Fully Controlled Hydroponic System

Cluster: 4
Team 10

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OBJECTIVE

Develop a fully controlled hydroponic system to maximize growth, ensure resource efficiency, enable year-round production and to maintain consistency & quality of the harvested produce.

BACKGROUND

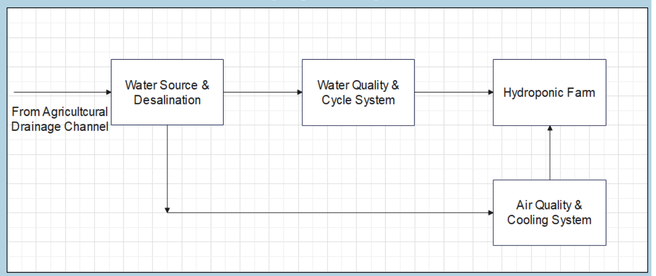
- **Problem statement: Providing end-to-end fully controlled hydroponics systems that empower farmers to grow anywhere sustainably to avoid the vast land cost, labors, climate challenges and water scarcity**

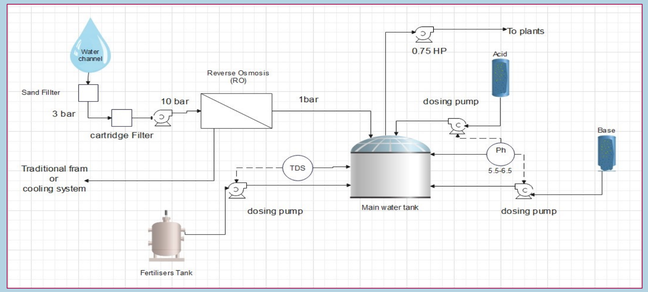
- **Constrains:**
- **Water does not exceed 4300 ppm**
- **Fertilizers and salt control ,Ex: strawberry plants: 800 to 900 ppm**
- **pH control, Ex: strawberry plants: 5.5 to 6**
- **The inlet temperature should set in between 15C to 45C**

Specification:
- **Maintain pH value into (5.5-6.5) range.**
- **Keep the humidity range of 40% to 70%**
- **Maintain the concentration of fertilizers according to the plan's need**
- **Preserve the temperature between (24-30)**
- **Provide enough water with a salinity's range (0-150 ppm)**
- **Create a one control unit to control & measure the environmental conditions.**

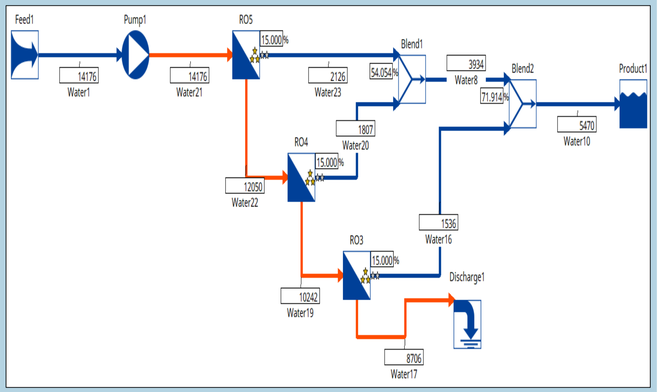
Project Design

This project has a combination between the simulation and the physical prototype. The project has four main units as can be seen from the below figure, where the water source & desalination unit is the simulation part, and the other units are physical part.





For the simulation part (water source & desalination), the agricultural waste channel at Qatif will be used as a water source of the farm. Therefore, the water was analyzed by Compact IC Flex Device to prove the validity of this water source, where the results don't excess the limits of the elements concentration based on Saudi Ministry of Environment Water & Agriculture. After that, the simulation of the Reverse Osmosis (RO) process was completed by AquaGrid software as can be seen below, where salinity is 60.89 ppm which is in the specification range



Quick Result

		Water1	Water8	Water10
Pressure	Pressure	0.00	0.00	0.00
Flow	Flow	14176.00	3933.84	5470.16
pH	pH	7.00	6.85	6.87
Cl⁻	Cl⁻	1152.59	30.48	36.93
Boron	Boron	0.00	0.00	0.00
TDS	TDS	1900.00	50.26	60.89

Chemical used for pH control:

- **Acid: phosphoric acid (85%) - Liquid**
- **Base: sodium bicarbonate (pure) - Solid**

Acid:

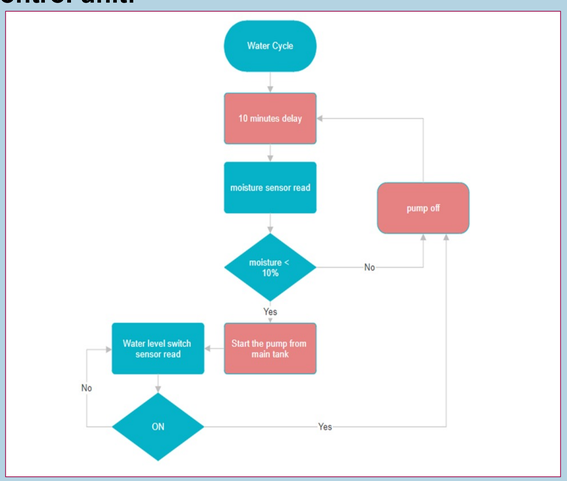
Trial	Amount of water	pH of Water	Amount of acid	pH of Acid with water	Delta pH
1	500 ml	6.813	5 ml	4.348	2.465
2	500 ml	6.213	10 ml	3.292	2.921
3	500 ml	6.299	20 ml	2.205	4.094

Base:

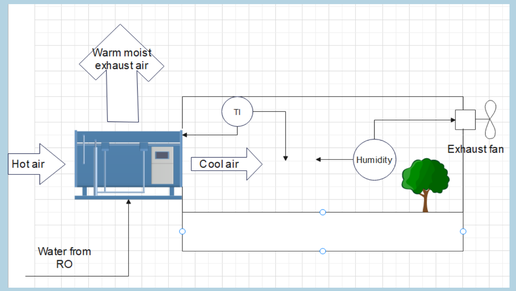
Trial	Amount of water	pH of Water	Amount of base	pH of base with water	Delta pH
1	500 ml	6.894	2.0422 g	7.495	-0.601
2	500 ml	6.277	5.0102 g	8.395	-2.118

Farm structure:

Control unit:

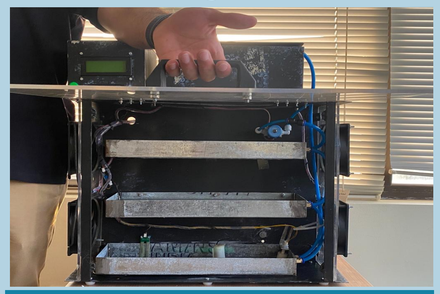


Air quality:



Prototype testing

The test was occurred by the physical prototype, where the functions are:
1.Monitors temperature, moisture, and water level (are controlled due to the specification range)
2.User-programmable temperature and moisture ranges
3.Automatic fan control for optimal conditions
4.Water sensors regulate water level



Conclusion

- **The project units met the specifications to provide the suitable conditions for the plant that fully self-controlled.**
- **The final cost of our real design was around 32K SR, where for prototype was around 4000 SR**

For the challenges & recommendations
- **Environmental Control :**

Challenge: Maintaining optimal humidity and temperature levels.
Recommendation: Implement a robust control system with sensors and actuators for real-time regulation