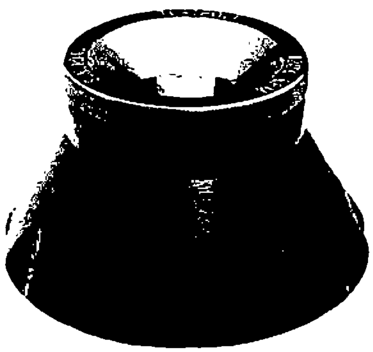
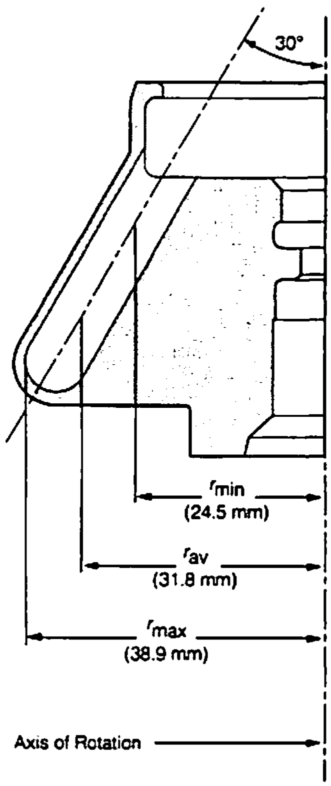
INSTRUCTIONS FOR USING THE TLA-120.1 FIXED ANGLE ROTOR

In the Beckman Optima™ MAX, MAX-E, TL, and TLX Series Ultracentrifuges





U.S. Patent 4,372,483
Japanese Patent 1551443
Swiss Patent 646,881

SPECIFICATIONS

Maximum speed	120 000 rpm
Density rating at maximum speed	1.7 g/mL
Relative Centrifugal Field* at maximum speed	
At r_{max} (38.9 mm)	627 000 × g
At r_{av} (31.8 mm)	513 000 × g
At r_{min} (24.5 mm)	395 000 × g
k factor at maximum speed	8
Conditions requiring speed reductions	see RUN SPEEDS
Number of tube cavities	14
Available tubes	see Table 1
Nominal tube dimensions	8 × 34 mm
Nominal tube capacity	0.5 mL
Nominal rotor capacity	7 mL
Approximate acceleration time to maximum speed (rotor fully loaded)	2 1/2 min
Approximate deceleration time from maximum speed (rotor fully loaded)	2 min
Weight of fully loaded rotor	0.6 kg (1.2 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:

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

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:

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

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DESCRIPTION

This Beckman rotor has been manufactured in an NSAI-registered ISO 9001 or 9002 facility for use with the appropriately classified Beckman ultracentrifuge.

The TLA-120.1, rated for 120 000 rpm, is a fixed angle rotor with a tube angle of 30 degrees from the axis of rotation. The rotor can centrifuge up to 14 tubes per run, and is used in the Beckman Optima™ MAX, MAX-E, TL, and TLX series tabletop ultracentrifuges. This rotor develops centrifugal forces that are suitable for rapid pelleting and isopycnic separations.

The rotor is made of titanium and is finished with black polyurethane paint. The lid is aluminum and is blue-anodized for corrosion resistance. A plunger in the lid locks the rotor to the drive hub before the run begins. Two lubricated O-rings made of Buna N rubber maintain atmospheric pressure inside the rotor during centrifugation.

The rotor is specially designed with a fluid-containment annulus, located below the O-ring sealing surface (see Figure 1). The annulus retains fluid that may escape from leaking or overfilled tubes, thereby preventing the liquid from escaping into the instrument chamber.

The ultracentrifuge identifies rotor speed during the run by means of a magnetic speed sensor system in the rotor chamber of the instrument and magnets on the bottom of the rotor. This overspeed protection system ensures that the rotor does not exceed its permitted speed.

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

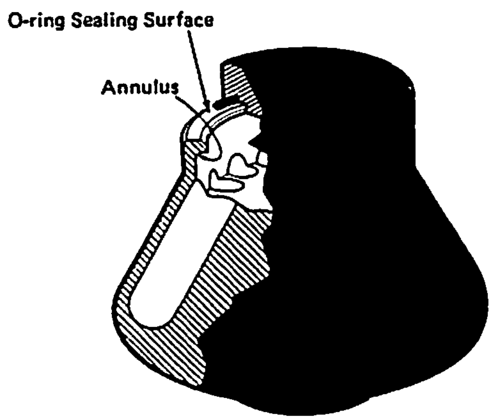


Figure 1. Fluid-Containment Annulus

PREPARATION AND USE

Specific information about the TLA-120.1 rotor is given here. Information common to this and other rotors is contained in Rotors and Tubes for Tabletop Preparative Ultracentrifuges *(Beckman publication TLR-IM), which should be used together with this manual for complete rotor and accessory operation. Publication TLR-IM is included in the literature package shipped with the rotor.*

NOTE

Although rotor components and accessories made by other manufacturers may fit in the TLA-120.1 rotor, their safety in this rotor cannot be ascertained by Beckman. Use of other manufacturers' components or accessories in the TLA-120.1 rotor may void the Beckman 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.

TUBES

Tubes that may be used in the TLA-120.1 rotor are listed in Table 1. Be sure to observe the maximum rotor speed limits and fill volumes shown. Refer to Appendix A of *Rotors and Tubes* for information on the chemical resistances of rotor and tube materials.

Polyallomer and polycarbonate tubes have been centrifuge tested for use at temperatures between 2 and 25°C. Pretest tubes under anticipated run conditions before centrifuging them at temperatures above 25°C.

Table 1. Available Tubes (8 × 34 mm) for the TLA-120.1 Fixed Angle Rotor

Description	Part Number (pkg/100)	Fill Volume (mL)	Max Speed (rpm)	Operating Temperature (°C)
thickwall polycarbonate	343776	0.5	120 000	2 to 40
thickwall polyallomer	343777	0.5	80 000	2 to 40*
Quick-Seal® polyallomer	361078	0.5	120 000	2 to 40*

* Some deformation at the opening of these tubes will occur at temperatures above 20°C.

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 lightly but evenly lubricated with Spinkote™ lubricant (306812).

2. Be sure that the two O-rings are lightly but evenly coated with silicone vacuum grease (335148) to ensure a proper seal.

3. Load the filled tubes into the rotor. If fewer than 14 tubes are run, they must be positioned symmetrically around the center of the rotor. *Tubes placed opposite each other must be filled to the same level with liquid of the same density.*

4. Insert the rotor into the rotor vise (346133). Place the lid on the rotor and tighten it firmly (clockwise) by hand. No tool is required.

ROTOR INSTALLATION

1. Remove external moisture from the rotor by blotting with an absorbent towel just prior to installation.

2. Carefully place the rotor on the drive hub.

3. Lock the rotor in place by gently pressing the plunger in the rotor lid down until you hear a click. when you remove your finger, the plunger will remain depressed (see Figure 2) if it is properly engaged. If the plunger pops up, repeat the procedure. Gently pull up on the rotor to be sure that it is locked firmly in place.

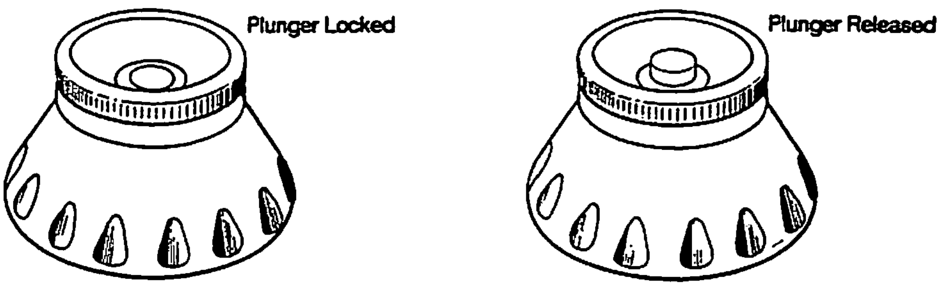


Figure 2. The Plunger in Locked and Released Positions

NOTE

In all ultracentrifuges except the Optima MAX or MAX-E, it is very important to lock the rotor in place before beginning the run to ensure that the rotor remains seated during centrifugation. Failure to lock the rotor in place before beginning the run may result in damage to both rotor and instrument.

4. Refer to the instrument instruction manual for ultracentrifuge operation.

Vertical banding of sample and gradient occurs during centrifugation. With deceleration, tube contents reorient back to a horizontal position. For gradient stability when preformed gradients are used, select slow acceleration and deceleration profiles (see the instrument instruction manual).

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. To release the plunger at the end of the run, gently press it down into the lid until you hear a click. When you remove your finger, the plunger will pop up to its released position (see Figure 2).
2. Remove the rotor from the instrument and place it in the rotor vise.
3. Unscrew the lid (counterclockwise) by hand. Remove the lid.
4. Use a hemostat to remove the tubes.

The Beckman CentriTube Slicer is designed to recover sample fractions from small plastic tubes. (See the Supply List for part numbers.) Contact your Beckman representative to obtain information about this system.

RUN TIMES

The k factor of the rotor is a measure of the rotor's pelleting efficiency. (Beckman 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:

$$k_{adj} = k \left(\frac{120\,000}{\text{actual run speed}}\right)^2 \qquad (4)$$

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:

$$\frac{t_a}{t_b} = \frac{k_a}{k_b} \qquad (5)$$

where the k factors have been adjusted for the actual run speed used.

Finally, use equation(1) above to calculate the k factor when the column of liquid is such that the operational r_{max} and r_{min} are significantly different from the r_{max} and r_{min} of the rotor. 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

The centrifugal force at a given radius in a rotor is a function of run speed. Comparisons of forces between different rotors are made by comparing the rotors' relative centrifugal fields (RCF). When rotational speed is selected 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.

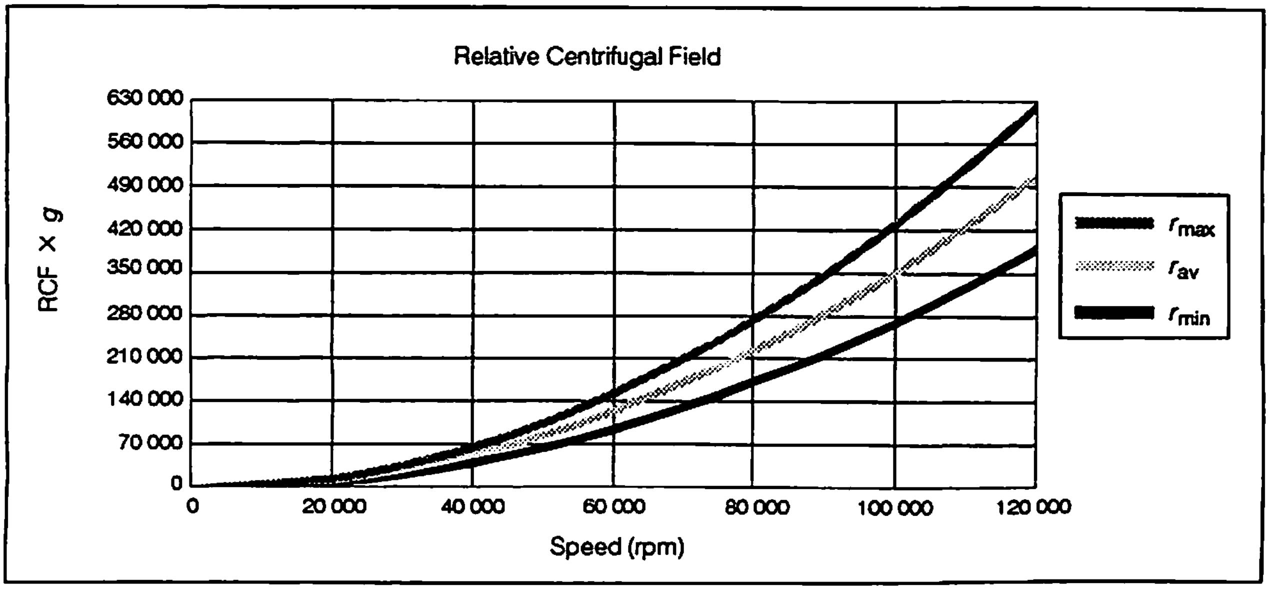
Table 2. Relative Centrifugal Fields for the TLA-120.1 Rotor. Entries in this table are calculated from the formula

$$RCF = 1.12r\,(RPM/1000)^2$$

and then rounded to three significant digits.

Rotor Speed (rpm)	Relative Centrifugal Field ($\times g$) At r_{max} (38.9 mm)	At r_{av} (31.8 mm)	At r_{min} (24.5 mm)	k Factor*
120 000	627 000	513 000	395 000	8
115 000	576 000	471 000	363 000	9
110 000	527 000	431 000	332 000	10
105 000	480 000	393 000	303 000	11
100 000	436 000	356 000	274 000	12
95 000	393 000	321 000	248 000	13
90 000	353 000	289 000	222 000	14
85 000	315 000	257 000	198 000	16
80 000	279 000	228 000	176 000	18
75 000	245 000	200 000	154 000	21
70 000	214 000	175 000	135 000	24
65 000	184 000	151 000	116 000	28
60 000	157 000	128 000	99 000	32
55 000	132 000	108 000	83 000	39
50 000	109 000	89 000	68 600	47
45 000	88 000	72 000	56 000	58
40 000	70 000	57 000	44 000	73
35 000	53 400	43 600	33 600	95
30 000	39 200	32 100	24 700	129
25 000	27 200	22 100	17 200	186
20 000	17 400	14 300	11 000	291

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



To centrifuge nonprecipitating solutions more dense than 1.7 g/mL, the maximum allowable run speed must be reduced according to equation (6).

$$\text{reduced maximum speed} = (120\,000 \text{ rpm}) \sqrt{\frac{1.7 \text{ g/mL}}{\text{density of tube contents}}} \tag{6}$$

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. Precipitation during centrifugation would alter the density distribution of CsCl and this would change where the sample bands. Figures 3 and 4, together with the description and examples below, show how to reduce run speeds when using CsCl gradients.

SELECTING CsCl GRADIENTS

NOTE

The curves in Figures 3 and 4 are for solutions of CsCl salt only. If other salts are present in significant concentrations, the overall CsCl concentration must be reduced. This prevents precipitation of salts concentrated at the tube bottom.

Solid CsCl has a density of 4 g/mL, and if precipitated during centrifugation may cause rotor failure. Precipitation will also alter density distribution, and therefore sample separation. Curves are provided up to the maximum rated speed of the rotor, but note also that *tubes must never be centrifuged faster than the limits in Table 1*. In general, lower speeds provided better resolution, but longer run times will be required to achieve particle separation and gradient equilibrium.

Rotor speed is used to control the slope of a CsCl density gradient, and must be limited so that CsCl precipitation is avoided. The reference curves in Figure 4 show gradient distribution at equilibrium. Each curve in Figure 4 is within the density limits allowed for the TLA-120.1 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 4 can be generated from step or linear gradients, or from homogeneous solutions. But the total concentration of CsCl in solution must be equivalent to a homogeneous solution corresponding to the curves in Figure 3.) If the desired gradient curve is not shown in Figure 4, interpolate between the nearest curves and draw it in. Figure 4 can also be used to approximate the banding positions of sample particles.

ADJUSTING FILL VOLUMES

Figures 3 and 4 show that several fill volumes are possible in a tube. If a tube is partially filled, float mineral oil (or some other low-density, immiscible liquid) on top of the tube contents to fill the tube to its maximum volume. 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 *one-quarter-filled* tube of a 1.71-g/mL homogeneous CsCl solution at 20°C may be centrifuged at 120 000 rpm (see Figure 3). The segment of the 120 000-rpm curve (Figure 4) from the one-quarter-filled line to 1.86 g/mL at the tube bottom represents this gradient. The same solution in a *half-filled* tube may be centrifuged at 100 000 rpm. Figure 4 presents the gradient profile (use the three-quarter-filled segment only). A tube *full* of the 1.71 g/mL CsCl solution may be centrifuged no faster than 80 000 rpm.

TYPICAL EXAMPLES FOR DETERMINING CsCl RUN PARAMETERS

EXAMPLE A: **A separation that is done frequently is the banding of plasmid DNA in cesium chloride with ethidium bromide. The starting density of the CsCl solution is 1.55 g/mL. In this separation the covalently closed, circular plasmid bands at a density of 1.57 g/mL, while the nicked and linear species band at 1.53 g/mL. At 20°C, where will particles band?**

1. In Figure 3, find the curve that corresponds to the desired run temperature (20°C) and the tube fill level (full). The maximum allowable rotor speed is determined from the point where this curve intersects the homogeneous CsCl density (116 000 rpm).

2. In Figure 4, sketch in a horizontal line corresponding to each particle's buoyant density.

3. Mark the point in the figure where each density intersects the curve corresponding to the run speed (116 000 rpm) and temperature (20°C).

4. Particles will band at these marked points along the tube axis.

In this example, the particles will band at about 31.2 and 29.8 mm from the axis of rotation during centrifugation (about 2.4 mm of centerband-to-centerband separation at the rotor's 30-degree tube angle). When the tube is held upright there will be about 2.76-mm centerband-to-centerband separation. This distance, d_{up}, can be calculated from the formula:

$$d_{up} = \frac{d_\theta}{\cos\theta} \qquad (7)$$

where d_θ is the centerband-to-centerband distance when the tube is held at an angle, θ, in the rotor.

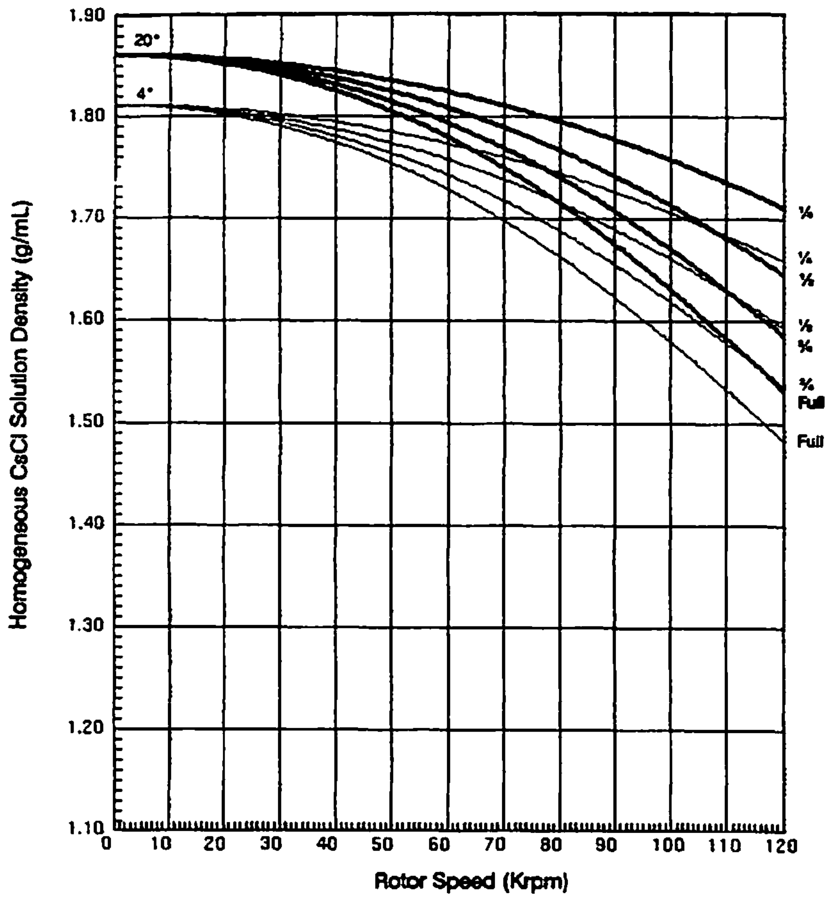


Figure 3. Precipitation Curves. Using combinations of rotor speeds and homogeneous CsCl solution densities that intersect on or below these curves ensures that CsCl will not precipitate during centrifugation. Fill volumes are indicated on the curves.

EXAMPLE B: Knowing particle buoyant densities (for example, 1.75 and 1.77 g/mL), how do you get the best separation? Assume 20°C operation.

1. In Figure 4, sketch in a horizontal line corresponding to each particle's buoyant density.

2. Select the curve that gives the best particle separation at the desired temperature (20°). The tube volume required for this separation is shown on the horizontal axis.

3. Note the speed and homogeneous CsCl concentration for the selected curve (in this case, 70 000 rpm).

4. From Figure 3, determine the maximum allowable homogeneous CsCl density that corresponds to the selected temperature, speed, and fill volume from Figure 4.

In this example, particles will separate better along the 70 000-rpm curve than along the higher-speed curves. At 70 000 rpm, particles will band at about 31.7 and 30.1 mm from the axis of rotation. In this example, the 1.6-mm separation achieved during centrifugation will reorient to about a 1.85-mm separation when the tube is held upright.

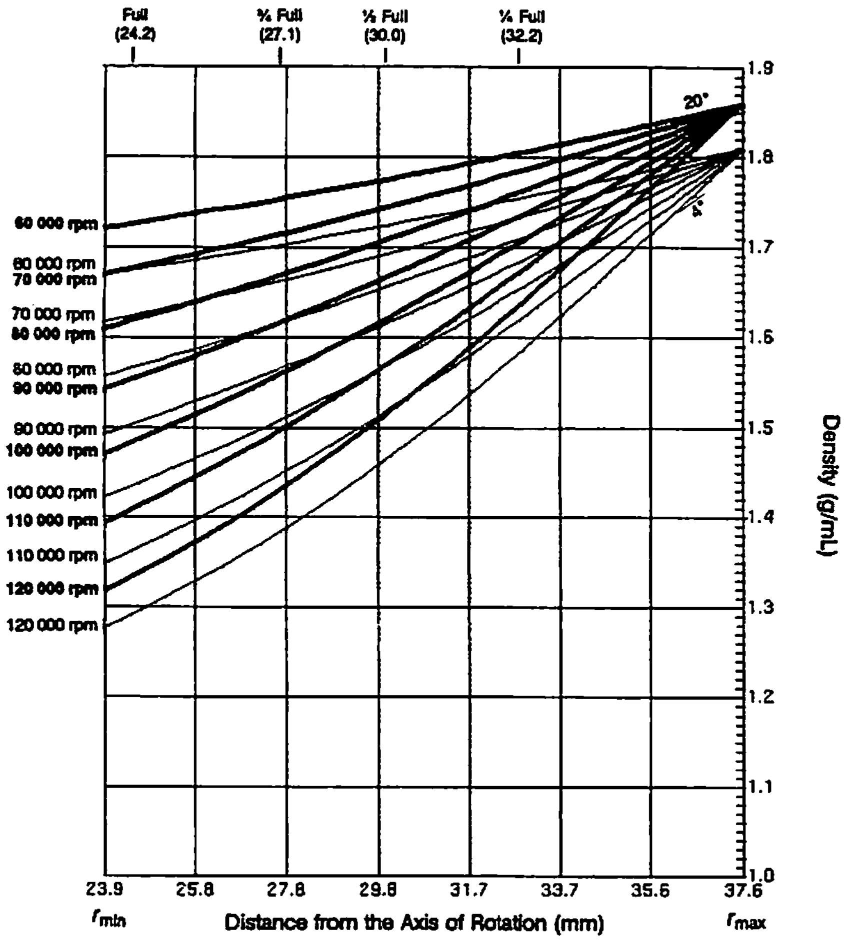


Figure 4. CsCl Gradients at Equilibrium. Centrifugation of homogeneous CsCl solutions at the maximum allowable speeds (from Figure 3) results in gradients presented here. Density increases from the top to the bottom of the tube.

CARE AND MAINTENANCE

MAINTENANCE

- Keep the threads of the rotor lightly but evenly lubricated with Spinkote lubricant (306812).
- Regularly apply silicone vacuum grease (335148) to the O-rings. Replace the O-rings about twice a year or whenever worn or damaged. *Do not use sharp tools on the rotor.*

Store the rotor in a dry environment (not in the instrument) with the lid removed. Store the lid upside down to protect the plunger fingers from being damaged. If the plunger becomes damaged, call your Beckman Field Service representative regarding its repair or replacement. Refer to Appendix A in *Rotors and Tubes* for the chemical resistances of rotor and tube materials. Your Beckman 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 run conditions, 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 Beckman Solution 555™ (339555), that won't damage the rotor. The Rotor Cleaning Kit (339558) contains two plastic-coated brushes and two quarts of Solution 555 for use with rotors and accessories. Dilute the detergent 10 to 1 with water.

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

3. 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-rings before replacing them in the grooves in the lid.

Clean metal threads as necessary (at least every 6 months). Use a brush and concentrated Solution 555. Rinse and dry thoroughly, then lubricate lightly but evenly with Spinkote to coat all threads.

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

DECONTAMINATION

If the rotor or other components are contaminated with radioactive, toxic, or pathogenic materials, follow appropriate decontamination procedures as outlined by appropriate laboratory safety guidelines and/or other regulations. Consult Appendix A in *Rotors and Tubes* to select an agent that will not damage the rotor.

STERILIZATION AND DISINFECTION

- The rotor and all rotor components can be autoclaved at 121°C for up to an hour. Remove the lid and O-rings from the rotor and place the rotor and lid 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.

While Beckman 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.

RETURNING A ROTOR

Before returning a rotor or accessory for any reason, prior permission (a Returned Goods Authorization form) must be obtained from Beckman Instruments. This RGA form may be obtained from your local Beckman sales office. It should contain the following information:

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

To protect our personnel, it is the customer's responsibility to ensure that the 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 RGA form when mailing the rotor and/or accessories to:

Beckman Instruments, Inc.
Spinco Business Center
1050 Page Mill Road
Palo Alto, CA 94304

Attention: Returned Goods

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

* Flammability hazard. Do not use in or near an operating ultracentrifuge.

SUPPLY LIST

> **NOTE**
>
> To obtain copies of referenced publications, contact Beckman Instruments, Technical Publications Department, 1050 Page Mill Road, Palo Alto, CA 94304, U.S.A. (telephone 650-859-1753; fax 650-859-1375).

Contact Beckman Sales (1-800-742-2345 in the United States) or your local Beckman office or see the Beckman *Ultracentrifuge Rotors, Tubes, & Accessories* catalog (BR-8101) for detailed information on ordering parts and supplies. For your convenience, a partial list is given below.

REPLACEMENT ROTOR PARTS

TLA-120.1 rotor assembly 362224
Rotor lid assembly 362225
O-ring, outer, rotor lid (OD 45 mm; 1 3/4 in.) 854519
O-ring, inner, rotor lid (OD 18 mm; 11/16 in.) 824412
Rotor vise assembly 346133

OTHER

Tubes . . . . see Table 1
Tube rack (8-mm diameter) 348304
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 (8-mm dia. tubes) 349661
Hemostat (6-in., curved) 927208
Fraction Recovery System Adapter Kit (for TL-series tubes) 347828
Beckman CentriTube Slicer 347960
CentriTube Slicer replacement blades (pkg of 10) 348299
CentriTube Slicer adapter (for 8-mm tubes) 347956
Tube removal tool (Quick-Seal tubes) 361668
Spinkote lubricant (2 oz) 306812
Silicone vacuum grease (1 oz) 335148
Rotor Cleaning Kit 339558
Beckman Solution 555 (1 qt) 339555
Rotor Cleaning brush 347404

ULTRACENTRIFUGE ROTOR WARRANTY

All Beckman 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.

Warranty Conditions (as applicable)

1) This warranty is valid for the time periods indicated above from the date of shipment to the original Buyer by Beckman or an authorized Beckman 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.

3) This warranty covers the Beckman Centrifuge Systems only (including but not limited to the centrifuge, rotor, and accessories) and Beckman shall not be liable for damage to or loss of the user's sample, non-Beckman tubes, adapters, or other rotor contents.

4) This warranty is void if the Beckman Centrifuge System is determined by Beckman to have been operated or maintained in a manner contrary to the instructions in the operator's manual(s) for the Beckman 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 rotor in a centrifuge not of Beckman manufacture, or if the rotor is used in a Beckman centrifuge that has been modified without the written permission of Beckman, or is used with carriers, buckets, belts, or other devices not of Beckman manufacture.

7) Rotor parts subject to wear, including but not limited to rotor O-rings, VTi, NVT™, MLN, TLV, 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 rotor is determined by Beckman to be defective, Beckman 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 centrifuge is damaged due to a failure of a rotor covered by this warranty, Beckman 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), and (ii) if the centrifuge is currently covered by a Beckman warranty or Full Service Agreement, all labor necessary for repair of the centrifuge.

3) If a Beckman rotor covered by this warranty is damaged due to a malfunction of a Beckman ultracentrifuge covered by an Ultracentrifuge System Service Agreement, Beckman will repair or replace the rotor free of charge.

4) If a Beckman rotor covered by this warranty is damaged due to a failure of a Beckman tube, bottle, tube cap, spacer, or adapter, covered under the Conditions of this Warranty, Beckman 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 rotor or instrument due to the failure or malfunction of a non-Beckman tube, bottle, tube cap, spacer, o adapter is not covered under this warranty, although Beckman 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 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 Palo Alto, California, USA, of any Beckman rotor at the request of the user. (Shipping charges to Beckman 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 Service Agreement. Contact your local Beckman office for details of service coverage or cost.

Before shipping, contact the nearest Beckman 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 AR NON-RADIOACTIVE, NON-PATHOGENIC, NON-TOXIC, AND OTHERWISE SAFE TO SHIP AND HANDLE IS REQUIRED.

Beckman Worldwide Offices

AFRICA, MIDDLE EAST, EASTERN EUROPE
Beckman Instruments International S.A.
22, rue Juste-Olivier
CH-1260 Nyon
Switzerland
Telephone: (41) 22-994 07 07
Fax: (41) 22-994 07 00

AUSTRALIA
Beckman Instruments (Australia) Pty. Ltd.
24 College Street
Gladesville, NSW 2111
Australia
Telephone: (61) 2 9844-6000
Fax: (61) 2 9844-6096

AUSTRIA
Beckman Instruments GmbH
Handelskai 340
A-1020 Vienna
Austria
Telephone: (43) 1 729 2164
Fax: (43) 1 729 2170

CANADA
Beckman Instruments (Canada) Inc.
6733 Mississauga Road, Suite 604
Mississauga, Ontario
Canada L5N 6J5
Telephone: (905) 819-1234
Fax: (905) 819-1485

CHINA
Beckman Beijing Representative Office
6th Floor, Beijing Municipal Computer Building
No. 249, Dong Si Nan Da Jie
Beijing
China 100005
Telephone: (8610) 6527 9344-9
Fax: (8610) 6527 8819

FRANCE
Beckman Instruments France S.A.
92/94 Chemin des Bourdons
93220 Gagny, France
Telephone: (33) 1 43 01 70 00
Fax: (33) 1 43 02 58 30
e-mail: beckman_france@beckman.com

GERMANY
Beckman Instruments GmBH
Frankfurter Ring 115
D-80807 München
Germany
Telephone: (49) 89 35870-0
Fax: (49) 89 35870-490
e-mail: beckman_deutschland@beckman.com

HONG KONG
Beckman Instruments (Hong Kong) Ltd.
15th Floor
Gee Chang Hong Centre
65 Wong Chuk Hang Road
Aberdeen, Hong Kong\
China
Telephone: (852) 2814 7431
Fax: (852) 2814 1599

ITALY
Beckman Analytical S.p.A.
Centro Direzionale Lambardo
Palazzo F/1, Via Roma 108
20060 Cassina De Pecchi
Milano
Italy
Telephone: (39) 2-953921
Fax: (39) 2-95392264
e-mail: beckman_italia@beckman.com

JAPAN
Beckman Coulter (Japan) Ltd.
Sasazuka Center Bldg.
5-1, Toranomon 3-chome
Minato-ku, Tokyo 105-0001
Japan
Telephone: 813-5404-8306
Fax: 813-5552-8308

MEXICO
Beckman Instruments de Mexico
S.A. de C.V.
Angel Urraza 1119
Colonia del Valle
A.P. 44-100
Mexico, 03100, D.F.
Telephone: 525 559-16-35
Fax: 525 559-36-12

NETHERLANDS
Beckman Instruments Nederland B.V.
Nijverheidsweg 21
P.O. Box 47
3640 AA-Mijdrecht
The Netherlands
Telephone: (31) 297-230630
Fax: (31) 297-288082

SINGAPORE
Beckman Instruments (Singapore) Pte. Ltd.
331 North Bridge Road
Odeon Towers, #07-01/02
Singapore 188720
Telephone: (65) 339-3633
Fax: (65) 336 6303

SOUTH AFRICA
Beckman Instruments Pty. Ltd.
Stand 1A Fedsure Park
Tonetti Street
1685 Halfway House
Johannesburg
Republic of South Africa
Telephone: (27) 11-805-2014/5

SPAIN
Beckman Instruments España S.A.
Avda. del Llano Castellano 15
28034 Madrid
Spain
Telephone: (34) 1358 0051

SWEDEN
Beckman Instruments A.B.
Archimedesvaegen 2
Box 65
S-161 26 Bromma
Sweden
Telephone: 46 (0)8-98 53 20
Telefax: 46 (0)8-98 74 34

SWITZERLAND
Beckman Instruments International S.A.
22, rue Juste-Olivier
CH-1260 Nyon
Switzerland
Telephone: (41) 0800 850 810
Fax: (41) 22 994 07 00

TAIWAN
Beckman Instruments (Taiwan) Inc.
8th Floor
216 Tun Hwa South Road, Section 2
Taipei 106, Taiwan
Republic of China
Telephone: (886) 02 2378-3456
Fax: (886) 02 2377-0408

UNITED KINGDOM
Beckman Instruments (UK) Ltd
Oakley Court
Kingsmead Business Park
London Road
High Wycombe
Bucks [illegible]
England
Telephone: (44) 1494 441181
Fax: (44) 1494 447558
e-mail: beckman_uk@beckman.com

Authorized dealers in other countries.

Beckman Coulter, Inc. • 4300 N. Harbor Boulevard, Box 3100 • Fullerton, California 92834-3100
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