Thermo Scientific Fiberlite Rotors

User Reference Manual

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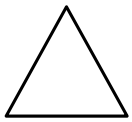
1. Safety Marks and Notices



CAUTION- SAFETY MARK!

This mark points to an important safety instruction in connection with the operation and handling of the rotor. Failure to do so may void warranty or result in damage to the rotor, centrifuge, and in the loss of samples. The operator is instructed to follow the accompanying instructions before use or maintenance of Thermo Scientific Fiberlite rotors and accessories.

WARNING - SAFETY MARK!

This mark signifies a critical safety consideration that must be adhered to. Failure to do so creates the potential of harm to the rotor, centrifuge and even personal injury. The operator is strongly urged to strictly follow all instructions that accompany this symbol.

IMPORTANT SAFETY CONSIDERATIONS!

- Please read before using your rotor -

Chemical and Biological Safety

Use solutions, samples or material that are chemically or biologically active or potentially dangerous mixtures, only after you read, understand:

- all safety documents, data sheets or other information provided by the solutions, samples, materials, or bio-active material, parts, components, instruments and tools involved in the experiment,
- all relevant federal and local safety regulations, and
- institute all necessary precautionary and safety steps.

If a supplier provides any of the biologic products involved in the experiment, you must familiarize yourself with all cautionary information available from the supplier's literature with respect to the origin and properties of these products. If such information is inadequate or unavailable, contact your institution's safety officer.

 In addition, you must keep the following under consideration at all times before, during and after centrifugation.

- Spills may generate aerosols. Be familiar with and adhere to safety precautions for aerosol containment. Implement aerosol containment particularly when working with virulent organisms such as Hepatitis (B and C), HIV (all forms), mycobacteria, etc. Infectious sample mixtures must be handled according to appropriate laboratory procedures and methods to prevent potentially lethal consequences.
- Handle all body fluids, whether human or animal, as if they are capable of transmitting life-threatening infectious disease. Available laboratory tests do not eliminate the hazard.
- Follow local and federal guidelines related to health, safety and environment to dispose waste solutions.
- If, at the end of a centrifuge run, there is evidence of leakage of biologically active or radioactive samples, you should assume that some fluid escaped the rotor. In that case, you should immediately start appropriate decontamination procedures for the rotor (see section 2.3.3), centrifuge and all related accessories, such as vacuum pump(s) and connecting vacuum tubes that might have been exposed to the sample. If not certain, call the manufacturer of your centrifuge for instructions.

Mechanical Limitations and Worker Safety

The failure mode of Thermo Scientific **Fiberlite** rotors is much different than rotors made from metals. In case of a total failure and disruption, **Fiberlite®** rotors will cause less damage to the centrifuge than their metallic equivalents. However, total disruption of a large or high-energy rotor may still result in some damage to the centrifuge and loss of samples. Make sure you follow instructions in this manual and in other documents provided by manufacturers of the centrifuge, bottles, and tubes and by suppliers of sample mixtures or reagents. Follow all operational procedures correctly for each run.

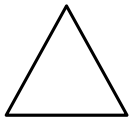
 Never use a rotor without a lid. Super-speed or General Purpose rotors not tied down securely on the spindle may jump off and cause damage to the drive shaft and the centrifuge chamber.

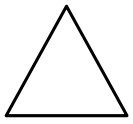
 Never attempt to touch or stop a rotor by hand. Failure to do so may damage the surface finish of the rotor and, over time, expose some pointed ends of carbon filaments, which may break through the skin like a wooden splinter.

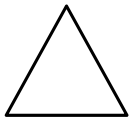
 Trying to stop a rotor also presents a serious personal hazard: loose items like scarves or sleeves of a lab-coat can be caught by the spinning rotor and cause injury.

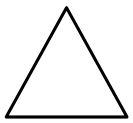
 Always check, prior to starting a run, the condition of the segmented over-speed disk of an ultra rotor. The over-speed disk is located at the bottom of the metallic hub. If the disk is scratched, partially peeled or otherwise damaged, replace the disk with a new one of the same type.

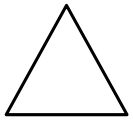
 Excessive vibration of a high-speed centrifuge will indicate a grossly unbalanced rotor. Stop the run immediately, remove all bottles from the rotor and check counterbalancing of the bottles in accordance with the manufacturer of your centrifuge. Most high/super centrifuges require counterbalancing within ±1.0 gram. Ultra speed, fixed angle rotors require counterbalancing better than ±0.5 gram. Ask the manufacturer of your centrifuge for proper counterbalancing procedure.

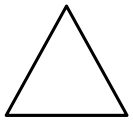
 Do not exceed maximum rotor speed under any circumstance. Speed reduction may be necessary because of weight considerations of tubes, adapters, condition of the rotor, or the density of the solution being centrifuged. Be sure to follow appropriate instructions contained in this rotor manual.

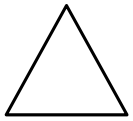
 Do not put a rotor covered with moisture on the pre-cooled drive spindle, or it can freeze into place. Never leave the rotor on the hub for long periods. Keep mating surfaces of the rotor and spindle clean.

 If any unusual vibrations, sounds or odors occur, turn off power to the centrifuge immediately and do not operate the centrifuge until the cause of the improper behavior is determined.

 Do not try to lift a rotor by force or by swaying it. If not removed immediately, rotors may stick to the spindles of some high-speed centrifuges due to condensation that can quickly freeze over the spindle. Leave the rotor in the centrifuge and wait until the centrifuge comes down to room temperature. Then, try lifting the rotor again. If you still cannot remove the rotor, contact Thermo Fisher Scientific for advice.

 Lifting, carrying and reaching in-and-out of the centrifuge poses the potential of lower back-injuries. Lift, carry and handle the rotor with care, with your body in complete balance at all times. Ask your institution's safety officer or write to Occupational Safety and Health Administration (OSHA) for advice. Dropping the rotor on the floor from a bench-top distance may render it unusable. If a rotor is dropped on the floor, you must contact Thermo Fisher Scientific to arrange for a free inspection.

 Never use any abrasive tools to clean the rotor. If needed, uses soft brushes and wash only with mild soap or detergent solutions.

 High or super speed rotors need to be screwed onto the spindle using the tie-down knob on the rotor lid. Ultra rotors do not need to be tied down; they are simply placed over the spindle.

<u>IMPORTANT</u>:

It is the customer's responsibility to decontaminate, disinfect or sterilize the rotor and ensure complete safety before contacting* Thermo Fisher Scientific *for service or inspection.

2. Rotor Model Designations

All **Thermo Scientific Fiberlite** high and super speed rotors are named to provide basic information about them following some conventional designations. For example, the model name **F10S-6x500** indicates that this rotor is a **F**ixed Angle high speed rotor, capable of achieving a maximum speed of **10**,000 rpm, equipped with a Thermo Scientific **S**orvall hub, and that the rotor has **6** cell cavities with **500**mL capacity each. Since manufacturers of high and super speed centrifuges use different styles of spindles in their instruments, the second (in some cases 2nd & 3rd) capital alpha letter identifies the hub.

The **Fiberlite** ultra speed rotor designation is slightly different than the high speed rotors because the spindles of all ultra rotors have been standardized around a single design. An ultra speed rotor is interchangeable between different manufacturers' instruments. This eliminates the need for instrument differentiation. Therefore, ultra rotor names have two letter designations. For example, F40-8x100 is a **F**ixed Angle ultra rotor, capable of achieving 40,000 rpm top speed, having **6** cell cavities, each with a capacity of **100**mL.

Typically, centrifuges capable of achieving top speed between 20,000 and 30,000 are called high or super speed centrifuges. Ultra speed centrifuges range in speed from approximately 25,000 to over 100,000*rpms*.

3. Characteristics of Composite Materials

A composite structure is a non-chemically combined material created by the synthetic assembly of two or more components. These components include selected filler or reinforcing agent and a compatible matrix binder, i.e., a resin, in order to yield specific characteristics and properties. The components of a composite material do not dissolve or otherwise merge completely into each other, but they act in concert. The components and interface between them can be physically identified and characterized. In addition, it is the behavior and properties of the interface that generally control the properties of a composite structure.

The key advantage the composite technology is that it provides wide design flexibility and manufacturing latitude to meet the technical, performance and cost demands imposed by different applications. The goal in creating a composite structure is to combine similar or dissimilar materials in order to develop specific properties that meet desired requirements.

From the centrifugation point of view, what make composite materials, specifically carbon fiber and epoxy combinations, highly desirable are that they do not corrode and that they provide significantly better strength to density and stiffness to density ratios than both aluminum and titanium. These properties, when applied properly, result in better, safer, higher performance centrifugation products.

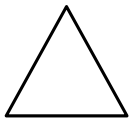
4. Rotor Preparation

It is advisable to keep your **Fiberlite** carbon fiber rotor in a cold-room, so that the run can start immediately after bottles are placed in the rotor, eliminating the need to wait for temperature equilibration in the centrifuge. If kept at room temperature, **Fiberlite** rotors will take approximately 1-3 hours to cool down to under 10^{o}C after it is placed in a refrigerator. However, because carbon fiber rotors provide effective temperature insulation, you only need to chill your sample. Once placed in the rotor, the rotor will maintain up to 95% of the sample temperature throughout the spin cycle.

It is always important to visually inspect the rotor and its components before and after each run for any unusual nicks, checking, or other abnormalities. See Rotor Care, Cleaning and Disinfecting.

5. Tube and Bottle Preparation

Commonly used rotor bottles have a flat bottom with rounded edges and may be covered with either a screw closure or a sealing cap. Other types of bottles with conical or rounded bottoms may be used with inserts. Typically these bottles are supplied with a non-contaminating screw closure without a liner.

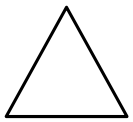


To ensure leak-proof performance, especially at forces greater than 10,000xg or when spinning hazardous materials, sealing cap assemblies (cap and gasket) should be used. Other special purpose caps, made for low temperature storage or to resist aggressive chemicals are specified as such by their respective manufacturers.

For certain applications, round-bottom or conical-bottom tubes may also be used with appropriate adapters for support during centrifugation. These types of bottles are typically specified with reduced g-force rating. Check with the manufacturer for the maximum g-force rating of your bottle.

There are several different polymeric materials used in the construction of centrifuge bottles. Each material offer different kinds of resistance to solvents, pH, temperatures, environments, autoclaving and stress crack. Eventually, however, all of these materials will develop stress-cracks from continued use. Consult with the bottle manufacturer to

select the correct type that will suit your application, and deliver desired performance and cost.

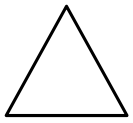
 Glass tubes or bottles are rarely used in a high-speed rotor. However, if glass tubes are to be used, follow manufacturer's instructions to sure that the material can withstand the required g-forces.

6. Instrument Considerations

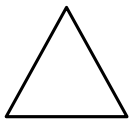
Fiberlite rotors can be used in both vacuum and non-vacuum environments. There will not be an appreciable difference in the rotor's performance in any high or super- speed centrifuge because none of the high/super speed centrifuges provide a significant level of vacuum during centrifugation.

7. Rotor Care, Cleaning and Disinfecting

The rotor body does not need washing and cleaning after every run. However, periodic washing under warm water, using a mild detergent solution will help reduce the amount of salt deposits from spills and permit easy placement of sample bottles in the rotor cavities. **Our** specially formulated FIBERClene is designed to extend the life of your carbon fiber rotor, as well as to provide an effective, ecologically safe cleaner for general cleaning purposes.

 Please observe the following:

- Do not use any sharp objects or tools on the rotor and any of its components. Use only soft bristle brush to remove dry salts that might be deposited in the cavities or other locations unreachable by hand.
- The rotor contains some anodized metallic components, such as the hub, lid-knob and tie-down screw. Do not allow any salts or corrosive chemicals to accumulate over these components. Wash them periodically or, as required after each run.
- Regularly check the condition of o-rings. Replace worn, cracked or damaged o-rings. This rotor utilizes o-rings for proper sealing of the cavities to maintain atmospheric pressure in the rotor during the run. All rotor o-rings and the surfaces of the o-ring slots (they are placed in), must be kept clean, and always lightly greased, using a silicon vacuum grease.
- Air-dry all rotor components; do not wash any rotor components in a dishwasher. Do not soak in detergent solutions for long periods, i.e. overnight.

 After some usage, the painted and unpainted surfaces of the rotor may develop hairlinechecking. This checking is not structural and will not adversely affect the life and performance of your rotor.

 **Disinfecting, sterilization, decontamination**

- All rotor components, including the o-rings may be autoclaved at 121^{o}C for up to an hour. O-rings and gaskets may be left on the rotor. The rotor should be placed in the autoclave upside down. Ethanol (70%), or bleach (10%) may also be used. However, ethanol disinfecting should be done away from the centrifuge at a location, i.e., a vent hood, safe for handling flammable liquids. Wash all rotor components thoroughly with water to remove residual ethanol, bleach or other solutions.

  Note: Repetitive autoclaving may cause discoloration.

- A rotor contaminated with radioactive material must be decontaminated with a solution that will not damage the anodized surfaces of the metallic components or painted surfaces of the rotor body. Solutions such as Radcon Surface Spray or IsoClean Solution (for soaking) and Radiacwash are suitable. Most of these solutions are available from most supply catalogues, such as those published by VWR, Thermofisher, Cole Parmer, etc.

  Note: **Thermo Fisher Scientific** offers no guarantee, implied or expressed, effectiveness of sterility or disinfecting with respect to procedures and materials mentioned in this document. Sterility, disinfecting or decontamination methods should be selected in consultation with the laboratory safety officer of your institution.

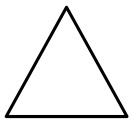
- For regular cleaning and maintenance purposes, **our cleaning solution** will suffice.

8. In Case of Trouble - What To Do

The most common problem is spillage of sample during the run from loosely capped bottles and the resulting imbalance, bent shafts and/or rotor freezing over the spindle.

 If a bottle develops a significant leak in the middle of the run, there could be some damage to the drive assembly and the centrifuge chamber caused by the grossly unbalanced rotor. It is strongly recommended, therefore, that bottles are re-used only

for the number of times (or less if subjected to aggressive chemicals) recommended by the manufacturer.



Do not try to lift a frozen rotor by excessive force or by swaying it. If not removed immediately, rotors may stick to the spindles of some high-speed centrifuges due to condensation that quickly freeze over the spindle. In such a case, leave the rotor in the centrifuge and let the centrifuge chamber come down to room temperature. Then, try lifting the rotor again. If you still cannot remove the rotor, call **Thermo Fisher Scientific** for assistance.

9. Product Return Procedure

RETURNING A ROTOR

Before returning a rotor or accessory for any reason, prior permission (a Returned Goods Authorization form) must be obtained. This RGA form may be completed on the website (http://www.piramoon.com/RGA.html) or obtained by calling Thermo Fisher Scientific.

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, 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.***

10. Field Rotor Inspection Program

Thermo Fisher Scientific offers a free Rotor Inspection Program on Thermo Scientific Fiberlite rotors that is available to our customers at no charge. If you have rotors that have been in use for over 2.5 years, you may wish to have an evaluation conducted at your premises to ensure their continued viability without potential danger of failure. For more information on requesting this service from your local representative, contact Thermo Fisher Scientific.

11. Warranty Statement

Thermo Scientific Fiberlite Rotor Warranty Statement

Thermo Fisher Scientific designs, manufactures and sells centrifugation products incorporating advanced composites technology. We are the exclusive and sole provider of this limited warranty (the "warranty") for its Products offered at the time of purchase.

Thermo Scientific Fiberlite composite rotors (Products) are manufactured to be direct replacements of conventional rotors and to run in certain existing models of Thermo Scientific centrifuges and centrifuges sold by other manufacturers. Composite rotors are designed and tested to specifications exceeding those published by [most of] the manufacturers of these centrifuges. Rotors manufactured of advanced composite materials have performance characteristics and maintenance requirements that are different from rotors of metallic construction. The owners are strongly urged to read the instruction manual to familiarize themselves with these requirements. Failure to follow the instructions may void the limited warranty provided below.

LIMITED WARRANTY

Subject to the conditions specified below, all Fiberlite rotors are warranted against defects of material and workmanship which develop for fifteen (15) years ("Warranty Period") after delivery by us or by an authorized distributor, provided that investigation and factory inspection by Thermo Fisher Scientific discloses that such defect developed under normal and proper use, such use including, but not limited to speeds not in excess of the maximum speed of the rotor (properly reduced for certain fluid densities, fluid gradients, tube assemblies, and adapters) as specified in the instruction manual. Thermo Fisher Scientific will correct either by repair or, at its discretion, by replacement any defects of material or workmanship which develop within the Warranty Period. Furthermore, should a centrifuge be damaged due to the failure of a Fiberlite rotor covered by this limited warranty, Thermo Fisher Scientific will, at its discretion, repair or replace the rotor and will assume the cost paid to a third party for repairing the damaged centrifuge.

CONDITIONS:

1. This warranty may not be assigned, extended or otherwise transferred to a third party without the prior written consent of Thermo Fisher Scientific.

2. This warranty covers rotor only and Thermo Fisher Scientific shall not be liable for damage to metal component parts, accessories, or ancillary supplies including but not limited to knobs, hubs, buckets, seals, o-rings, bottles and tubes, bottle and tube caps, bottle and tube adapters, or bottle and tube contents.

3. This warranty is void if the rotor is operated or maintained in a manner contrary to the instructions in the User's manual for either the rotor or the centrifuge, or if the rotor is modified without the written permission of Thermo Fisher Scientific.

Rotor Replacement

Any rotor claimed to be defective must, if requested by Thermo Fisher Scientific, be returned to the factory, transportation charges prepaid, and will be returned to the owner transportation charges collect unless the product is found to be defective, in which case Thermo Fisher Scientific will pay all transportation charges.

DISCLAIMER

IT IS EXPRESSLY AGREED THAT THE ABOVE LIMITED WARRANTY STATES THERMO SCIENTIFIC'S ENTIRE AND EXCLUSIVE LIABILITY AND BUYER'S EXCLUSIVE REMEDY FOR ANY CLAIM OR DAMAGES OF GOODS OR PARTS, THEIR DESIGN, SUITABILITY FOR USE, INSTALLATION OR OPERATION. THIS LIMITED WARRANTY SHALL BE IN LIEU OF ALL OTHER EXPRESS OR IMPLIED WARRANTIES, INCLUDING BUT NOT LIMITED TO THE WARRANTY OF FITNESS AND THE WARRANTY OF MERCHANTABILITY, WHICH ARE HEREIN EXPRESSLY DISCLAIMED. FURTHERMORE, THERMO SCIENTIFIC SHALL HAVE NO LIABILITY FOR SPECIAL OR CONSEQUENTIAL DAMAGES OF ANY KIND WHATSOEVER, INCLUDING BUT NOT LIMITED TO LOST PROFITS, ARISING OUT OF THE MANUFACTURE, USE, SALE, HANDLING, REPAIR, MAINTENANCE, OR REPLACEMENT OF THE PRODUCT; AND, EXCEPT AS OTHERWISE PROVIDED IN THIS LIMITED WARRANTY, THERMO SCIENTIFIC'S LIABILITY SHALL NOT UNDER ANY CIRCUMSTANCES EXCEED THE CONTRACT PRICE FOR THE PRODUCTS FOR WHICH LIABILITY IS CLAIMED.

Rotor Identification

Some centrifuges have a rotor identification system which prevents the installed rotor from running above its maximum rated speed. Refer to the below chart for the rotor entry code.

	RC-6 Plus		RC-6		Evolution RC		RC-5C		RC-5C Plus		RC-26 Plus		RC-3c/RC-3C Plus	
Fiberlite Rotor	Code	Max Speed (rpm)	Code	Max Speed (rpm)	Code	Max Speed (rpm)	Code	Max Speed (rpm)	Code	Max Speed (rpm)	Code	Max Speed (rpm)	Code	Max Speed (rpm)
F21S-8x50	41	20,000	25	20,000	SS-34	20,500	6	20,000	06 or 26	20,000	26	20,000		
F18S-12x50	27	16,500	27	16,500	SA-600	16,500	04	16,500	04	16,500	4	16,500		
F13S-14x50cy	42	13,000	34	13,000	SLA-600TC	13,000	10	9,000	23	13,000	10	13,000		
F14S-6x250	34	14,000	34	14,000	SLC-1500	14,000	10	13,000	22	14,000	22 / 28	14,000		
F14S-6x250y	34	14,000	34	14,000	SLC-1500	14,000	10	13,000	22	14,000	22 / 28	14,000		
F12-6x500 LEX	54	12,000	N/A	N/A	SLA-3000	12,000	3	9,000	17	10,000	30	10,000		
F10-4x1000 LEX	55	9,500	N/A	N/A	SLC-4000	9,000	8	7,000	3	7,000	3	7,000		
F10S-6x500	35	10,000	35	10,000	SLC-3000	10,000	3	9,000	17	10,000	30	10,000		
F10S-6x500y	35	10,000	35	10,000	SLC-3000	10,000	3	9,000	17	10,000	30	10,000		
F9S-4x1000y	33	8,000	33	7,000	SLC-4000	9,000	8	7,000	3	7,000	3	7,000		
F8S-6x1000y	N/A	N/A	N/A	N/A	SLC-6000	8,500	N/A	N/A	N/A	N/A	N/A	N/A	34	6,000

**13,000 rpm*
***9,000 rpm*

	Fiberlite Rotors for Beckman® Centrifuges											
	J-20XP		J-20(i)		J-25(i)		J-26XP		J-30(i)		JE	
Fiberlite Rotor	Code	Max Speed (rpm)	Code	Max Speed (rpm)	Code	Max Speed (rpm)	Code	Max Speed (rpm)	Code	Max Speed (rpm)	Code	Max Speed (rpm)
F18BA-12x50	JA-17	17,000	JA-17	17,000	JA-17	17,000	JA-17		JA-17	JA-17	N/A	N/A
F10BA-6x500y	JLA-10.500	10,000	JLA-10.500	10,000	JLA-10.500	10,000	JLA-10.500	10,000	JLA-10.500	10,000	N/A	N/A
F14BA-14x50cy	JA-12	14,000	JA-12	14,000	JA-12	14,000	JA-12	14,000	JA-12	14,000	50	14,000
F14BA-6x250y	JA-14	14,000	JA-14	14,000	JA-14	14,000	JA-14	14,000	JA-14	14,000	250	14,000

- **Chemical Resistance**

The Chemical Resistance Charts below indicate the general chemical resistance of various materials to a number of chemicals. Both the materials and chemicals are commonly used in experiments involving centrifuges and ultracentrifuges. By reading down a particular column, the reader can determine the resistance of that material to each chemical – either satisfactory(S), marginally satisfactory (M), unsatisfactory (U) or unknown (blank). The chemicals are listed by their most common name within six categories (gradient forming media, acids, salts, solvents, bases, and other).
This chart has no guarantee for tubes or bottles. The user should test them under actual conditions of use because chemical resistance varies with speed, temperature, etc.

PA--(Polyallomer)	SS--(Stainless Steel)	TI--(Titanium Alloy)	NBR--(Nitrile-Butadione)
PC--(Polycarbonate)	PET--(Polyethylene Terephthalate)	PPO--(Polyphenylene Oxide)	NY--(Nylon)
PE--(Polyethylene)	AL--(Aluminum Alloy)	POM-(Polyacetal)	SI--(Silicon Rubber)
PP--(Polypropylene)	CF--(Carbon Fiber)	CR--(Neoprene Rubber)	VI--(Victon, Fluorine Rubber)

S Satisfactory	U Unsatisfactory
M Marginal	- No Test Made

CHEMICALS	PA	PC	PE	PP	SS	PET	AL	CF	TI	PPO	POM	CR	NBR	NY	SI	VI
GRADIENT MEDIUM																
Cesium Acetate	S	S	S	S	M	-	M	S	S	S	S	S	S	S	S	S
Cesium Bromide	S	S	S	S	M	S	M	S	S	S	S	S	S	S	S	S
Cesium Chloride	S	S	S	S	M	S	M	S	S	S	S	S	S	S	S	S
Cesium Formate	S	S	S	S	M	S	M	S	S	S	S	S	S	S	S	S
Cesium Iodide	S	S	S	S	M	S	M	S	S	S	S	S	S	S	S	S
Cesium Sulfate	S	S	S	S	M	S	M	S	S	S	S	S	S	S	S	S
Dextran (Sulfate)	S	S	S	S	M	S	M	S	S	S	S	S	S	S	S	S
Ficoll-Paque	S	S	S	S	M	-	M	S	S	S	S	S	S	S	S	S
Glycerol	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S	S
Metrizamide	S	S	S	S	M	-	M	S	S	S	S	S	S	S	S	S
Potassium Bromide	S	S	S	S	M	S	U	S	S	S	S	S	S	S	S	S
Rubidium Bromide	S	S	S	S	M	S	M	S	S	S	S	S	S	S	S	S
Rubidium Chloride	S	S	S	S	M	S	M	S	S	S	S	S	S	S	S	S
Sodium Bromide	S	S	S	S	M	S	U	S	S	S	S	S	S	S	S	S
Sodium Iodide	S	S	S	S	M	S	M	S	S	S	S	S	S	S	S	S
Sucrose	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S	S
Sucrose, alkaline	S	U	S	S	M	U	M	S	S	S	S	S	S	S	S	S

PA--(Polyallomer)	SS--(Stainless Steel)	TI--(Titanium Alloy)	NBR--(Nitrile-Butadione)
PC--(Polycarbonate)	PET--(Polyethylene Terephthalate)	PPO--(Polyphenylene Oxide)	NY--(Nylon)
PE--(Polyethylene)	AL--(Aluminum Alloy)	POM-(Polyacetal)	SI--(Silicon Rubber)
PP--(Polypropylene)	CF--(Carbon Fiber)	CR--(Neoprene Rubber)	VI--(Victon, Fluorine Rubber)

S Satisfactory	U Unsatisfactory
M Marginal	- No Test Made

CHEMICALS	PA	PC	PE	PP	SS	PET	AL	CF	TI	PPO	POM	CR	NBR	NY	SI	VI
ACIDS																
Acetic Acid (5%)	S	S	S	S	M	S	S	S	S	S	M	S	M	S	S	M
Acetic Acid (60%)	S	U	M	M	U	U	S	M	S	S	U	M	M	-	M	U
Acetic Acid (glacial)	S	U	M	M	U	U	S	U	S	S	U	U	U	U	U	U
Aqua Regia	U	U	U	U	U	-	U	U	S	U	U	U	U	-	M	M
Boric Acid	S	S	S	S	S	S	U	S	S	S	U	S	S	S	S	S
Chromic acid (10%)	S	M	S	S	U	S	U	S	S	S	U	U	U	U	M	S
Chromic acid (50%)	M	U	S	S	U	-	U	U	S	U	U	-	-	-	-	S
Citric Acid	S	S	S	S	S	S	S	S	S	M	U	S	S	M	S	S
Formic Acid (50%)	S	M	S	S	U	S	U	M	S	S	U	S	U	U	S	U
Hydrochloric Acid (10%)	S	M	S	S	U	S	U	S	S	S	U	S	S	-	S	S
Hydrochloric Acid (35%)	S	U	S	S	U	U	U	M	M	S	U	M	M	U	U	M
Hydrofluoric Acid (10%)	S	M	S	S	U	-	U	S	U	-	U	S	U	S	-	-
Hydrofluoric Acid (50%)	M	U	S	S	U	-	U	M	U	U	U	S	U	-	U	M
Lodoacetic Acid	S	M	S	S	S	M	S	S	S	S	S	M	-	M	M	M
Lactic Acid	S	S	M	S	S	-	-	-	S	S	-	-	-	-	-	S
Mercaptoacetic Acid	M	U	U	U	S	U	U	S	S	S	S	M	-	U	U	S
Nitric Acid (10%)	S	S	S	S	M	S	M	S	S	S	U	U	U	M	M	S
Nitric Acid (50%)	S	M	M	M	M	U	M	U	S	S	U	U	U	M	U	S
Oleic Acid	S	S	S	S	U	S	S	S	S	S	U	U	-	S	M	M
Oxalic Acid	S	S	S	S	U	-	M	S	M	S	U	S	M	S	U	S
Perchloric Acid	M	U	M	M	U	U	U	U	S	S	U	-	U	U	U	S
Phosphoric Acid (10%)	S	S	S	S	M	S	U	S	U	S	U	S	S	U	U	S
Phosphoric Acid (50-85%)	M	U	S	S	M	S	U	S	U	M	U	U	S	U	U	S
Piric Acid	M	U	S	S	U	-	U	M	U	S	U	U	S	U	U	S
Stearic Acid	S	S	S	S	S	S	S	S	S	S	S	S	S	S	M	S
Sulfuric Acid (10%)	S	S	S	S	U	S	U	M	U	M	U	S	S	S	U	S
Sulfuric Acid (50%)	S	U	S	S	U	S	U	U	U	U	U	S	-	M	U	S
Sulfuric Acid (98%)	S	U	M	S	M	U	U	U	U	M	U	U	U	U	U	S
Tartaric Acid	-	-	-	-	-	-	-	S	-	-	-	S	S	-	S	-
Trichloroacetic Acid	S	M	S	S	U	U	U	S	U	S	U	U	-	U	U	U

PA--(Polyallomer)	SS--(Stainless Steel)	TI--(Titanium Alloy)	NBR--(Nitrile-Butadione)
PC--(Polycarbonate)	PET--(Polyethylene Terephthalate)	PPO--(Polyphenylene Oxide)	NY--(Nylon)
PE--(Polyethylene)	AL--(Aluminum Alloy)	POM-(Polyacetal)	SI--(Silicon Rubber)
PP--(Polypropylene)	CF--(Carbon Fiber)	CR--(Neoprene Rubber)	VI--(Victon, Fluorine Rubber)

S Satisfactory	U Unsatisfactory
M Marginal	- No Test Made

CHEMICALS	PA	PC	PE	PP	SS	PET	AL	CF	TI	PPO	POM	CR	NBR	NY	SI	VI
SALTS																
Aluminium Chloride	S	S	S	S	U	S	U	M	U	S	U	S	S	M	M	S
Ammonium Acetate	S	S	S	S	S	S	S	S	S	S	S	S	-	S	S	S
Ammonium Carbonate	S	U	S	S	S	S	S	S	S	S	S	S	U	S	S	S
Ammonium Chloride	S	-	-	-	-	-	-	S	-	-	S	S	S	-	S	-
Ammonium Phosphate	S	M	S	S	M	-	U	S	S	S	S	S	S	S	S	S
Ammonium Sulfate	S	S	S	S	M	S	S	S	S	S	S	S	S	S	S	U
Barium Salts	S	S	S	S	M	S	M	S	S	S	S	S	S	S	S	S
Calcium Chloride	S	M	S	S	M	S	M	S	S	S	S	S	S	S	S	S
Calcium Hypochlorite	S	M	S	S	U	-	U	M	S	S	M	M	M	S	S	S
Ferric Chloride	M	S	S	S	U	-	U	S	S	S	M	S	S	S	S	S
Guanidine Hydrochloride	S	S	S	S	U	S	U	S	S	S	S	S	-	S	S	S
Guanidine Thiocyanate	S	-	S	S	-	U	-	-	S	-	-	-	-	-	-	-
Magnesium Chloride	S	S	S	S	M	S	M	S	S	S	S	S	S	S	S	S
Nickel Salts	S	S	S	S	S	S	M	S	S	S	S	S	-	S	S	S
Potassium Acetate	S	M	S	S	S	-	M	-	S	-	-	-	-	-	-	-
Potassium Carbonate	S	S	S	S	S	S	M	S	S	S	S	S	-	S	S	S
Potassium Chloride	S	S	S	S	U	S	U	S	S	S	S	S	-	S	S	S
Potassium Iodide	S	S	S	S	S	S	M	S	S	S	S	S	-	S	S	S
Potassium Permanganate	S	S	S	S	M	S	S	S	S	S	S	M	-	U	M	S
Silver Nitrate	S	S	S	S	M	S	U	S	S	S	S	M	-	S	U	S
Sodium Bicarbonate	-	-	-	-	-	-	-	S	-	-	S	S	S	-	S	S
Sodium Carbonate	S	S	S	S	S	S	M	S	S	S	S	S	S	S	S	S
Sodium Chloride	S	S	S	S	M	S	U	S	S	S	S	S	S	S	S	S
Sodium Dichromate	S	S	S	S	-	-	M	-	S	-	-	-	-	S	-	-
Sodium Nitrate (10%)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	U	S
Sodium Phosphate	-	-	-	-	-	-	-	S	-	-	S	S	S	-	U	S
Sodium Sulfate	S	S	S	S	M	S	U	S	S	S	S	S	-	S	S	S
Sodium Thiosulfate	-	-	-	-	-	-	-	S	-	-	S	S	S	-	S	S
Zinc Chloride	S	S	S	S	U	S	M	S	S	S	U	S	S	S	S	S
Zinc Sulfate	S	S	S	S	S	S	U	S	S	S	S	M	S	S	S	S

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M Marginal	- No Test Made

CHEMICALS	PA	PC	PE	PP	SS	PET	AL	CF	TI	PPO	POM	CR	NBR	NY	SI	VI
SOLVENTS																
Acetone (50%)	U	U	S	U	S	U	S	M	S	U	M	U	U	M	S	U
Amyl alcohol	S	M	U	U	-	-	S	M	S	M	S	S	S	S	S	M
Benzene	U	U	U	U	S	U	S	U	S	U	M	U	U	S	S	S
Carbon Tetrachloride	U	U	U	U	M	U	U	U	U	U	M	U	M	S	S	S
Chloroform	U	U	U	U	S	U	U	M	U	U	M	U	U	S	S	S
Cresol	-	U	U	U	S	U	S	M	S	U	S	U	U	U	U	U
Diethyl Ether	U	U	U	U	S	U	S	U	S	U	S	U	U	S	S	U
Diethyl Ketone	U	U	U	M	M	-	S	M	S	-	M	U	M	S	S	U
Dimethyl Sulfoxide	M	U	S	S	S	U	S	S	S	S	S	U	-	S	S	U
Dimethylformamide	M	U	S	S	S	U	S	M	S	U	S	S	-	S	S	U
Ethyl Acetate	U	U	M	U	M	U	M	M	S	U	M	M	U	S	S	U
Ethyl Alcohol (50%)	S	U	S	S	S	M	S	S	S	S	M	S	-	S	S	S
Ethyl Alcohol (95%)	S	U	S	S	S	U	S	M	S	S	M	S	S	S	S	S
Ethylene Glycol	S	U	S	S	M	-	S	S	S	S	S	S	S	S	S	S
Isopropyl Alcohol	S	U	S	S	S	-	S	S	U	S	S	M	-	S	S	S
Methyl Alcohol	S	U	S	S	S	M	S	M	S	S	M	S	S	S	S	U
Methyl Ethyl Ketone	U	U	U	U	S	U	S	U	S	U	M	U	U	S	S	U
Methylene Chloride	U	U	U	U	M	U	U	S	U	U	S	U	-	M	M	M
N-Butyl Alcohol	M	M	M	S	-	-	M	M	S	M	S	S	S	S	S	S
Phenol (1%)	S	U	S	S	S	U	U	M	S	M	S	U	U	U	U	S
Toluene	U	U	U	U	S	U	S	M	U	U	M	U	U	S	S	S
Xylene	U	U	U	U	S	U	S	M	S	U	M	U	U	U	U	S

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CHEMICALS	PA	PC	PE	PP	SS	PET	AL	CF	TI	PPO	POM	CR	NBR	NY	SI	VI
BASES																
Ammonium Hydroxide (10%)	S	U	S	S	S	-	U	S	S	S	U	S	U	S	S	S
Ammonium Hydroxide (28%)	S	U	S	S	S	U	U	M	S	S	U	S	-	S	S	U
Aniline (10%)	U	U	U	M	S	U	S	M	S	U	S	U	U	U	S	S
Potassium Hydroxide (5%)	S	U	S	S	M	M	U	S	M	S	U	S	-	S	M	S
Potassium Hydroxide (45%)	S	U	S	U	M	U	U	S	U	S	U	S	S	U	U	M
Pyridine (50%)	M	U	S	S	U	U	U	U	U	U	M	U	U	S	S	U
Sodium Hydroxide (1%)	S	U	S	S	S	M	U	S	S	S	U	S	-	S	M	S
Sodium Hydroxide (10%)	S	U	S	S	S	M	U	S	S	S	U	S	S	S	U	S
Sodium Hydroxide (50%)	M	U	S	M	S	U	U	S	M	M	U	-	-	S	U	U
OTHERS																
Culture Media	S	S	S	S	-	-	S	-	-	M	-	-	-	-	-	-
Diethylpyrocarbonate	S	U	S	S	S	U	S	S	S	U	S	S	-	S	S	S
Ethylene Oxide Vapor	S	M	S	S	S	-	S	U	S	-	-	U	U	S	S	U
Formaldehyde (40%)	S	S	S	S	M	S	M	S	S	S	S	S	S	S	S	U
Hydrogen Peroxide (3%)	S	S	S	S	S	S	S	M	S	S	M	S	U	S	U	S
Hydrogen Peroxide (5%)	S	S	S	S	S	S	S	M	U	U	U	M	U	U	U	M
Kerosene	U	U	U	U	S	U	S	S	S	U	S	U	S	S	S	S
Liquid Paraffin	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
2-Mercaptoethanol	S	M	S	S	S	U	S	M	S	S	S	U	-	S	S	S
Milk	S	S	-	-	-	-	S	-	-	M	-	-	-	-	-	-
Petroleum	M	M	U	U	U	S	-	S	S	S	S	S	S	S	S	S
Serum	S	S	-	-	-	-	S	-	-	M	-	-	-	-	-	-
Sodium Hypochlorite (5%)	S	U	M	M	S	S	M	U	S	S	U	U	M	S	S	S
Tris Buffer (neutral)	S	S	S	S	S	S	S	S	S	U	S	S	-	S	S	S
Triton X-100	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Vegetable Oils	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Urea	S	S	S	S	S	S	S	S	S	S	S	S	-	S	S	S

• Glossary

Angular velocity, ω: rate of rotation, measured in radians per second ($\omega = 2\pi$ rpm/60 or $\omega = 0.10472$ x rpm)
Anodization: an electrochemical coating on aluminum surfaces for corrosion resistance
buoyant density: the density of a particle in a specific medium
centrifugal effect: accumulated value of:

$$\int_{t_1}^{t_2} \omega^2 \, dt$$

where t is time and ω is angular velocity
Centrifugal Force: in a centrifugal field, the force which causes a particle to move away from the center of rotation
clearing factor, k: calculated for Fiberlite rotors as a measure of the rotor's relative pelleting efficiency:

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

OR

$$k = \frac{253303 \times \ln (r_{max} / r_{min})}{(RPM/1000)^2}$$

clearing time, *t*: in this simple formula, $t = k/s$, where t is time in hours, k is the clearing factor of the rotor, and s is the sedimentation coefficient in Svedberg units (S)
density: mass per unit of volume (g/mL)
density separation: a centrifugal separation process based on differences in particle densities
differential separation: a centrifugal separation process based on differences in size between particles
fixed angle rotor: a rotor in which the tubes are held at an angle (usually 20 to 45 degrees) from the axis of rotation
isopycnic: a method of particle separation or isolation based on particle buoyant density; sedimentation equilibrium (often done with CsCl gradients); particles are centrifuged until they reach a point in the gradient where the density of the particle is the same as the density of the gradient at that point
maximum volume: the maximum volume to which a tube should be filled for centrifugation (sometimes referred to as maximum fill volume or nominal fill volume)
near vertical tube rotor: a rotor in which the tubes are held at a slight angle (usually 7 to 10 degrees) from the axis of rotation
pelleting: a centrifugal separation where particles in a sample sediment to the bottom of the tube (differential separation); differential pelleting separates particles of different sizes by successive centrifugation steps of progressively higher g-force and/or longer run duration
polyallomer: random block copolymer of ethylene and propylene used for some thin-wall, thick-wall ultra centrifuge tubes
rate zonal: a method of particle separation, based on differential rate of sedimentation, using a pre-formed gradient with the sample layered as a zone on top of the gradient
relative centrifugal field (RCF): 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:

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

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

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

$\underline{r_{max}}$ the position of the liquid in the tube at the maximum distance from the axis of rotation when the rotor is at speed (maximum radius, in mm)

$\underline{r_{min}}$ the position of the liquid in the tube at the minimum distance from the axis of rotation when the rotor is at speed (minimum radius, in mm)

sedimentation: the settling out of particles from a suspension in the earth's field of gravity; in the centrifuge this process is accelerated and the particles move away from the axis of rotation

sedimentation coefficient, *s* : sedimentation velocity per unit of centrifugal force:

$$s = \frac{dr}{dt} \times \frac{1}{\omega^2 r}$$

supernatant: the liquid above the sedimented material following centrifugation

Svedberg units, *S*: a unit of sedimentation velocity is:

$1S = 10^{13}$ seconds

swinging bucket rotor: a rotor in which the tubes or bottles are carried in buckets or racks that swing up to the horizontal position during centrifugation (sometimes referred to as a horizontal or swing-out rotor)

vertical tube rotor: a rotor in which the tubes or bottles are held parallel to the axis of rotation

wettable tubes: tubes made of a material that is impervious to adherence of solutes