NED University of Engineering and Technology

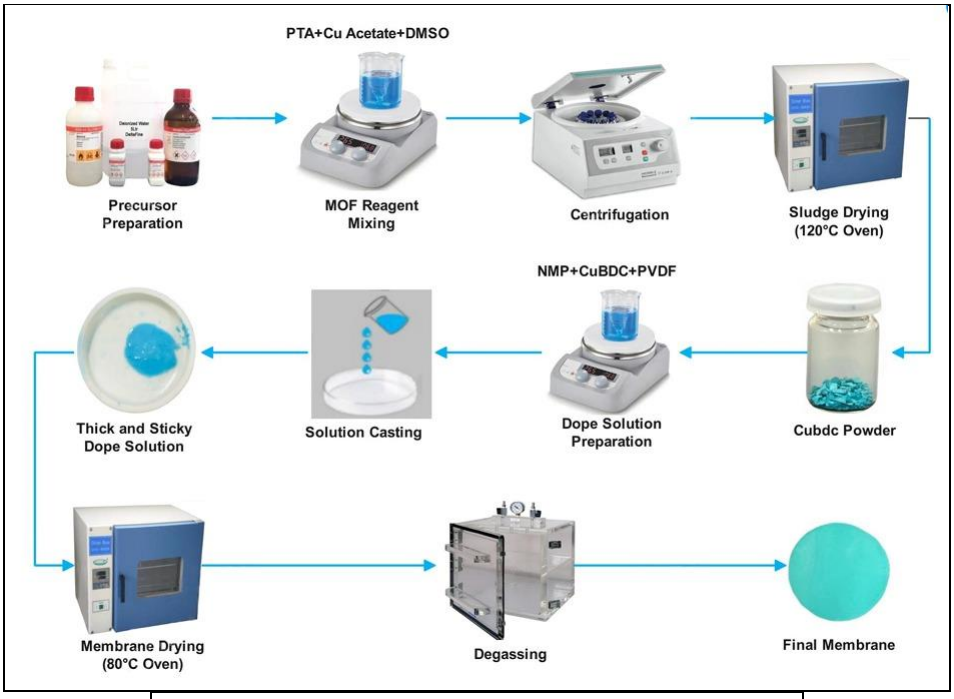
Final Year Design Project Showcase
Batch-2022
Year 2026

	Department: Chemical Engineering Programme: Chemical Engineering
1	**Project Title** Development of Porous Coordination Polymers (PCP) Materials for Sustainable Wastewater Treatment and Environmental Remediation.
2	**Project Idea** This project revolutionizes wastewater treatment by using a novel Porous Coordination Polymer (PCP) to rapidly strip toxic lead from industrial water. We pioneered a green synthesis process to embed these highly selective PCPs/MOFs into a PVDF filtration matrix. The result is a scalable, cost-effective product that saves industries from compliance fines while protecting our most vital resource of clean water.
3	**Process** • **Green Synthesis:** Synthesized highly selective Porous Coordination Polymers (PCPs) named Copper benzene dicarboxylate (CuBDC) using eco-friendly DMSO solvent instead of conventional DMF, completely eliminating toxic solvent waste from the manufacturing phase. • **Matrix Integration:** These active PCP blue crystals were then permanently embedded into a robust PVDF polymeric support, transforming fragile powders into a highly durable filtration membrane. • **Targeted Filtration:** Lead nitrate [$Pb(NO_3)_2$] solution was then passed through the composite matrix, the engineered molecular networks instantly captured the dissolved lead (Pb^{2+}) ions.
4	**Outcome** The project delivered a lab-scale PCP-PVDF filtration membrane demonstrating the effective removal of lead from contaminated water. By validating our green synthesis approach, we created an eco-friendly composite material. Ultimately, this establishes a strong foundation for developing a scalable, cost-effective industrial solution to help manage heavy metal pollution and support environmental compliance.

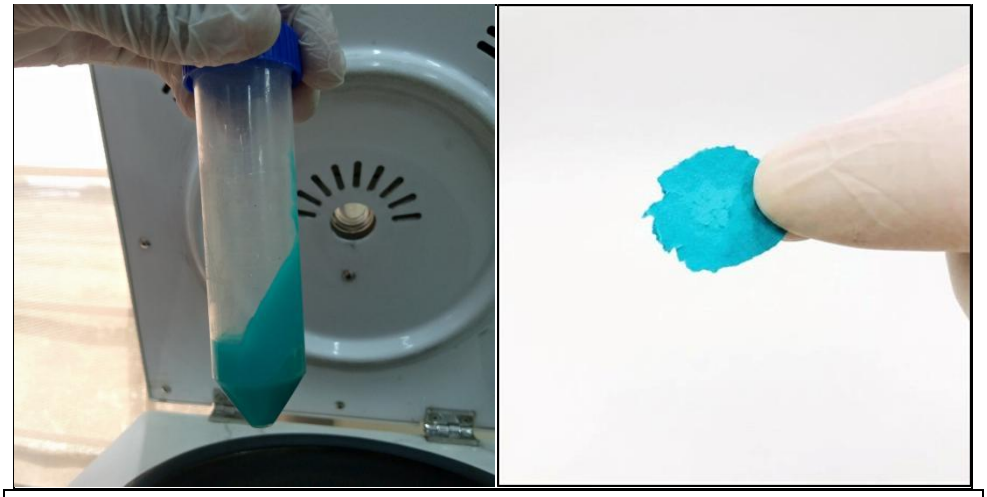
5	**Evidence (Theoretical Basis)** • **The Challenge:** Global freshwater shortages and industrial heavy metal pollution demand advanced filtration. However, standard PVDF membranes foul easily and rely on harsh, environmentally damaging cleaning chemicals. • **The Breakthrough:** We engineered a novel Mixed-Matrix Membrane (MMM) specifically designed to strip toxic lead (Pb^{2+}) from industrial wastewater. • **The Innovation:** We pioneered a **green chemistry** approach, replacing toxic DMF with eco-friendly DMSO, to synthesize highly porous CuBDC Porous Coordination Polymers (PCPs). Embedding these 2D nanosheets into a PVDF matrix successfully combines the polymer's immense mechanical strength with the PCP's massive, fouling-resistant surface area. • **The Global Impact:** It directly advances UN **SDGs 6**, **9**, and **14** by securing affordable clean water, driving sustainable industrial infrastructure, and protecting marine ecosystems.
6	**Competitive Advantage or Unique Selling Proposition** • **Superior Performance:** Outperforms standard commercial PVDF by utilizing CuBDC to actively trap toxic lead (Pb^{2+}) while highly resisting membrane fouling. • **Green & Cost-Effective:** Replacing toxic solvents with eco-friendly DMSO drastically cuts hazardous waste fees, while the membrane's anti-fouling properties reduce expensive cleaning downtime. • **SDG Compliance:** Delivers a scalable, low-maintenance solution for industries to avoid heavy metal discharge fines and directly advance UN SDGs 6, 9, and 14.
a	**Attainment of any SDG** (e.g., how it is achieved and why it is necessary for the region) • **SDG 6 (Clean Water & Sanitation):** Achieved by rapidly stripping toxic lead from industrial wastewater, ensuring safe, usable water in regions facing severe freshwater scarcity. • **SDG 9 (Industry, Innovation & Infrastructure):** Achieved by upgrading traditional filtration with a novel, green-manufactured composite membrane that provides a scalable, sustainable solution for industrial facilities. • **SDG 14 (Life Below Water):** Achieved by cutting off heavy-metal pollution at the source, preventing toxic industrial discharge from devastating rivers, coastal waters, and marine ecosystems.
b	**Any Environmental Aspect** (e.g., carbon reduction, energy-efficient, etc.) This project directly purifies the environment by stripping toxic lead from industrial wastewater, preventing severe heavy-metal contamination. Additionally, it champions green manufacturing by using eco-friendly DMSO, eliminating hazardous waste, and its highly permeable, anti-fouling design significantly lowers the energy and harsh chemicals required during operation.
c	**Cost Reduction of Existing Product** • **Reduced Regulatory Costs:** Replacing toxic DMF with eco-friendly DMSO during synthesis eliminates expensive hazardous waste handling and chemical disposal fees. • **Decreased Maintenance Expenses:** Fouling resistance extends the filter's lifespan, minimizing costly operational downtime and the need for expensive chemical cleaning agents.

d	**Process Improvement which Leads to Superior Product or Cost Reduction, Efficiency Improvement of the Whole Process** (e.g., What is the issue with the current process, and what improvement do you suggest) • **The Issue:** Standard membranes foul rapidly and rely on toxic, expensive solvents for production, leading to high maintenance and hazardous waste costs. • **The Improvement:** Our green synthesis uses eco-friendly DMSO to create a highly permeable, anti-fouling CuBDC-PVDF membrane. This innovation eliminates toxic manufacturing waste while slashing operational pumping energy and cleaning downtime. • **Future Scope:** The tunable nature of these green MOFs will be adapted to target and capture a broader range of hazardous heavy metals, such as cadmium, chromium, etc.	
e	**Expansion of Market share** (e.g., how it expands and what is the problem with the current market) • **Current Market Problem:** The wastewater treatment market relies on standard polymeric filters that lack heavy-metal selectivity and foul rapidly, causing expensive maintenance. Meanwhile, existing specialized heavy-metal removal systems are far too costly for widespread industrial adoption, leaving a gap for affordable solutions. • **How We Expand Share:** Our membrane bridges this gap by offering high-end heavy-metal removal at the lower operating cost of a standard filter. By combining superior fouling resistance with a certified "green" manufacturing profile, it captures a massive, rapidly growing market share of industrial buyers driven by strict global environmental regulations.	
f	**Capture New Market** (e.g., niche market or unaddressed segment) • **The Unaddressed Niche:** Small-to-Medium Enterprises (SMEs) such as regional electroplating, textile, and tannery plants that face increasingly strict environmental discharge fines but lack the capital for massive chemical treatment plants. • **How We Capture It:** By providing a compact, highly permeable membrane that delivers premium lead rejection at a fraction of standard capital and operating costs, making advanced regulatory compliance affordable for this massive, underserved industrial segment.	
g	**Any Other Aspect** Nil	
7	**Target Market** (Industries, Groups, Individuals, Families, Students, etc) Please provide some detail about the end-user of the product, process, or service • **Primary (SMEs):** Local tanneries, textile dyeing units, and electroplating workshops that urgently need a compact, affordable filtration system to avoid strict environmental discharge fines. • **Secondary (Large Industries):** High-volume manufacturers seeking energy-efficient, green-synthesized membranes to lower operational costs and achieve Zero Liquid Discharge (ZLD) sustainability targets. • **Tertiary (Municipalities):** Urban water treatment boards requiring scalable, anti-fouling defenses to protect public drinking grids and coastal ecosystems from toxic industrial runoff.	
8	**Team Members** (Names along with email address)	Muhammad Mashood Ahmed (GL), mashoodahmed3891@gmail.com Rutab Farooque, farooquerutab@gmail.com Mohib Ghouri, m.mohibghouri@gmail.com M. Saad Alam, alamsaad13664@gmail.com
10	**Supervisor Name** (along with email address)	Engr. Talha Hasan Khan, talhahasankhan@neduet.edu.pk
11	**Video (If any)**	Please provide the link to the video

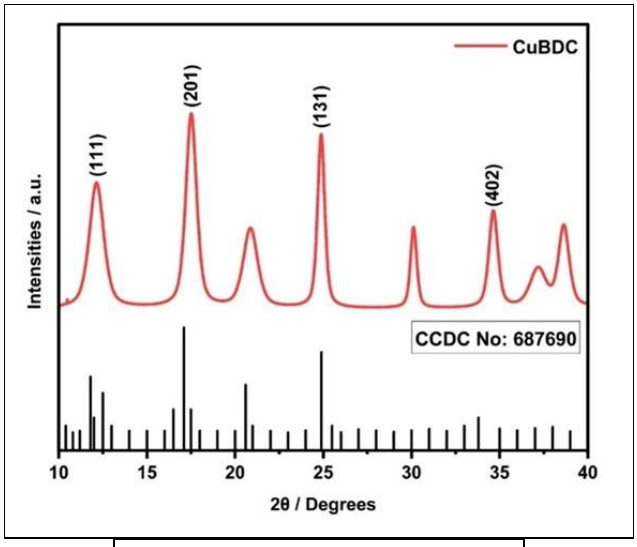
Pictures (to be pasted below):



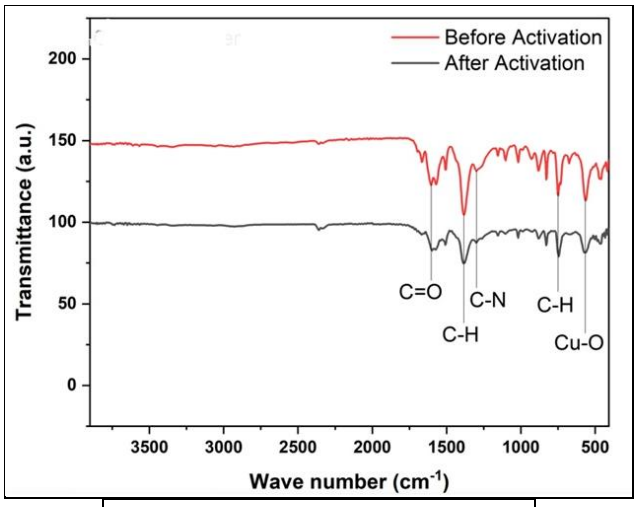
Flow Diagram of PCP-PVDF membrane synthesis



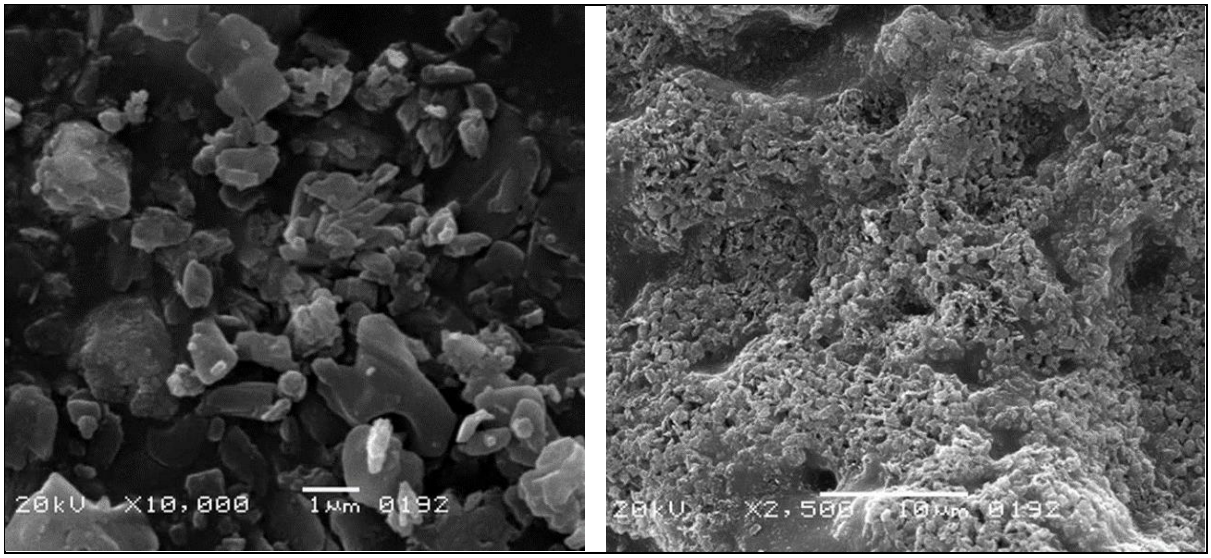
Centrifuged CuBDC blue paste and CuBDC-PVDF membrane images



CuBDC Powder XRD pattern



CuBDC Powder FTIR Spectras



CuBDC powder and membrane SEM images