipitate during centrifugation in the SW 55 Ti rotor. Curves are provided at two temperatures: 20°C (black curves) and 4°C (gray curves). Curves in Figures 2 and 3 are provided up to the maximum rated speed of the rotor.

NOTE

The curves in Figures 2 and 3 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.

The reference curves in Figure 3 show gradient distribution at equilibrium. Each curve in Figure 3 is within the density limits allowed for the SW 55 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 3 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 3.) Figure 3 can also be used to approximate the banding positions of sample particles. Curves not shown in the figure may be interpolated.

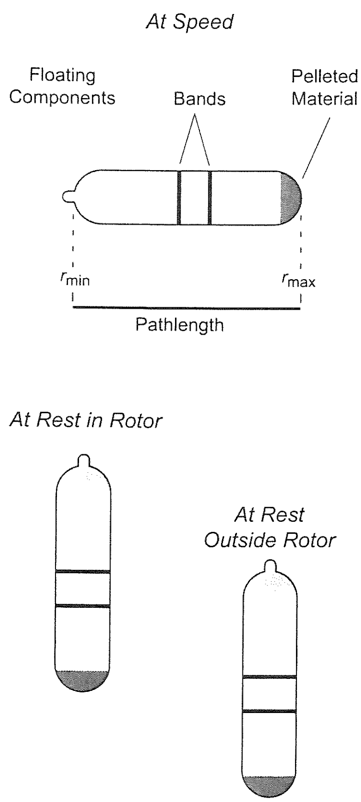
ADJUSTING FILL VOLUMES



Figures 2 and 3 show that several fill volumes are possible in a tube. If a thinwall 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 *quarter-filled* tube of 1.55-g/mL homogeneous CsCl solution at 4°C may be centrifuged at 52 000 rpm (see Figure 2). The segment of the 55 000-rpm curve (Figure 3) from the quarter-filled line to the tube bottom represents this gradient. The same solution in a *half-filled* tube may be centrifuged no faster than 47 000 rpm (curves not shown in the figure may be interpolated), and 40 000 rpm in a *three-quarter-filled* tube. A tube *full* of the 1.55-g/mL CsCl solution may be centrifuged no faster than 36 000 rpm.

TYPICAL EXAMPLES FOR DETERMINING CsCl RUN PARAMETERS



Example A: **Starting with a homogeneous CsCl solution density of 1.39 g/mL and approximate particle buoyant densities of 1.39 and 1.45 g/mL, at 20°C, where will particles band at equilibrium?**

1. In Figure 2, find the curve that corresponds to the desired run temperature (20°C) and fill volume (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 3, 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.

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

In this example, particles will band about 86 and 90 mm from the axis of rotation, about 3.5 mm of centerband-to-centerband separation.

To determine interband volume in milliliters, use the following equation:

$$V = \pi r^2 h \tag{7}$$

where r is the tube radius in centimeters and h is the interband separation in centimeters.

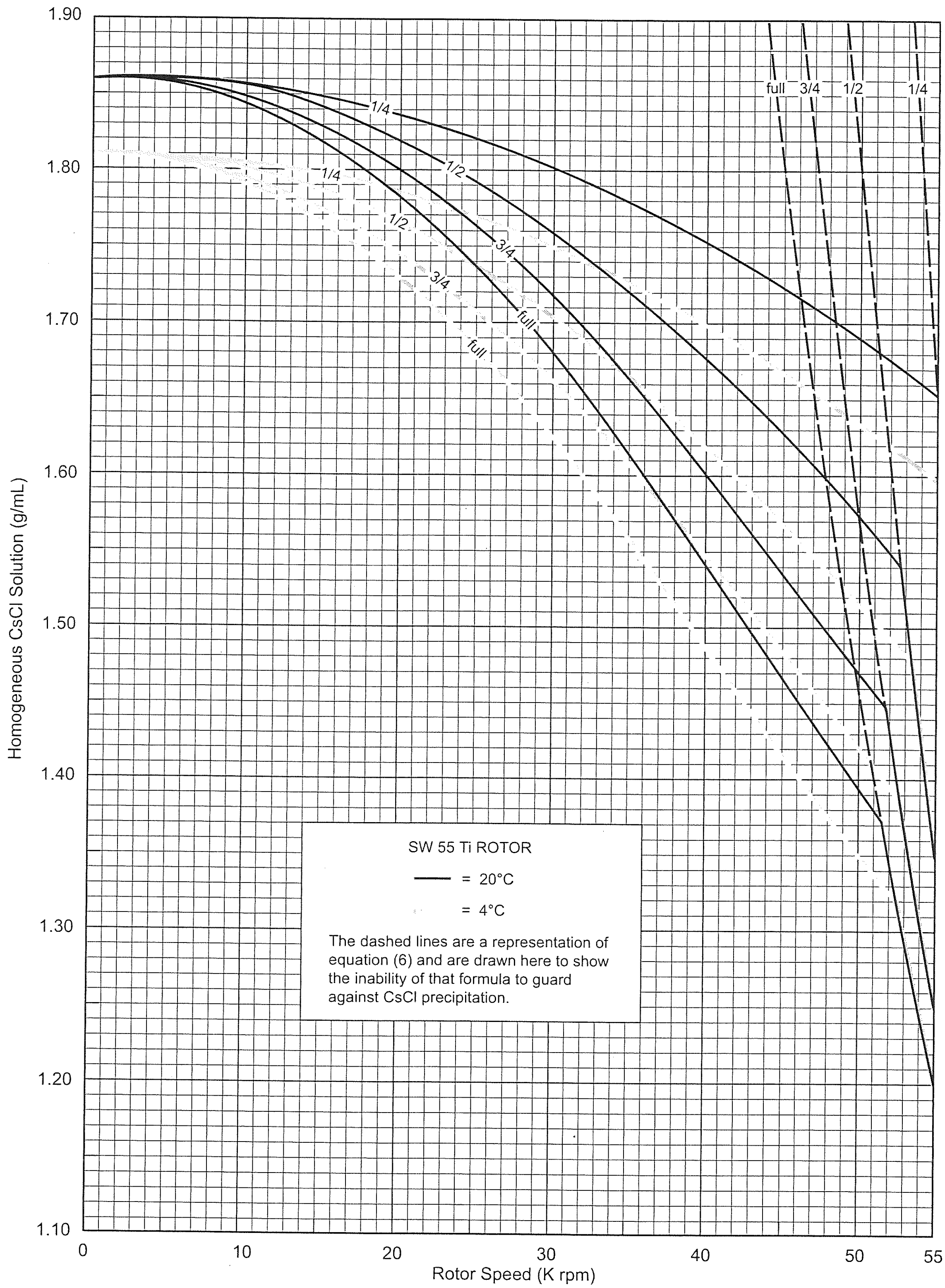


Figure 2. Precipitation Curves for the SW 55 Ti Rotor. Using combinations of rotor speeds and homogeneous CsCl solution densities that intersect on or below these curves ensures that CsCl will not precipitate during centrifugation. The dashed lines are representations of equation (6), and are shown here to illustrate the inability of that equation to predict CsCl precipitation.

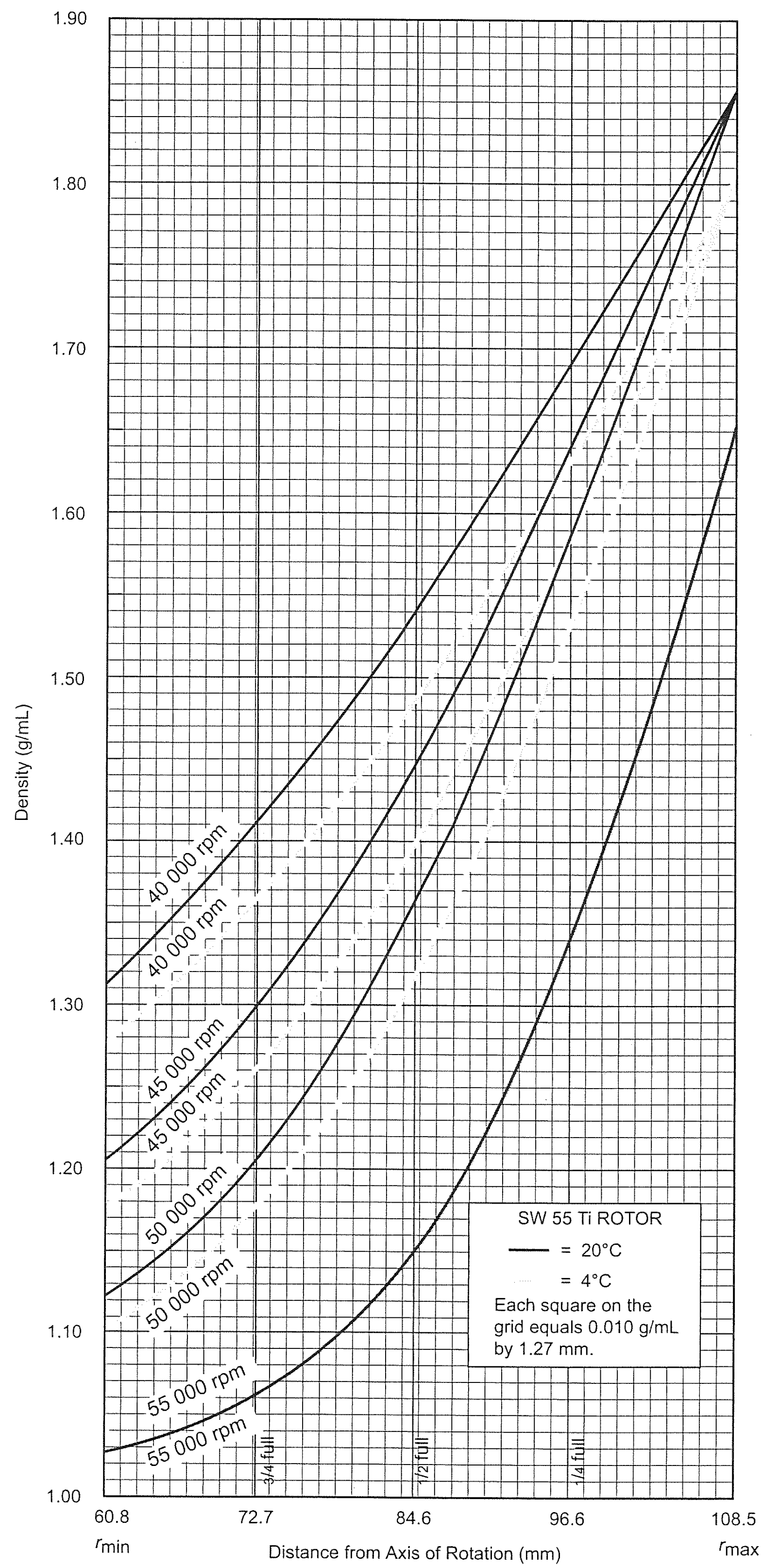


Figure 3. CsCl Gradients at Equilibrium for the SW 55 Ti Rotor. Centrifugation of homogeneous CsCl solutions at the maximum allowable speeds (from Figure 2) results in gradients presented here.

Example B: Knowing particle buoyant densities (for example, 1.375 and 1.42 g/mL), how do you achieve good separation?

1. In Figure 3, sketch in a horizontal line corresponding to each particle's buoyant density.
2. Select the curve at the desired temperature (4°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 2, select the maximum homogeneous CsCl density (in this case, 1.55 g/mL) that corresponds to the temperature and run speed established above. These parameters will provide the particle-banding pattern selected in Step 2.

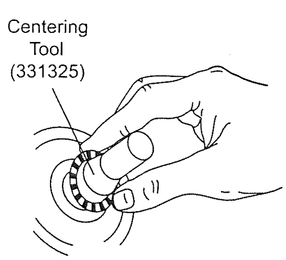
In this example, particles will band at about 74 and 79 mm from the axis of rotation (about 5 mm apart).

CARE AND MAINTENANCE

MAINTENANCE

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.

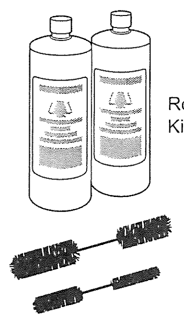


- Regularly inspect the overspeed disk on the bottom of the rotor adapter. If it is scratched, damaged, or missing, replace it. Replacement instructions are in Section 7 of *Rotors and Tubes*.
- Frequently check the bucket O-rings (824412) for signs of wear. Keep O-rings lightly coated with silicone vacuum grease (335148) Replace O-rings every 6 months, or whenever worn or damaged. Keep the gaskets lightly coated with silicone vacuum grease.
- Regularly lubricate the bucket cap threads with a thin, even coat of Spinkote lubricant before every run.

Refer to Appendix A in *Rotors and Tubes* for the chemical resistances 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.



Rotor Cleaning Kit (339558)

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

1. Wash the rotor buckets, O-rings, and caps in a mild detergent, such as Beckman Solution 555™, that won't damage the rotor. The Rotor Cleaning Kit contains two plastic-coated brushes and two quarts of Solution 555 (339555) for use with rotors and accessories. Dilute the detergent 10 to 1 with water.

2. Wash the rotor body with a sponge or cloth dampened with a mild detergent, such as Beckman Solution 555, diluted 10 to 1 with water.

NOTE

Do not immerse the rotor body in water, since the hanger mechanism is difficult to dry and can rust.

3. Rinse the cleaned rotor and components with distilled water.

4. Air-dry the buckets upside down. *Do not use acetone to dry the rotor.*

Clean metal threads frequently to prevent buildup of residues and ensure adequate closure. Use a brush and concentrated Solution 555. Rinse and dry thoroughly, then lubricate lightly but evenly with Spinkote to coat all threads.

SUPPLY LIST

NOTE

Publications referenced in this manual can be obtained by calling Beckman Coulter at 1-800-742-2345 in the United States, or by contacting your local Beckman Coulter office.

Contact Beckman Coulter Sales (1-800-742-2345 in the United States; worldwide offices are listed on the back of this manual) or see the Beckman *Ultracentrifuge Rotors, Tubes & Accessories* catalog (BR-8101, available at www.beckmancoulter.com) for detailed information on ordering parts and supplies. For your convenience, a partial list is given below.

REPLACEMENT ROTOR PARTS

SW 55 Ti rotor assembly	342194
Buckets (set of 6, with caps and O-rings)	342199
Bucket cap	342190
Bucket O-ring	824412
Overspeed disk (55 000 rpm)	328896
Rotor stand	332400
Bucket holder rack	331313

OTHER

Tubes and accessories	see Table 1
OptiSeal tube rack	361650
Quick-Seal Cordless Tube Topper kit, 60 Hz	358312
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 (13-mm dia. tubes)	348122
Floating spacer removal tool	338765
Tube removal tool (Quick-Seal tubes)	361668
Extractor tool (*k*onical tube adapters)	354468
Spinkote lubricant (2 oz)	306812
Silicone vacuum grease (1 oz)	335148
Rotor Cleaning Kit	339558
Beckman Solution 555 (1 qt)	339555
Rotor cleaning brush	339379
Centering tool (for overspeed disk replacement)	331325