Tushar Verma

Final Year Undergraduate
Department of Chemical Engineering
Indian Institute of Technology Kanpur

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Education

Year	Qualification	School/Institution	CPI/%
2022-Present	B.Tech	Indian Institute of Technology Kanpur	7.5/10
2022	CBSE XII	Satluj Public School, Sirsa, Haryana	93%
2020	CBSE X	Satluj Public School, Sirsa, Haryana	94%

Scholastic Achievements

- Awarded the **Merit-cum-Means Scholarship** by **IIT Kanpur** annually since **2023**, given to the **top 1%** meritorious students.
- Secured **All India Rank 3985** in **JEE Main 2022** conducted by National Testing Agency, amongst **1.5M** appeared participants.
- Secured **All India Rank 7673** in **JEE Advanced 2022** conducted by IIT Bombay, amongst **0.5M** shortlisted candidates.
- Received **Silver Honor** (**Top 7%**) in the **International Youth Math Challenge 2020** among **6,500+** global participants.

Work Experience

Undergraduate Researcher *Dec'24 - Jun'25*
Mentor: Prof. K.P. Rajeev | NETP Lab, IIT Kanpur

- Conducted **numerous** electrolysis experiments using $\mathbf{D_2O}$ and $\mathbf{PdCl_2}$ electrolyte to investigate **nuclear reaction** possibilities.
- Enhanced detection with **three innovative methods** (boron-coated CR-39, triple tracks, Gd-γ ray spectroscopy) to validate **neutron emissions** from the electrolytic cell.
- Recorded **neutron activity** exceeding **0.107 mCi**, with **neutron yield** amplified by **4x** using **0.25 T magnetic fields**.
- Engineered a **reliable** and **consistent nuclear track detector** using boron-coated CR-39, achieving a **115% efficiency gain**.

Capstone Project

Methyl Benzoate Process Design *Aug'25 - ongoing*
Course Project: ChE453 | Prof. Raghavendra Ragipani

- Conducted a detailed **economic feasibility** and **market trend analyses**, forecasting future raw material costs and defining process data to establish the overall project's viability.
- Developed **Aspen simulations** for distillation design, validated with a **UNIQUAC thermodynamic model** from NIST data, to achieve **98%+ product recovery** with reduced energy use.
- Collaborated in an **8-member multidisciplinary team** to optimize the complete process flowsheet, including reactor design, separation, and operating conditions.

Publication

Neutron Emission During D_2O Electrolysis *May'25*
Ankit Kumar, ***Tushar Verma***, Pankaj Jain, et al. | NETP Lab
DOI: 10.13140/RG.2.2.32604.50565 | Preprint

- Engineered and calibrated a custom **neutron detection system**, enhancing detection **efficiency** by **115%** and minimizing errors.
- Designed and executed **25+ experimental protocols** to investigate neutron emission under varied **electrolysis conditions**.
- Conducted **statistical analysis** on neutron data using **Origin** and **ImageJ**, correlating with microscopy to validate emissions.

Key Skills

- **Programming:** Python, Js, SQL, MATLAB, Mathematica
- **MATLAB:** ode45, ode15s, bvp4c, pdepe, lsqnonlin, fmincon
- **Libraries:** TensorFlow, Scikit-learn, NumPy, Matplotlib, Manim
- **Technical:** ImageJ, Origin, Aspen Plus, COMSOL Multiphysics
- **Detectors:** XPS, HPGe, CR-39, NaI detector, BF_3 detector

Key Projects

Ethyl Benzene Process Optimization *Mar'25 - Apr'25*
Course Project: ChE352 | Prof. Nitin Kaistha

- Built an **optimization framework** using sensitivity analysis and MATLAB **fmincon**, achieving **47.6% TAC reduction**.
- Designed **dual-control systems** using **Ziegler–Nichols** and **Tyreus–Luyben** tuning to achieve **99.9% purity**, validating the industrial-scale design via material and energy balances.
- Optimized a **three-column distillation network** with heat integration, ensuring energy savings and a **3-year payback**.

COMSOL Electrolysis Cell Simulation *Jul'24 - Nov'24*
UGP | *Mentor*: Prof. Raj G.S. Pala | ECCSEL, IIT Kanpur

- Developed **COMSOL Multiphysics** model of $\mathbf{H_2O}$ **electrolysis cell** using **geometries**, **boundary conditions**, and **operating parameters** for accurate **electrochemical simulation**.
- Analyzed **I–V characteristics** (1.2–1.9 V) using **fine mesh discretization** and **electrochemical transport modeling**.
- Investigated the effects of **cathode dimensions**, **electrode spacing**, and **electrolyte concentration** on key outputs like **current density** and **total enthalpy**.

PID Controller Optimization *Oct'24 - Nov'24*
Course project: ChE381 | Prof. Ishan Bajaj

- Designed a **PID optimization framework** to minimize Integral Absolute Error (IAE), achieving a reliable score of **2.4166**.
- Benchmarked classical PI tuning methods, including **Ziegler-Nichols** and **Skogestad IMC**, on a **three-tank cascade system**, improving controller performance by **80%**.
- Demonstrated the optimized PID provides **4× better performance** than classical PI for **third-order systems**.

McCabe-Thiele Distillation Analysis *Mar'24 - Apr'24*
Course project: ChE213 | Prof. Soumik Das

- Designed an advanced **distillation column** framework using the **McCabe-Thiele graphical method** for **multi-section columns** with **side stream extraction**.
- Developed precise **vapor-liquid equilibrium** curves by fitting **experimental VLE data** with **curve-fitting techniques**.
- Optimized **operating lines** for ideal **reflux ratios**, enhancing **process efficiency** and **separation performance**.

Kinetic Modelling and Optimization *May'23 - Jul'23*
Course project: ESC113 | Prof. Harshwardhan H. Katkar

- Built **kinetic models** in **MATLAB** and **Python**, implementing **numerical methods** like Runge-Kutta to solve governing **ordinary differential equations (ODEs)** for reactor design.
- Analyzed complex **reaction mechanisms** and optimized **operating conditions** to achieve **maximum product yield** and overall **process optimization**.

Position of Responsibility

Member, Finance Committee *Aug'24 - Apr'25*

- Elected by **75+** Senate panel to the **4-member** Gymkhana F.C.
- Managed an **INR 2Cr+** budget and revised financial policies, achieving a **50% reduction** in unnecessary expenditures.

Relevant Courses

**ongoing, **online*

- Transport Phenomenon
- Heat & Mass Transfer
- Thermodynamics
- Chem. Process Syn. & Des.
- Process Control & Dynamics
- Capstone Project*
- Hydrogen Energy
- Electrochemical Energy
- Manuf. Energy Systems*
- Nuclear Chemical Engg.
- Intro to Radioactive Sources**
- Nuclear Activation Analysis**