



The Creation of a Modular pH Correction Device for Space Exploration

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Abstract

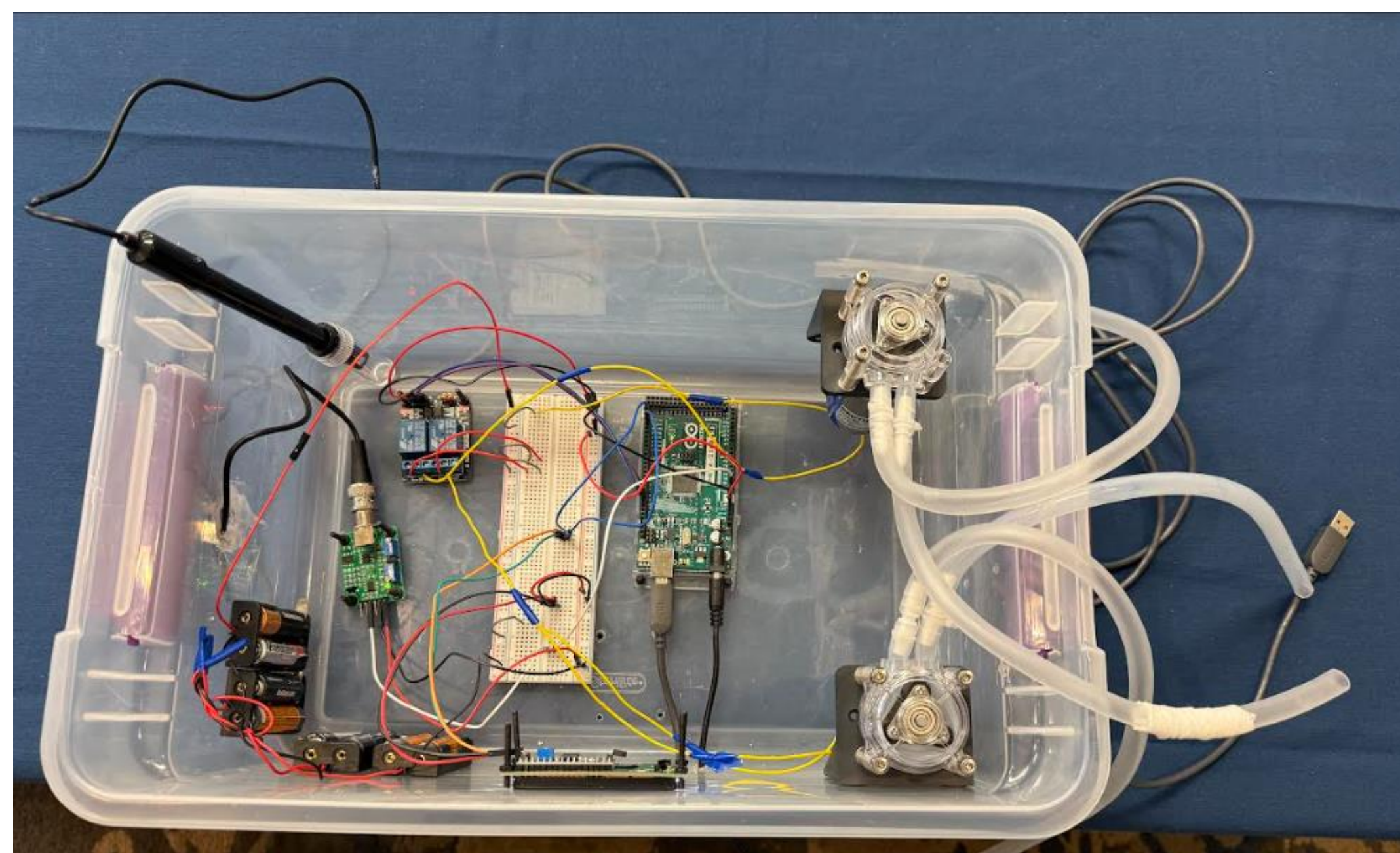
The TDC-94 IV Fluid Generation (IVGEN) Mini pH Correction project focuses on developing a compact and automated system to produce sterile intravenous (IV) fluids in space. Ensuring proper pH balance is critical for IV fluid safety, as it must comply with stringent United States Pharmacopeia (USP) standards. This project aims to design and build a prototype capable of measuring and automatically correcting the pH of potable water to ensure it meets medical-grade requirements. By addressing the unique challenges of space-based IV fluid production, the IVGEN Mini project contributes to advancements in space medicine and automated fluid processing technologies.

Objective

The main objective was to design an automated device capable of measuring and adjusting the pH of potable water to fall within the USP-recommended range of pH 4.5–7.0, ensuring the safe production of IV fluids.

Mechanical Methods

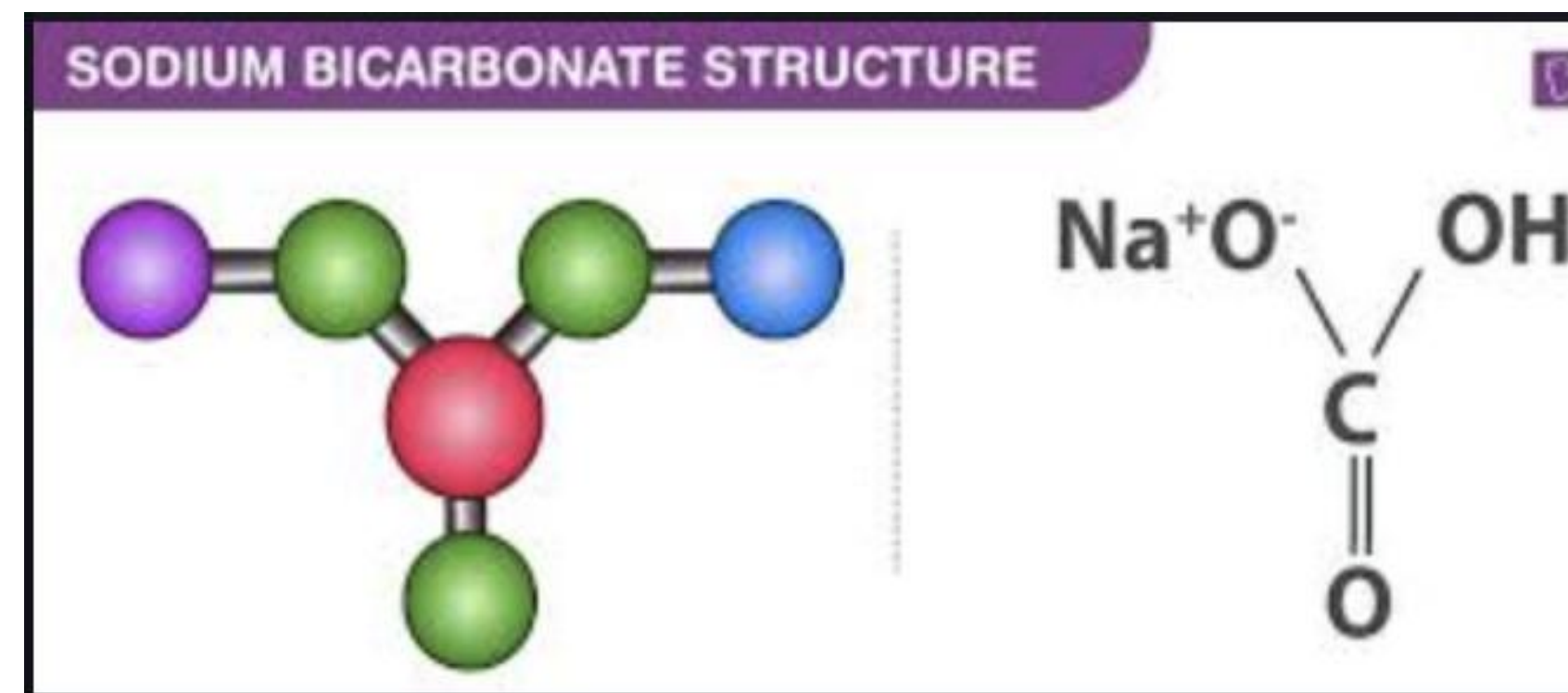
The Device operates with a simple peristaltic pump and pH Sensor System. When the pH of the liquid is not at the desired level a signal will be sent which will trigger the motors which will pump either an acid or base into the solution until it reaches the desired pH. The pH will be read using a pH Sensor and displayed on an LCD screen to inform the user of the current Ph of the solution. The solution in the container will be spun by a magnetic stir rod to ensure the fluids are not stagnant, as well as ensuring proper mixing.



Previous Prototype

Chemical Methods

Since the water is filtered and recycled, we can assume its pH will tend to be more acidic. To counteract this and raise the pH, we have selected a mild alkaline buffer, Sodium Bicarbonate (NaHCO_3). Additionally, a phosphate buffer will be used to stabilize the pH, ensuring consistency and suitability for IV fluid production.



Sodium Bicarbonate (NaHCO_3)

Schematic & Design

```
1 #include <Wire.h>
2 #include <LiquidCrystal_I2C.h>
3
4 #define RELAY1 7 // relay control pin for Pump 1
5 #define RELAY2 8 // relay control pin for Pump 2
6 #define TRANSISTOR1 6 // transistor for Pump 1
7 #define TRANSISTOR2 9 // transistor for Pump 2
8 #define PH_SENSOR_A0 // pH sensor connected to analog pin A0
9
10 int pumpSpeed = 120; // Example RPM for display
11 float pH_Value = 0.0; // pH reading variable
12
13 LiquidCrystal_I2C lcd(0x27, 16, 2); // LCD setup (change address if needed)
14
15 void setup() {
16   Serial.begin(9600); // Initialize Serial Monitor for debugging
17
18   // Configure pump relays and transistors
19   pinMode(RELAY1, OUTPUT);
20   pinMode(RELAY2, OUTPUT);
21   pinMode(TRANSISTOR1, OUTPUT);
22   pinMode(TRANSISTOR2, OUTPUT);
23
24   // Ensure pumps are off initially
25   digitalWrite(RELAY1, HIGH);
26   digitalWrite(RELAY2, HIGH);
27   digitalWrite(TRANSISTOR1, LOW);
28   digitalWrite(TRANSISTOR2, LOW);
29
30   // initialize i/o
31
32   lcd.init();
33   lcd.backlight();
34   lcd.setCursor(0, 0);
35   lcd.print("Pump Speed: ");
36
37   void loop() {
38     // Read pH Sensor
39     int pHraw = analogRead(PH_SENSOR_A0); // Read analog pH value
40     float voltage = pHraw * (5.0 / 1023.0); // Convert analog reading to voltage
41     pH_Value = voltage * 1.5; // Approximate pH calibration
42
43     // Display pH value
44     lcd.setCursor(0, 1);
45     lcd.print("pH: ");
46     lcd.print(pH_Value, 2); // Display pH with 2 decimal places
47     lcd.print(" "); // Clear extra characters
48
49     // Turn On Pumps
50     digitalWrite(TRANSISTOR1, HIGH);
51     digitalWrite(TRANSISTOR2, HIGH);
52     digitalWrite(RELAY1, LOW);
53     digitalWrite(RELAY2, LOW);
54
55     lcd.setCursor(0, 1);
56     lcd.print("Speed: ");
57     lcd.print(pumpSpeed);
58     lcd.print(" RPM ");
59     delay(5000); // Pumps run for 5 seconds
60
61     // Turn OFF Pumps
62     digitalWrite(TRANSISTOR1, LOW);
63     digitalWrite(TRANSISTOR2, LOW);
64     digitalWrite(RELAY1, HIGH);
65     digitalWrite(RELAY2, HIGH);
66
67     lcd.setCursor(0, 1);
68     lcd.print("Stopped ");
69
70     delay(3000); // Wait before restarting
71
72     // Print pH value in Serial Monitor for debugging
73     Serial.print("pH Value: ");
74     Serial.println(pH_Value);
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