IV Gen Mini pH Correction

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Background

The TDC-94 IV Fluid Generation (IVGEN) Mini pH Correction project focuses on developing an innovative system to generate sterile IV fluids in space. These fluids must meet stringent United States Pharmacopeia (USP) standards, including pH balance, to ensure safety and efficacy. IV fluids are essential for medical care in space exploration, but the variability of pH in water sources like ISS potable water presents a unique challenge. This project aims to research, design, and build a functional prototype that can measure and correct the pH of potable water to produce safe IV fluids.. The IVGEN Mini project aims to design a portable device capable of automatically adjusting the pH of potable water. The system must not only be highly functional but also optimized for space constraints like mass and volume. The final product will allow for the automated production of pH corrected IV fluids to meet USP standards.

PH Correction Functionality

The pH correction functionality in the IVGEN Mini project is essential for ensuring that the IV fluids produced meet strict United States Pharmacopeia (USP) standards for safe medical use. Here's how it works:

- **Measurement**: The system first measures the pH of potable water, identifying if it falls within the acceptable range for IV fluids.
- **Analysis**: The device compares the measured pH to the target value required by USP standards.
- **Adjustment**: If the pH is outside the ideal range, the system automatically adjusts it by adding small amounts of acid or base to achieve the correct balance.
- **Continuous Monitoring**: The device may continuously monitor the pH to ensure stability, correcting it in real-time if deviations occur.
- **Sterility and Final Check**: After pH adjustment, the water is verified to be sterile and at the correct pH, making it suitable for IV use.

This automated pH correction feature is designed to be compact, efficient, and reliable to operate in the constrained environment of space, where precise fluid generation is critical for astronauts' health.

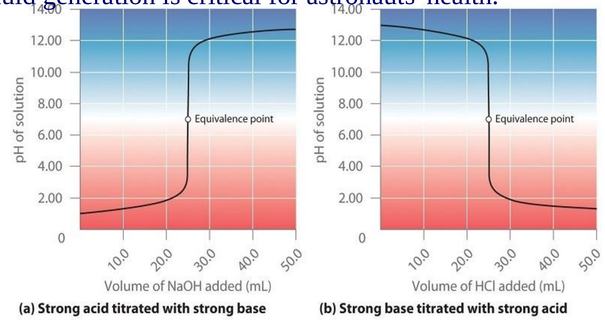

Figure 1: Acid and Base effectiveness with Titration

Design Constraints

- Generation of new IV Fluid should be mostly **automated** (<4 hours support)
- Fluid should be generated at a minimum of **1.2 L/hr**

Automation

Our project automates the generation of sterile IV fluids in space by using advanced sensors and microcontrollers. The system continuously monitors and adjusts the pH of potable water to meet USP standards. It automatically injects precise amounts of acid or base and validates the final pH, ensuring safe and efficient fluid production for astronauts, all through a user-friendly, hands-free interface.

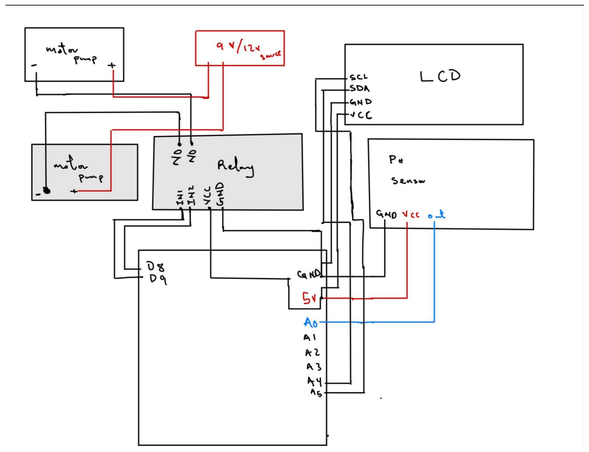

Figure 2: Circuit Diagram for pH testing mechanics

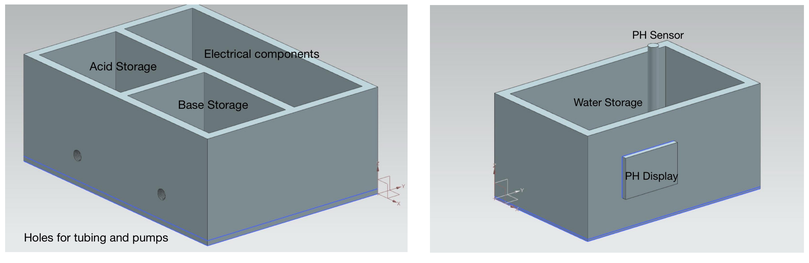

Figure 3: CAD rendering of respective containers

Description of CAD

The CAD model demonstrates the features of all the concepts implemented on the model. It shows the storage of the base and acid as well as where the placement of all the main electrical components of the design. The CAD model shows an empty slot in the water storage container for a display of the current PH of the water in the tank to keep the users informed. It also displays holes in the side where the pipe with the pump will run into to deliver the acid or base depending on the PH of the water. Also showcased in the display is the interchangeable storage of the acid and basis so that once it is empty there can be backup storage containers that can be easily removed and inserted.

Terrestrial Applications

- **Water Treatment**: pH adjustment is used in water treatment to optimize coagulation, disinfection, and neutralize acidic or basic contaminants in drinking and wastewater.
- **Agriculture**: Farmers adjust soil pH to enhance nutrient availability and optimize crop growth.
- **Pharmaceuticals**: pH control is crucial in drug formulation to ensure stability, solubility, and bioavailability.
- **Food & Beverage**: pH is controlled in food processing, such as fermentation, pickling, and brewing, to ensure product quality and safety.
- **Chemical Manufacturing**: pH is adjusted in chemical processes to optimize reactions, such as in the production of fertilizers or detergents.
- **Cosmetics**: The pH of skincare and hair products is adjusted to match the skin's natural pH and prevent irritation.
- **Aquaculture**: pH is controlled in aquariums and fish farms to maintain healthy aquatic environments.

Summary

The TDC-94 IV Fluid Generation (IVGEN) Mini pH Correction project aims to create a compact, automated device to generate sterile IV fluids in space by adjusting the pH of potable water to meet United States Pharmacopeia (USP) standards. This innovation addresses the pH variability in ISS water sources, essential for safe medical care during space missions. Beyond space, pH adjustment has critical applications in various fields as stated in the real-world applications.

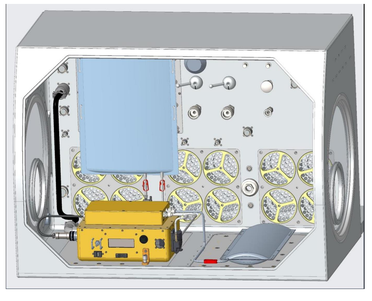

Figure 4: Existing IV GEN Mini

Future Work

- Scalability
- Modular parts
- Volume optimization
- Improved efficiency

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References

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