Degradation Strength Test Method

1. Purpose
   1. The purpose of this experiment is to investigate the mechanical strength of various polymers as they are exposed to a saline solution over time. This data is necessary as we look for a coating/link material to use in a gradually expanding stent, which uses the degradation of the polymer to slowly expand inside the blood stream.
2. References
   1. Park, T. G. (1995). 2.1. Degradation of poly(lactic-co-glycolic acid) microspheres: Effect of copolymer composition. Biomaterials, 16, 1123-1130. Retrieved March 17, 2016.
3. Sample and Test Preparation
   1. Test Sample Preparation
      1. Aluminum sheets are machined according to D-100001.
      2. The mold sheet is placed on top of the flat plate.
      3. Each pocket is filled with at least XXmm3 of material. The material must be in small beads or shreds and it must be spread around the entire pocket.
      4. The two plates are placed in a vacuum bag and the air is removed.
      5. The assembly is placed in an oven at 400 degrees F for 2 hours.
      6. The vacuum back is removed when possible.
      7. The assembly is heated to 400 degrees, and the die punch (D-XXX) is pushed doen lightly in each pocket to ensure that no polymer is stuck to the walls of the pocket.
      8. The assembly is cooled to 230 degrees F.
      9. The samples and mold plate are removed using a putty knife, all the samples are collected and allowed to cool.
   2. Testing Apparatus Preparation
      1. Tank
         1. The tray is constructed using a 3D printer using ABS filament and waterproofed using \_\_\_\_\_.
         2. The tray design is attached, the inlet angle is a 30° triangle to ensure that all samples have a similar velocity profile across their face. Holes are drilled on either side of the tank that can hold the rubber tubing with a press fit; the tubing is attached and the seam is waterproofed using \_\_\_.
      2. Tray
         1. The tray is constructed using a 3D printer using ABS filament.
         2. The tray fits inside the tank with 1 mm clearance of the tank walls on either side. The center of the tray has a pattern of cups that are sized to grip onto the samples using a press fit. The bottom of each cup has a thru-hole to allow draining of the saline solution upon removal from the tank. Each end of the tray has a grip to pull it out of the tank. These grips are shaped like an airfoil to reduce the impact on the flow and to indicate the direction of flow.
      3. Top cap
         1. The top cap is constructed using a 3D printer and ABS filament.
         2. The cap is made with a matching pattern of shallow oversized cups that catch the tops of the dog bones when placed on top of the tray. There is a cutout that allows the finger grips of the tray to pass through so that they can be gripped for removal. The top cap is used so that a rectangular duct approximation method can be used to calculate the Reynolds number.
      4. Pump
         1. A pump is chosen that has a sufficient flow rate to match the Reynolds number of the saline solution flowing in the tank with that of blood in an average 3 mm ID Coronary artery to a tolerance of +/-200. The Reynolds number was calculated in both the coronary artery and the tank using the MatLab code in Appendix A.
      5. Incubator and Saline Solution
         1. The tank and pump are placed in an incubator at 36.5°C to mimic the conditions of the human body.
         2. Earle’s Balanced Salt Solution is used to mimic the Ph level of plasma. It is emptied and replaced every 2 weeks during testing to maintain consistent fluid properties.
      6. Tensile test apparatus
         1. Method 1
            1. 6 aluminum plates are used to fix the sample in the tensile tester. 4 are flat plates, and 2 have a negative of the sample ends. The sample is placed inside the negative cutout and the plates are placed on either side of the sample so that it is sandwiched in place. The assembly is attached to the tensile tester using the stock clamps.
         2. Method 2
            1. The sample is attached to the machine using the stock clamps.
      7. Dummy dog bones
         1. Dog bones of equal dimensions as the polymer samples are constructed using a laser cutter or plasma cutter out of aluminum. Dummy dog bones replace any sample pulled out of the tank for testing. If method 1 of sample preparation was used, these can be used as dummy dog bones.
   3. Test Method
      1. After sample preparation, \_\_ samples are passed through the tensile test method (2.3.2) to get base values.
      2. Tensile Test Method:
         1. After sample preparation, \_\_ randomized samples are chosen and tested using an Instron 3300 single column test system with a 50 N force gauge. Each sample is pulled at a rate of 1 mm per minute until failure. The following values are recorded.
            1. Incubation time
            2. Material
            3. Modulus of elasticity
            4. Ultimate stress
            5. Ultimate strain
         2. After testing, the broken samples are placed in a labeled container that indicates their incubation time.
      3. Incubation method
         1. The samples are placed in their trays, and the tank is filled with saline solution. The tank is placed in the incubator full of samples and covered with a plexi-glass sheet to reduce evaporation. If needed, multiple tanks can be placed in series if the Reynolds number of the flow still meets the requirements specified in 2.2.4.
         2. During incubation, if the fluid level reaches the top of the top cap due to evaporation, solution is added to the tank until full.
         3. The EBSS is emptied and refilled every 2 weeks.
      4. Sample Removal Method
         1. \_\_ randomized samples are removed to be passed through the Tensile Test Method (2.3.2). Time intervals follow the same method of the Park, T. paper.
            1. Time interval (days)

0

8

15

22

36

52

* + - 1. After the samples are removed, they are replaced with dummy dog bones to keep the flow properties consistent.
      2. The tank is placed back in the incubator.