pH REGULATION MODULE FOR ASTRONAUT USAGE

Department of Mechanical Engineering, UT Tyler, Senior Project 2024-2025
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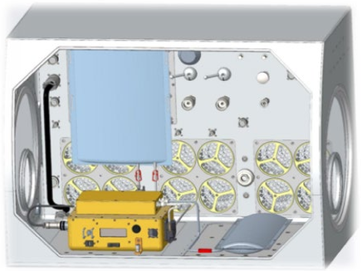
Background

- NASA's IVGEN Mini generates safe, sterile IV fluids on-site, reducing storage needs.
- ISS water needs to be purified to be mixed with pharmaceuticals to meet USP standards (pH 4.5-7.0).
- Prototype is needed in the ISS and is meant to be used under microgravity.

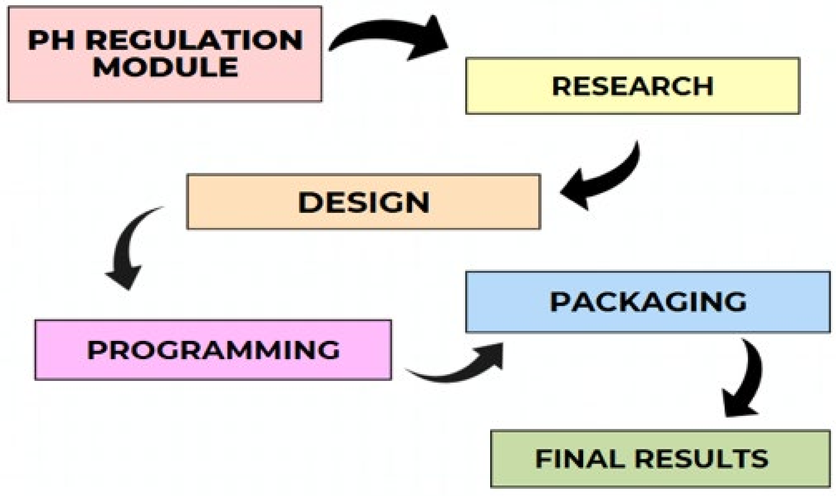


IVGEN Mini System

Concept Statement

- The purpose of this project is to design, build, and test a fluid module that can monitor and regulate the pH levels of potable water for astronaut usage.

Design Flow Chart



pH Module Automation

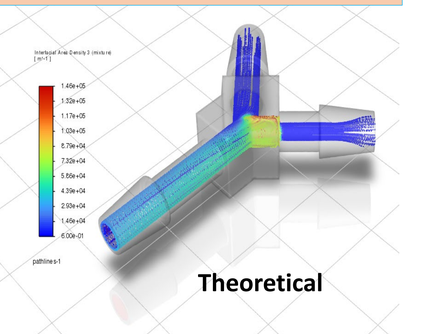
```
void controlPump(int pumpPin, float pH, bool firstActivation) {
  int runTime = 0;

  if (firstActivation) {
    if (pH >= 8.00) runTime = 6000;
    else if (pH >= 7.50) runTime = 4000;
    else if (pH >= 7.00) runTime = 3000;
  } else {
    if (pH >= 8.00) runTime = 6000;
    else if (pH >= 7.50) runTime = 4000;
    else if (pH >= 7.00) runTime = 2000;
  }
```

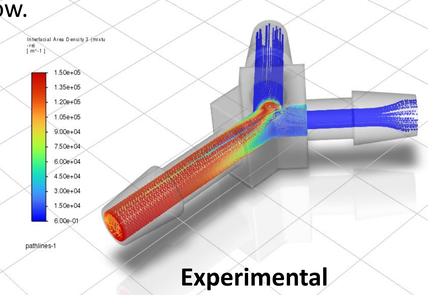
Code operates on timed intervals and adjusts the pH by activating the dosing pump for a specific duration, based on the pH sensors readings.

CFD Simulations

- Citric Acid represented by blue. Water represented by red.
- Check valve at buffer inlet prevents backflow.
- Mixing ensures accurate and consistent pH readings.



Theoretical



Experimental

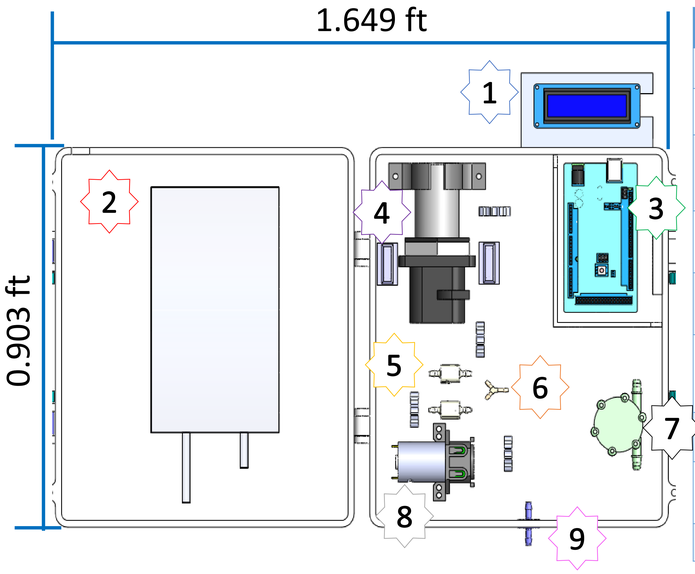
Specifications

SPECIFICATION	ACCEPTANCE CRITERIA
COMMUNICATION SYSTEM	Confirm the pH acceptable range of 4.5-7.0
HUMAN-SAFE DEVICE OUTPUT	Buffers chosen will not harm Astronauts.
pH RECOVERY TIME	Response time to restore target pH should not exceed 5 minutes.

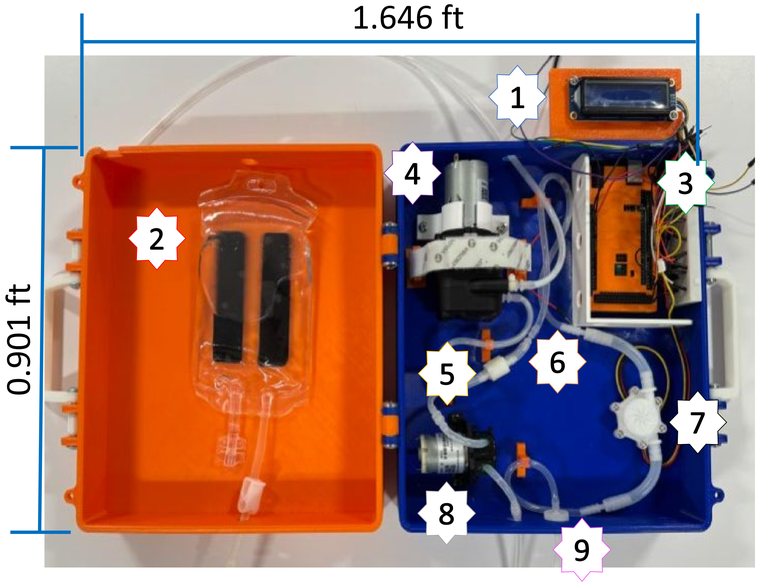
Results

Run	Initial pH	Final pH	Time	Average Flow Rate (L/min)
1	7.94	6.4	3 mins 35 secs	0.379
2	7.52	5.71	3 mins 54 secs	0.356
3	8.69	6.57	3 mins 53 secs	0.332

Progression from CAD to Prototype



#	Component
1	LCD
2	IV BAG
3	ENCLOSURE
4	MAIN PUMP
5	CHECK VALVE
6	MIXING JUNCTION
7	FLOW METER
8	DOSING PUMP
9	FILTER



Conclusion

- Automated control system adjusts and stabilizes pH levels within the range of 4.5 to 7 in under 5 minutes.
- Engineered for the International Space Station and microgravity environments.
- Medical-grade materials are recommended for safety.
- About 28% decrease in pH recovery time.

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