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Compact Vessel Cleaner (CVC): Protype Demonstration

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CVC System Breakdown

- Objective: To clear 3D printed support material from 3D vasculature models.
- Subsystems:

1. Water Reservoir
2. Pump
3. Heating Element
4. Model
5. Filter
6. Back to Step 1!

Preliminary Model

Preliminary model initially developed by team mentor for Model cleaning (used for proof of concept - NOT THE PROTOTYPE)

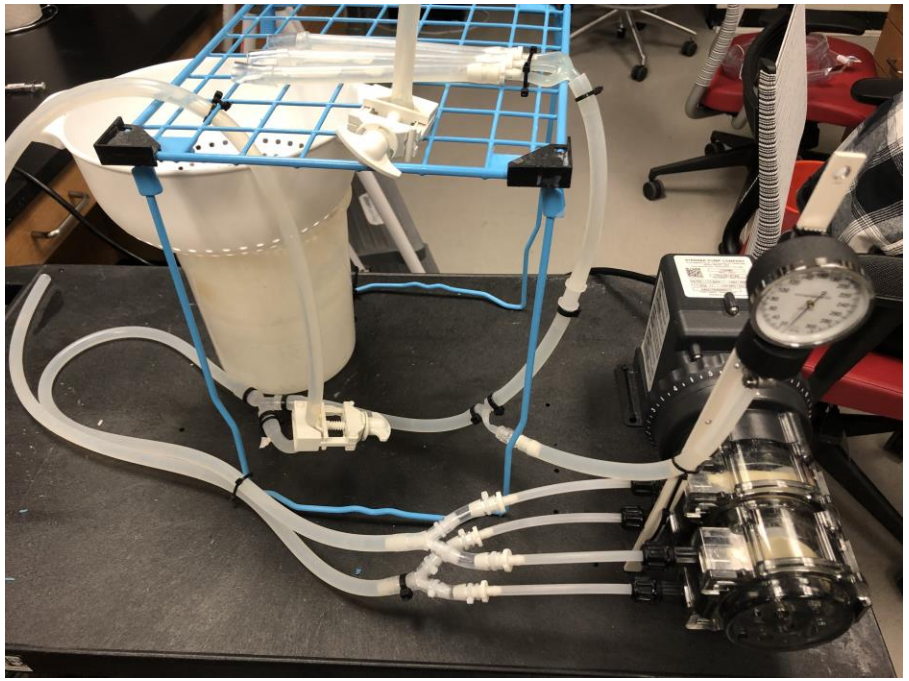

Figure 1. CVC Preliminary Model

Features:

- Sphygmomanometer measures instantaneous pressures
- Pulsatile Pump used to supply pressure
- Resistors used to increase pressure
- Water Reservoir
- Filter separates large-scale support particles

Current Drawbacks:

- No Time or Temperature measurements
- Sphygmomanometer vulnerable to water damage
- Temperature not adjustable
- No proper disposal system in place
- No Universal Connectors
- Pulsatile pump unnecessary for small-scale use
- Filter cannot separate small-scale support particles
- Water is not recycled after use

Client Expectations

Expectations developed by Dr. Tim Becker (Client), Mana Alyami (Mentor), & Dr. Carson Pete (Capstone Instructor): Completely Met, Partially Met, Not Met

- Universal Connectors to Switch Between Models
- Budget within $1,500
- Pressure gauge measuring millimeters of mercury
- Temperature gauge measuring degrees Celsius
- Heat Switch (Adjusts Temperature)
- Pump Switch
- Mesh Filter that can easily filter support material and remove it from system.
- Timer to track cleaning time
- Water Pump (Constant or Pulsatile) that Applies Pressure to Support Material
- Adjustable Setup
- All main subsystems (Filter, Pump, Reservoir, Model Connection, Heating Element) connected in system

Videos/Images

- Heating Element
- CVC Loop
- Pressure Collection

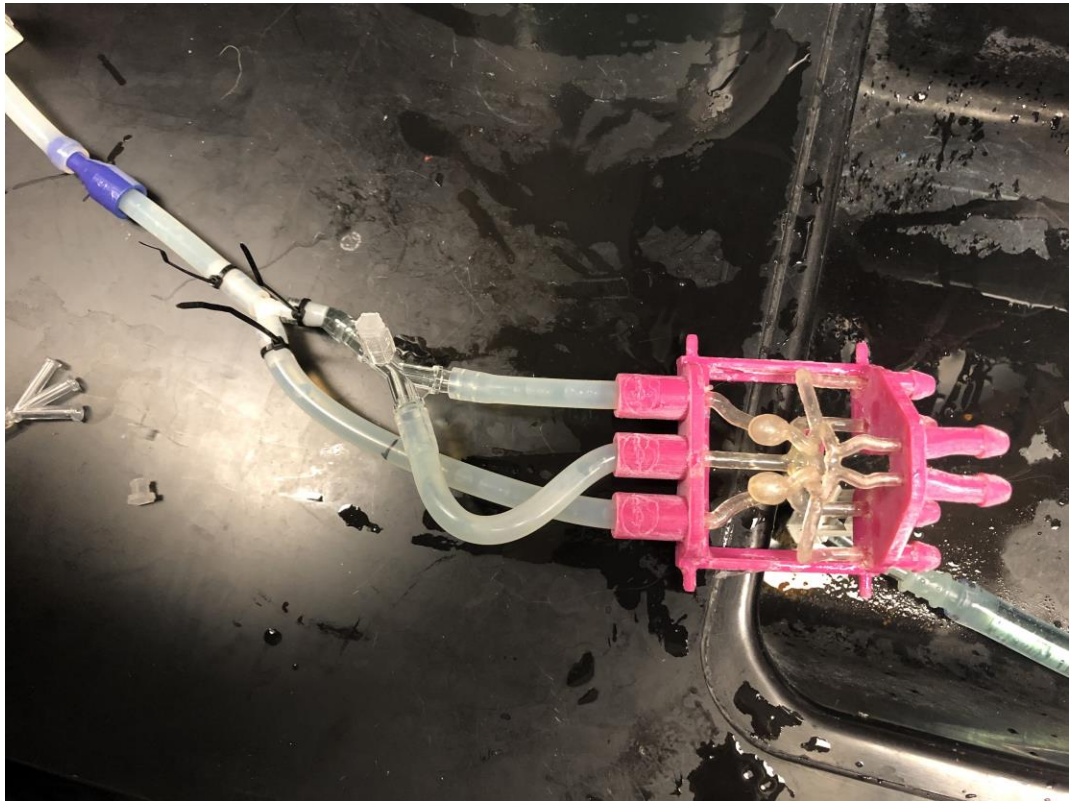

Figure 2. Circle of Willis Model attached to Universal connector

Results

- Without using uncleaned model, Fountain Pump outputs pressure at 10-15 mmHg; compared to Pulsatile pump outputting pressure from 20 – 60 mmHg
- Heating Element currently operates at a maximum temperature of 60.8 degrees Celsius (Beyond model threshold = 50); temperature measured using forehead thermometer.
- Filter does not fail due to static pump pressure
- LabVIEW can be used at prototyping phase for Pressure and Time measurements
- CVC can operate with Control and Circle of Willis Models

Preliminary Model

Further Construction:

- Connect heating element to overall system
- Reduce height difference between system elements prior to model – Increasing Pressure
- Reduce Resistive Tubing Length – Reduced Head Loss, Increased Pressure
- Use Arduino/Raspberry Pi for Temperature/Pressure/Time Measurement and system kill switch – stop system at pressure threshold
- Finalizing Frame/Transportation Unit

Further Testing:

- Phase 0: Full System Loop Operation (Almost Complete)
- Phase 1: Clean Control Model (Not Complete)
- Phase 2: Clean Circle of Willis Model (Not Complete)

Thank You