TEAM 104

Design of Bioreactor and Growth of Bacteria for Water Treatment Applications

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BIOE ISE 4 ME CHE

Introduction

Bioreactors provide the necessary controlled environment for cultivating microorganisms, which are used in various industrial fields. They are of importance as they ensure that the physical, chemical, and biological conditions required for microbial growth are consistently maintained. In this project, the focus is to develop a stirred-tank bioreactor designed for microbial growth and specifically Pseudomonas aeruginosa as a proof of concept. This kind of bacteria is known for its efficiency in degradation of PAH and has significant potential ahead.

Problem Statement

Bioreactors enable controlled bacterial growth, but current solutions often lack affordability, scalability, or performance for bacteria. This project designs a cost-effective bioreactor for optimal Pseudomonas aeruginosa growth in wastewater treatment, targeting PAH degradation. The focus is on efficiency, scalability, and maintaining functionality while reducing costs.

Objective

The objective of this project is to develop a bioreactor prototype that allows for the efficient and controlled cultivation of Pseudomonas aeruginosa. The design aims to be cost-effective while maintaining the performance of existing competitors. The system's performance will be evaluated to assess the potential for scaling and real-world applications.

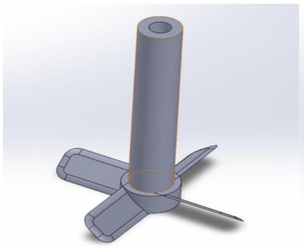
Constraints

1- pH level in vessel < 7 pH.
2- Shear Stress < 0.4 Pa.
3- 30 C < Temp. of vessel < 37 C.
4- Monitoring and Sensors 0.1 Resolution.

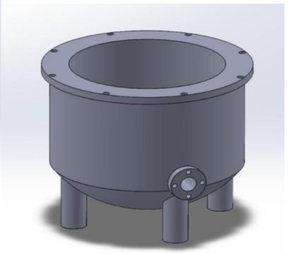
Specifications

1- Temperature Stability ±0.5° C Accuracy.
2- Real-Time Data Refresh Rate ≤ 5 s.
3- Alert Sensitivity ±10% Deviation from Setpoint.
4- Working Volume < 16 L.
5- Motor rpm < 500 RPM.
6- Liquid level < 70%.
7- Bacterial growth > 5mL/Cycle.
8- Cycle time < 3 days.
9- Degradation of contaminant >50%.

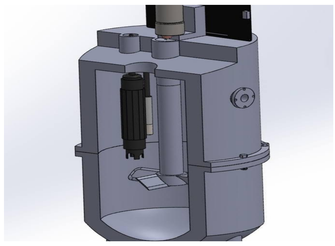
Prototype Design



stirrer

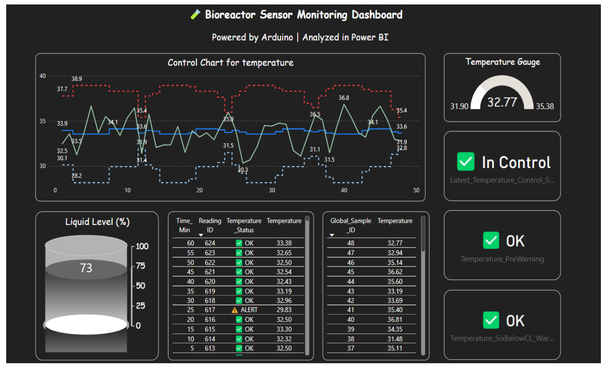


Vessel

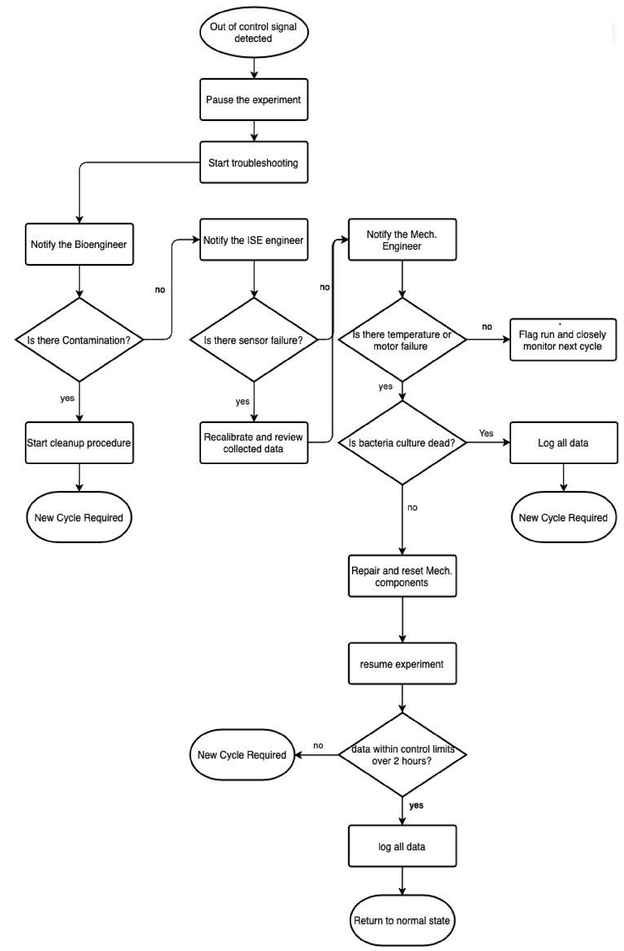


Designed prototype

Testing and Validation



- Mathematical formulations
  - $\frac{dC_L}{dt} = kLa(C_L^* - CL)$
  - $\mu = \frac{\mu_{max} C_s}{K_s + Cs}$



Conclusion

This project designed a cost-effective bioreactor to grow Pseudomonas aeruginosa for wastewater treatment. The prototype successfully maintained optimal growth conditions while meeting key specifications.