A Reusable, Compliant, Small Volume Blood Reservoir For In Vitro Hemolysis Testing Design and Manufacturing Instructions

Tool Reference

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Design and Manufacturing Instructions

1. ½"-Port reusable base

The rigid base was designed in SolidWorks (Dassault Systemes, Velizy, France) with two barb fittings to accept ½" ID tubing, a flow separator between the inlet and outlet ports, and a 0.10" external circumferential lip (Fig. 2A). The flow separator was shelled to remove excess material while maintaining a minimum thickness of 3/64". All corners and edges were smoothed on the model before manufacturing. Fabrication was accomplished with a stereolithography additive (SLA) printer (Viper SLA System, 3D Systems, Valencia, CA, USA) using the Somos Watershed XC11122 (DSM, Elgin, IL, USA) photopolymer resin. Following light sanding to remove the printer-generated structural supports, a liquid coat of the same photopolymer resin was brushed onto the blood-contacting surfaces before a 30-min UV cure and a final isopropanol rinse.

2. Disposable blood bag

A medical-grade, three-port, 500-mL compliant polyvinyl chloride (PVC) blood bag (Qosina, Edgewood, NY, USA) was diagonally heat-sealed and trimmed along the bottom to remove the existing orifices. An optional Luer fitting (Qosina, USA) was fixated into the apex with cyanoacrylate glue before fitting the bag over the base.

3. Clamp set

The clamp set consisted of two plastic halves designed to secure the compliant bag against the rigid base (Fig. 2B). Milled from rigid polyvinyl chloride (PVC) stock, the clamps have a 0.10" wide groove to accept the reservoir lip and two throughput holes for assembly using 10–32 machine bolts and wing nuts.

The single-piece design of the 3D-printed, optically clear, reusable base, devoid of seams or adhesives, reduced the possibility of cracking and contamination. Sufficient wall thicknesses and fillets ensured rigidity and fluid washout of the reservoir base, while lowering printing time and resin cost. With similar material properties as clinically used ABS plastic, the Watershed XC11122 resin meets ISO 10993 standard specifications for cytotoxicity, sensitization, and irritation, along with USP Class VI standards. As the SLA printing process leaves an inherently porous exterior, the integrated liquid resin finish reduced surface roughness to an $Ra < 0.3$ µm (Contour GT-KI, Bruker AXS, Madison, WI, USA), avoiding concerns of delamination and wear associated with topical sealants. Compressing the PVC bag between the circumferential lip and clamp created a labyrinth face seal and a leakproof assembly (Fig. 2C). Stain-resistant and easy to clean, the rigid bases have been washed and sanitized with degreasers, enzymatic detergents, 70% ethanol, and 10% bleach without issue before reuse with a new blood bag.