**ID: MTP-1**

**Prototyping Protocol: – (Micropump PP-1)**

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**Protocol Description – (Micropump Temperature and Flow Rate Testing Protocol)**

This protocol is for the fabrication of a micropump which can be used to supply fluid to a small bioreactor. The device was designed to deliver up to 300 ml/min of fluid and is composed of one or more small stepper-motors and some 3D printed parts. Due to heat from the motor, the 3D printed parts were made from a thermoresistant ceramic and need to be temperature tested. The 3D printed pieces will have measurements taken before and after the testing in at least five different locations. The 3D printed pieces will be placed down upon a flat surface and both a heat gun and thermometer gun will be used in unison during the test. Each component for at least four separate trials will be heated using the heat gun while the temperature is monitored with the thermometer gun. Observers will note if any deformation or warping is visibly noticed. Once the temperature reaches 40℃, the 3D printed part will be kept at 40 ±3℃ for a period of five minutes. Afterward, the part will be allowed to cool and measurements will be taken to detect non-visible deformation/warping.

To test the sustained flow rate, the flow meter will be attached to the pump and operated under low flow rate (<50 ml/min), medium flow rate (>100ml/min and <200 ml/min) and high flow rate (>200 and <300 ml/min) conditions. Flow rate values will be recorded at 10s intervals and the test will be considered successful if the pump maintains consistent (<± 5 ml/min) flow for a 5 minute period under each condition. Following successful completion, another pump will be added to the circuit and tests will be repeated to ensure the system will be able to support up to 5 additional pumps without change to flow rate or functionality.

**Tools and Equipment**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **#** | **Tool** | **Name / # if applicable** | **Location** | **Purpose** |
| TE1 | Flow Meter | Sho-Rate Model 1250 | Purchased | Testing of fluid flow rate |
| TE2 | Heat Gun | Wagner Spraytech (HT1000) | Purchased | Testing printhead warping under high temperature |
| TE3 | Laser infrared thermometer gun | Etekcity Lasergrip 774 | Purchased | Accurate temperature readings |

**Materials**

|  |  |  |
| --- | --- | --- |
| **ID** | **Material** | **Purpose** |
| MAT1 | 3D printed Housing w/ guard revision x4 | Temperature testing of 3D printed ceramic part |
| MAT2 | 3D printed Bearing Hub w/ two bearing revision x4 | Temperature testing of 3D printed ceramic part |
| MAT2 | 1/8” OD 1/16” ID Tygon tubing | Small size tubing for flow rate testing |

**Machine Settings**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Machine Setting ID** | **Name** | **Location** | **Setting(s)** | **Reason** |
| MS1 | Temperature toggle | Thermometer Gun | Toggle for Celsius | Ensure that the 3D printed parts can withstand 37 degrees without warping |

**Values to be Recorded**

**Temperature Test**

|  |  |  |  |
| --- | --- | --- | --- |
| **Recorded Values ID** | **Max Temperature Recorded** | **Visual Deformation / Warping** | **Displacement / Warping Measurement** |
| RV1 | The maximum temperature that was recorded during testing | Was there visible warping or deformation during the test | Measurements before and after temperature test in at least five spots to confirm/deny unseen deformation |

**Fluidic Test**

|  |  |  |  |
| --- | --- | --- | --- |
| **Recorded Values ID** | **Low Flow Rate** | **Medium Flow Rate** | **High Flow Rate** |
| RV2 | Flow rate parameters set to <50 ml/min and measurement confirmation from flow meter | Flow rate parameters set to >100ml/min and <200 ml/min and measurement confirmation from flow meter | Flow rate parameters set to >200 and <300 ml/min and measurement confirmation from flow meter |