Final Year Project Showcase Batch-2020
Year 2024

Department: Food Engineering Programme: Food Engineering	
1	**Project Title** Utilizing Bottle Washer wastewater for Environmentally Responsible Soft Drink Manufacturing
2	**Project Idea** The project aims to develop an innovative solution for soft drink manufacturing by recycling and reusing wastewater from bottle washers. This approach not only conserves water but also minimizes environmental impact by reducing the overall wastewater generated during the production process. By implementing advanced treatment methods, the recycled water can meet the necessary standards for reuse in various stages of the manufacturing process, thereby promoting sustainability and resource efficiency in the soft drink industry.
3	**Process** Membrane bioreactor, Ultra-filtration.
4	**Outcome** Conducted a comprehensive analysis and synthesis of four distinct membrane compositions: • Tannic Acid with Polyethersulfone (PES) • Zinc Oxide with Polyethersulfone (PES) • Chitosan with Tannic Acid • Chitosan with Zinc Oxide Employed advanced simulation tools such as Material Studio, Comsol Multiphysics, and GPX-S to evaluate membrane performance based on temperature resistance, energy dynamics, and optimization parameters. dentified limitations in other membrane compositions: • Zinc Oxide with Polyethersulfone faced mechanical stability issues. • Chitosan-based membranes, though biocompatible, lacked energy dynamics and temperature resilience.
5	**Evidence (Theoretical Basis)** This project focused on addressing the environmental challenges associated with wastewater treatment in the beverage industry, specifically targeting the wastewater generated from bottle washing processes. The core of the project involved the development and optimization of a Membrane Bioreactor (MBR) system to effectively treat this wastewater, making the process more sustainable and energy-efficient. We synthesized and analyzed four different membrane compositions—Tannic Acid with Polyethersulfone (PES), Zinc Oxide with Polyethersulfone (PES), Chitosan with Tannic Acid, and Chitosan with Zinc Oxide. Using advanced simulation tools like Material Studio, Comsol Multiphysics, and GPX-S, we rigorously tested each composition for key performance indicators such as temperature resistance, energy dynamics, and mechanical stability. The Tannic Acid with Polyethersulfone membrane emerged as the most effective solution, demonstrating superior hydrophilicity, anti-fouling characteristics, and energy efficiency. It outperformed the other membranes in critical areas, making it an ideal choice for the MBR

	system. This composition not only provides a sustainable solution for wastewater treatment but also enhances the energy efficiency of the overall process. The project ultimately demonstrated that the Tannic Acid with Polyethersulfone membrane is the optimal choice for industrial applications in the beverage industry, offering a balance of strength, thermal stability, and energy efficiency.
6	**Competitive Advantage or Unique Selling Proposition** The Tannic Acid with Polyethersulfone (PES) membrane developed in our project offers a compelling competitive advantage through significant cost reduction, process improvement, alignment with Sustainable Development Goals (SDGs), superior performance, and potential for market expansion. By reducing energy consumption and operational costs, it provides a strong return on investment. The membrane enhances process efficiency with superior hydrophilicity, anti-fouling properties, and mechanical stability, leading to higher productivity. It aligns with SDG 6 (Clean Water and Sanitation) and SDG 12 (Responsible Consumption and Production), supporting sustainability goals. Additionally, its exceptional performance surpasses competitors, making it a preferred choice for wastewater treatment. Its versatility also allows for capturing new markets, offering companies a chance to expand their reach and enhance their market position.
a	**Attainment of any SDG** (e.g. How it is achieved and why it is necessary for the region) **SDG#9, Industry, Innovation and Infrastructure** Industry connects with the sector in bottle washer production, Innovation involves in the development of new and better processes for the wastewater treatment for bottle washer and likewise infrastructure also includes in the sustainable wastewater treatment due to its physical and organizational structure. The SDG aligns with the industry wastewater management which is responsible for availability and sustainable management of water. And the SDG 9 directly aligns with the innovation in wastewater treatment for bottle washer which aims to build resilient infrastructure and innovation. **SDG#6, Clean Water and Sanitation** Clean water and sanitation of wastewater treatment for bottle washer aligns with SDG 6 which aims to ensure the availability and sustainable management of water and sanitation. Wastewater for bottle washing processes usually contains contaminants like detergents, residue from cleaning agent and harmful substances. The target is to remove these substances from the wastewater so that the wastewater meets the acceptable quality 11 standard. Sanitation regulates the safe and effective management of wastewater to protect the human health as outlined in SDG 6. **SDG#14, Life below Water** Life below Water aligns with Sustainable Development Goal 14 (SDG 14), which focuses on sustainably using the seas, rivers, oceans and marine resources. Implementing with the SDG 14 practice ensuring to minimizing the impact of the industrial activities on the live that are below the water. Substances which are used in bottle washer processes such as cleaning agents are harmful to aquatic life. Responsible wastewater treatment ensures to remove these substances from water in order to save the marine life by minimizing the risk of a threat to marine ecosystem. Wastewater treatment practices should aim to promote ecosystem health
b	**Cost Reduction of Existing Product**
d	**Process Improvement which Leads to Superior Product or Cost Reduction, Efficiency**

	Improvement of the Whole Process The current process of treating bottle washer wastewater in the beverage industry often relies on conventional treatment methods that are energy-intensive, prone to membrane fouling, and lack efficiency in recycling water for reuse. These issues lead to higher operational costs, frequent maintenance, and suboptimal water recovery, which collectively reduce the overall efficiency of the process. Our project introduces a significant process improvement by integrating a Membrane Bioreactor (MBR) system utilizing a specially formulated Tannic Acid with Polyethersulfone (PES) membrane. This membrane composition addresses the key issues in the existing process by offering superior hydrophilicity and anti-fouling characteristics, which reduce membrane clogging and maintenance requirements. Additionally, the membrane's enhanced mechanical strength and chemical resistance ensure longer operational life and consistent performance. The improvement also extends to energy efficiency. The Tannic Acid with Polyethersulfone membrane requires lower energy inputs to maintain operational temperatures, directly reducing energy consumption and lowering costs. This optimized energy dynamics not only decrease the overall cost of wastewater treatment but also contribute to a more sustainable operation by minimizing the carbon footprint. By implementing this improved process, companies can achieve higher water recovery rates, reduce operational costs, and enhance the overall efficiency of their wastewater treatment systems. This leads to a superior product—clean water that meets the standards for reuse in production processes—while also delivering significant cost savings and environmental benefits.	
7	**Target Market** (Industries, Groups, Individuals, Families, Students, etc) Please provide some detail about the end-user of the product, process, or service Beverage Industry, Juise Processing Industry or Liquid food processing Industry	
8	**Team Members** (Names along with email address)	Hifza Waseem (waseem4304911@cloud.neduet.edu.pk) Eisha Qaiser (eisha4301730@cloud.neduet.edu.pk) Sara Ejaz (ejaz4304876@cloud.neduet.edu.pk) Wardah Hydari (hydari4305090@cloud.neduet.edu.pk)
10	**Supervisor Name** (along with email address)	Muhammad Hassam Siddiqui hassamsiddiqui@cloud.neduet.edu.pk
11	**Video (If any)**	Please provide the link of the video

Pictures (to be pasted below

Utilizing Bottle Washer Wastewater for Environmentally Responsible Soft Drink Manufacturing

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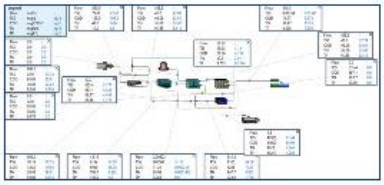
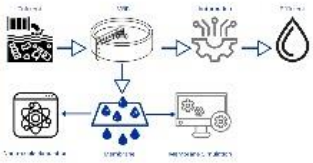
INTRODUCTION

We aim to revolutionize wastewater treatment by targeting the effluent from bottle washers, a significant source of water contamination in this sector.



Abstract

This project optimizes water recycling from bottle washer wastewater for sustainable soft drink manufacturing using advanced MBR and custom NF membrane technology with simulation and automation.



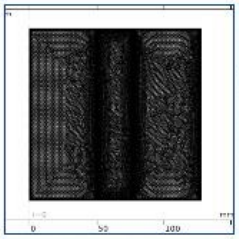
OBJECTIVE

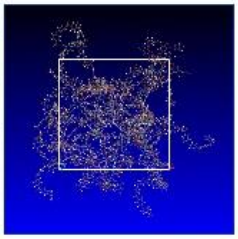
This project's core focus :

- Enhance water recycling for environmental preservation and resource conservation.
- Reduce wastewater treatment costs while ensuring treatment quality.
- Align practices with sustainability goals for responsible water management.
- Improve production efficiency through enhanced water management.

METHODOLOGY

Our approach involved systematic steps: fabricating a Membrane BioReactor (MBR) and membrane, and simulating using Material Studio, COMSOL, and GPSX software. Fabrication included selecting materials, assembling components, and overcoming challenges, while simulations informed design decisions, and GPSX software automated processes for improved workflow.



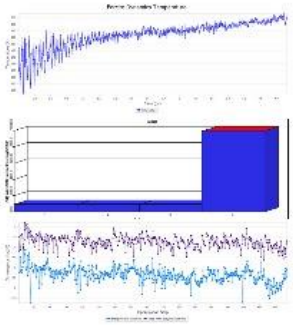


DISCUSSION

Soft drink manufacturing confronts wastewater challenges with harmful effluents. Membrane Bioreactor (MBR) technology efficiently treats wastewater, ensuring regulatory compliance and emphasizing sustainability for consistent performance.

RESULTS

Fabricated MBR system and membrane met design specs, aided by Material Studio and Comsol simulations. Integration of data improved performance in treating soft drink manufacturing wastewater.



APPLICATION

- Goes beyond beverages, providing wide environmental and societal benefits.
- Drives research in wastewater treatment and membrane science.
- Offers significant societal impact and applications.

CONCLUSION

Our project employs MBR systems, NF membranes, and automation for sustainable water management in soft drink manufacturing, cutting costs and meeting quality standards while advancing sustainability goals.

FUTURE RECOMMENDATION

Elevate wastewater treatment with PVDF membranes and advanced techniques such as ion exchange and forward osmosis, enhancing sustainability and water quality for future generations.

REFERENCE

Mention in the final Year Project. Will be provided on Recommendation