CENTRIFUGE SAMPLE HOLDER
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ABSTRACT OF THE DISCLOSURE

A sample holder for use in an ultra-high speed angle-type ultracentrifuge comprises a rigid, high-strength, polycarbonate tube member having a reduced diameter open-ended neck portion which is threadably engaged by a lightweight plastic cap. The open-ended neck portion of the sample holder terminates in an inwardly extending lip having a flat annular sealing surface along its outer face and a chamfered sealing surface along its inner edge. The plastic cap is provided with integral V-shaped rings for engaging the sealing surfaces of the lip.

This invention relates generally to centrifuges and more particularly to an improved disposable sample holder for use in an angle-type ultracentrifuge.

The use of centrifugal methods for the separation of virus from various sample materials has developed a need for an improved sample holder possessing characteristics of high strength, leak-tightness, simplicity of assembly and low cost. A high strength sample holder is necessary to withstand the very large centrifugal forces which the sample holder experiences at the ultra-high rotational speeds reached during the course of a routine centrifuging operation. Ultra-high centrifuge speeds are required in order to obtain a well defined density dependent stratification of the sample components within a practical time period. The sample holder must remain leak-tight during the centrifuging operation in order to prevent cross contamination and to protect operating personnel from the virulent components of the sample material. Simplicity of assembly becomes significant from an operating cost standpoint where tens of thousands of individual samples must be centrifuged, as is often the case in a virological laboratory. This feature is also significant in that sample holders which are simple to assemble reduce the possibility of contamination or disturbance of the sample where a liquid density gradient is used to stratify particles of various densities. A low-cost sample holder could be disposed of rather than re-used after a centrifuge operation. This would eliminate any chance of having some portion of a previous sample present in a later sample which is centrifuged in the same sample holder, thereby eliminating what probably constitutes the greatest single source of contamination in a virological laboratory.

It is, accordingly, a general object of the invention to provide an improved sample holder for use in an angle-type ultracentrifuge.

Another object of the invention is to provide an improved sample holder which is leak-tight before, during, and after centrifugation.

Another object of the invention is to provide an improved sample holder possessing sufficient strength to withstand the forces developed during a centrifugal operation.

Still another object of the invention is to provide an improved sample holder of sufficiently low cost so as to permit its disposal after a single use.

Other objects of the invention will become apparent from an examination of the following description of the invention and the appended drawings wherein:

FIG. 1 is an enlarged axial sectional view of an improved sample holder made in accordance with the present invention; and

FIG. 2 is a vertical full size sectional view of an angle-type centrifuge rotor loaded with sample holders as illustrated in FIG. 1.

In accordance with the present invention, an improved sample holder for use in an ultra-high speed angle-type ultracentrifuge is provided. A polycarbonate tube member having a U-shaped body portion and an open-ended neck portion of smaller diameter than the body portion is tapered or chamfered along the inner edge and threaded along the outer surface of its open-ended neck portion. A lightweight plastic cap having a threaded annular side portion engages the threaded tube neck portion. Integrimly fixed to the generally flat end portion of the cap is a V-shaped annular sealing ring which depends from the end portion to sealably engage the chamfered inner edge of the open-ended neck portion.

In order to facilitate an understanding of the invention, reference is first made to FIG. 1 wherein a sample holder made according to the present invention is illustrated. A polycarbonate tube member 1 has a U-shaped body portion 2, a neck portion 3 which is of smaller diameter than the body portion, and an annular transition portion 4 connecting body portion 2 and neck portion 3. The base of the body portion 2 is countersunk to conform with the bottom of the rotor pocket in which the tube member 1 is mounted during centrifugation.

An inwardly extending lip 5 is provided at the end of neck portion 3. The inner edge of lip 5 is chamfered to form a sealing surface 6 when engaged by cap 7. In an alternative form, the wall thickness of neck portion 3 could be increased sufficiently to provide a flat, annular, secondary sealing surface substantially equal in width to the secondary sealing surface 8 provided by lip 5. In addition to providing a secondary sealing surface 8, lip 5 also strengthens the end of neck portion 3 and minimizes distortion of sealing surface 6 during centrifugation. The use of a thickened neck portion may be less desirable than the lip previously described as it decreases the capacity of the tube while adding weight thereto. A slightly weaker tube wall also results as the thicker wall tends to develop stresses during curing.

The reduced-diameter neck portion 3 provides an increase in the strength and rigidity of the open end of the tube member 1, while permitting a smaller and lighter cap 7 to be used in closing the tube. The combined effects of the increased strength of the cap supporting neck portion and the use of a smaller lighter cap thereon, significantly reduce the possibility of tube failure at the high rotation induced loads (30,000 g's) experienced during centrifugation.

The tube member 1 may be produced by blow molding a suitable polycarbonate resin such as Lexan DL-264 made by General Electric. The finished polycarbonate tubes are transparent so that stratified layers in the liquid density gradient employed in zonal centrifugation may be visually identified and recovered without mixing. In addition, the polycarbonate tubes are sufficiently strong and rigid to operate in centrifugal fields of 30,000 g's and above.

Cap 7 is preferably made of polypropylene and alternatively of polyethylene. Polypropylene's high strength to weight ratio, extrudability, and ability to withstand autoclave sterilization (250° F. for 3 hours) without adverse effects make it most desirable as cap material. Polyethylene, on the other hand, is weakened somewhat during sterilization.
A first annular sealing ring 9, having a truncated-V-shaped cross section, is integral with and depends from the top 10 of cap 7. Surface 11 of sealing ring 9 is slightly less inclined from the axis of tube 1 than sealing surface 8 of lip 5 is from the axis of tube member 1. A 1° difference in the two angles of inclination has been found to provide a satisfactory seal. No additional benefit was realized with angular deviations up to 5°. The slight difference in inclination between the two surfaces ensures an interference fit and a resultant seal therebetween prior to centrifugation and at low rotational speeds. Once centrifugation has begun, the internal pressure developed by the sample within tube 1 actually assists sealing ring 9 in maintaining a seal by pressing against its inner surface 12 and thereby forcing its surface 11 into tighter contact with sealing surface 8 of lip 5. An increase in centrifugal field, therefore, with an accompanying increase in internal tube pressure, actually increases the ability of seal ring 9 to prevent sample losses. First sealing ring 9 also stiffens the top 10 of cap 7 and minimizes its deformation during centrifugation. This permits leak-free operation despite some deformation of the side wall 13 of the cap during centrifugation.

A second annular sealing ring 14 having a V-shaped cross section is integral with and depends from the top 10 of cap 7 to engage the secondary sealing surface 8 of lip 5. Second sealing ring 14 engages sealing surface 8 with its pointed tip rather than with its sloping side surface as is the case where first sealing ring 9 engages sealing surface 6.

FIG. 2 is a vertical cross section of a typical angle-type ultracentrifuge 15 loaded with sample holders 16 made in accordance with the present invention. A closure member 17 is placed over the centrifuge and sealed thereto using O-ring 18 as an additional safety precaution. As shown, tubes 1 are designed to fit snugly into cavities or wells 19 provided in rotor 20 so as to minimize stresses in the tube due to non-uniform loading during centrifugation. Each cap 7 also receives partial support from the wall of cavity 19 through the use of a ridge 21 about the base of side wall 13, the outer diameter of ridge 21 being substantially equal to that of tube 1.

The above description of one embodiment of the invention was offered for illustrative purposes only, and should not be interpreted in a limiting sense. It is intended that the invention be limited only by the claims appended hereto.

What is claimed is:

1. A disposable sample holder for use in an angle-type centrifuge comprising, in combination, one piece blow-molded polycarbonate tube member having a U-shaped body portion and an open-ended neck portion of smaller diameter than said body portion, said polycarbonate tube member being sufficiently strong and rigid to operate without failure in centrifugal fields of at least 30,000 g's, said neck portion terminating at its open end with an inwardly extending lip, said lip having a chamfered sealing surface along its inner edge; and a polypropylene cap having an end portion and an annular side portion, said side portion threadlessly engaging said neck portion of said tube member, an annular truncated-V-shaped sealing ring having inner and outer sloping surfaces integral with and depending from said end portion, said sealing ring contacting said chamfered sealing surface along its outer sloping surface, said outer sloping surface of said sealing ring being slightly less inclined from the axis of said cap, when in an unstrained condition, than said chamfered sealing surface is from the axis of said tube.

2. A disposable sample holder for use in an angle-type ultracentrifuge comprising, in combination, a one piece blow-molded polycarbonate tube member having a U-shaped body portion and an open-ended neck portion of smaller diameter than said body portion, said polycarbonate tube member being sufficiently strong and rigid to operate without failure in centrifugal fields of at least 30,000 g's, said neck portion terminating at its open end with an inwardly extending lip, said lip having a flat annular sealing surface along its outer face and a chamfered sealing surface along its inner edge; and a polypropylene cap having an end portion and an annular side portion, said side portion threadlessly engaging said neck portion of said tube member, first and second annular sealing rings integral with and depending from said end portion, said first sealing ring having a sloping surface adapted to contact the chamfered sealing surface along the inner edge of said neck portion to provide a primary seal, the sloping surface of said first sealing ring when in an unstrained condition being slightly less inclined from the axis of said cap than the chamfered surface of said lip is from the axis of said tube, said second sealing ring contacting the flat annular sealing surface along the outer face of said lip to provide a secondary seal.

References Cited

UNITED STATES PATENTS

3,074,579 1/1963 Miller.

3,265,296 8/1966 Mitchell 233—26

5,235,175 2/1966 McCormick 233—26

FOREIGN PATENTS

878,606 6/1953 Germany.

1,247,480 10/1960 France.

782,574 9/1957 Great Britain.

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