**The Product Design Specification of the Mechanical Testing System Coupled with an Environmental Chamber for Hydrogels:**
**Creep Testing System**

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**Function:** To measure creep properties of hydrogels in a pH and temperature controlled environment.

**Client Requirements:**

- Stand-alone system to measure creep properties of hydrogels.
- Maintain the pH of a solution from 4.5-8.
- Maintain the temperature of a solution at approximately 37 ± 3 ºC.

**Design Requirements:**

1. **Physical and Operational Characteristics**

   a. *Performance Requirements:* The creep testing system should be capable of being used for consecutive creep tests. Once the creep test has started, the system should require no observation/maintenance until after test is over.

   b. *Safety:* The chamber should be securely sealed to prevent potentially acidic, basic, very hot, and/or very cold solutions from escaping and causing injury to both the user and any surrounding lab equipment or electronics. Gloves should be worn when handling the solutions to be used in the chamber. Oven mitts should be worn if the solution to be used is very hot.

   c. *Accuracy and Precision:* The temperature should not vary more than ± 3 ºC of the desired temperature, and the pH should not vary by more than ± 0.5 pH units. Extensometer must be as accurate to 0.01 mm and as precise as possible.

   d. *Life in Service:* The chamber should maintain the temperature and pH of a solution over a time period of one creep test (approximately 1 hour-2 days). The acquisition system should record displacement at least once every second during this time.

   e. *Shelf Life:* The testing system should be stored in a cool, dry place. It should be covered to prevent dust, dirt, etc. from collection on the surface.

f. *Operating Environment:* The chamber is to be used at room temperature, local atmospheric pressure and humidity. It will be exposed to solutions of 4.5-8 pH and temperatures of 37 ± 3 ºC. As the sample breaks, the weight rack will contact the top of the LVDT with a force of approximately 0.0098 N (1 gram weight) to 4.9 N (500 g weight), although its likely that most hydrogels will exhibit creep under lighter loads than 500 g. The testing system will be handled by lab researchers.

g. *Ergonomics:* The testing system should enable the researcher to have adequate access to the sample before the creep test. The space surrounding the sample should have a diameter of at least 10 inches, so the sample can be adjusted by hand. The testing system should sit on a standard lab bench, to minimize reaching of the researcher during test preparation.

h. *Size:* The testing system should accommodate for tripling of hydrogel sample length (4 inches) during creep testing.

i. *Weight:* The chamber should be less than 33 lbs, as recommended by the Human Factors Design Handbook [6].

j. *Materials:* The materials of the chamber should be durable, transparent, easy to manufacture, affordable, insulating, and able to withstand changes in temperature from 37-40 degrees Celsius and changes in pH from 4.5-8. Materials immersed in solution should have high corrosion resistance, and high density to decrease buoyancy. The connection between the LVDT core and the weight rack must be a non-ferromagnetic material, as this will interfere with LVDT operation.

k. *Aesthetics, Appearance, and Finish:* The chamber should have a transparent shell so that the user can see the hydrogel sample inside. It should also have no sharp edges or extrusions.

**2. Production Characteristics**

a. *Quantity:* One creep testing system is needed.

b. *Target Product Cost:* See Appendix C.

**3. Miscellaneous**

a. *Standards and Specifications:* Testing system should accommodate hydrogel samples of ASTM approved dog-bone shape.

b. *Customer:* See client requirements.

c. *Patient-Related Concerns:* N/A

d. *Competition:* None commercially available.