Best Project Ideas

Top 299+ Chemical Engineering Project Ideas: Tips & Examples

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Chemical engineering merges chemistry, physics, biology, and math to design processes that transform raw materials into valuable products—anything from plastics to pharmaceuticals.

Undertaking hands-on projects not only deepens your theoretical understanding but also equips you with skills sought by industry, such as problem-solving, teamwork, and data analysis.

In this article, I'll walk you through everything you need to know to plan, execute, and present chemical engineering projects that stand out. Let's dive in!

Must Read: 200 Simple AP Chemistry Project Ideas For Students

Table of Contents

What Is a Chemical Engineering Project?

A chemical engineering project is a structured investigation or design exercise where you:

- Define a problem or goal
- Research relevant science and engineering principles
- Develop a plan, model, or prototype
- Conduct experiments or simulations
- Analyze data and draw conclusions
- Document and present your findings

Projects can be academic (coursework, capstone), personal passion projects, or professional assignments (internships, industry). They bridge the gap between theory and practice, letting you apply classroom knowledge in real-world contexts.

Why Do Chemical Engineering Projects Matter?

1. **Deepen Understanding**
   Hands-on work solidifies concepts like mass transfer, thermodynamics, and reaction kinetics far more than lectures alone.
2. **Skill Development**
   You'll gain technical skills (e.g., process simulation, lab techniques) and soft skills (e.g., communication, teamwork).
3. **Portfolio Building**
   A strong project portfolio impresses recruiters and grad-school committees—proof that you can tackle real challenges.
4. **Innovation & Creativity**
   Projects let you explore novel ideas—whether it's a greener solvent or an efficient reactor design.
5. **Networking & Collaboration**
   Working with peers, advisors, or industry partners expands your professional circle.

Benefits of Doing Chemical Engineering Projects

Benefit	Why It Matters
Practical Experience	Companies value graduates who've "been in the lab."
Problem-Solving Skills	Real-world challenges rarely match textbook exercises.
Enhanced Resume & Portfolio	Demonstrates initiative and technical competence.
Confidence & Independence	Completing a project end-to-end builds self-reliance.
Publication & Presentation	Possibility to publish papers or present at conferences.

Benefit	Why It Matters
Interdisciplinary Exposure	Chemical engineering overlaps with biotech, energy, and materials.
Leadership & Teamwork	Large projects often involve group work—practice leading.

How to Choose the Best Project

Choosing the right project is crucial. Consider these factors:

1. **Interest & Passion**
   • Select a topic that excites you—whether it's renewable energy, pharmaceuticals, or food processing.
   • Genuine curiosity fuels motivation.
2. **Feasibility**
   • Assess time, budget, and resource constraints.
   • Check lab availability, equipment, and software licenses (e.g., MATLAB, Aspen HYSYS).
3. **Scope & Scale**
   • Avoid being too ambitious for your timeframe.
   • Define clear, achievable objectives.
4. **Relevance**
   • Align with current industry trends (e.g., carbon capture, bioplastics).
   • Consider market needs or academic gaps.
5. **Skill Development**
   • Choose projects that help you learn new tools or methods.
   • Balance between building on strengths and challenging yourself.
6. **Guidance & Mentorship**
   • Ensure you have access to an advisor or expert.
   • Regular feedback accelerates progress.

Top 299+ Chemical Engineering Project Ideas 2025-26

Reaction Engineering (1–30)

1. **Kinetics of Esterification Reaction**
   This project studies how temperature and catalyst amount affect the rate of making an ester by measuring product yield over time using a batch reactor.
2. **Modeling a Continuous Stirred Tank Reactor (CSTR)**
   You will build and simulate a CSTR to see how flow rate and reaction kinetics change conversion, using MATLAB or Python.
3. **Optimizing Plug Flow Reactor (PFR) Performance**
   This project compares plug flow and stirred reactors by measuring reactant conversion at different reactor lengths and flow speeds.
4. **Catalytic Decomposition of Hydrogen Peroxide**
   You'll test different catalysts (like manganese dioxide) to speed up H_2O_2 breakdown and measure oxygen evolution rate.
5. **Thermal Cracking of Hydrocarbons**
   Study how heating heavy oil in a tubular reactor breaks it into lighter products, analyzing gas chromatography outputs.

6. **Gas–Solid Reaction in a Packed Bed**
   Investigate how pellet size and gas flow affect conversion in a packed bed reactor with calcium carbonate and CO_2.
7. **Biofuel Production via Transesterification**
   Produce biodiesel from vegetable oil using a base catalyst, then measure methyl ester yield and purity.
8. **Photocatalytic Degradation of Dyes**
   Use titanium dioxide and UV light to break down water pollutants, measuring color removal over time.
9. **Hydrogen Production by Water–Gas Shift**
   Examine how temperature and gas ratio affect H_2 yield from CO and H_2O in a fixed-bed reactor.
10. **Oxidation of Sulfur Dioxide to Sulfur Trioxide**
    Simulate contact process kinetics and measure SO_3 formation under different catalyst and temperature conditions.
11. **Microwave-Assisted Organic Synthesis**
    Compare reaction times and yields using microwave heating versus conventional heating for a simple organic reaction.
12. **Transient Behavior of CSTR Start-Up**
    Monitor concentration changes when a CSTR is fed with reactant step-change, and compare to theoretical curves.
13. **Enzyme-Catalyzed Reaction in a Packed Bed**
    Immobilize lipase on beads and study how flow rate affects fatty acid conversion in a packed column.
14. **Hydrolysis of Sucrose Using Acid Catalyst**
    Measure rate of sucrose breakdown into glucose and fructose at various acid concentrations and temperatures.
15. **Selective Hydrogenation of Acetylene**
    Test Pd-Ag catalysts for turning acetylene into ethylene selectively, measuring by gas chromatography.
16. **Modeling Reactor Heat Transfer**
    Build a model of heat removal in an exothermic reactor and validate with simple lab data.
17. **Catalytic Cracking Using Zeolite**
    Study how zeolite type and temperature affect conversion of vacuum gas oil into gasoline fractions.
18. **Polymerization Kinetics in Batch Reactor**
    Measure monomer conversion and molecular weight growth over time for a free-radical polymerization.
19. **Gas-Liquid Reaction in Bubble Column**
    Investigate mass transfer coefficient by absorbing CO_2 into water in a bubble column reactor.
20. **Nitric Acid Production via Ostwald Process**
    Simulate ammonia oxidation kinetics and measure NO and NO_2 yields under varying conditions.
21. **Oxidation of Alcohols with $KMnO_4$**
    Measure how temperature and concentration affect rate of converting ethanol to acetic acid.
22. **Reaction Engineering with Supercritical CO_2**
    Study solubility and reaction rate of an organic reaction in supercritical CO_2 medium.
23. **High-Pressure Hydrogenation in Batch Reactor**
    Test how pressure influences hydrogenation rate of an unsaturated compound using a

Parr reactor.

24. **Catalyst Deactivation in Fixed-Bed Reactor**
    Monitor how sulfur poisoning reduces catalyst activity over time when converting syngas to methanol.
25. **Heterogeneous Catalysis in a Monolithic Reactor**
    Compare mass transfer and reaction rates in monolith vs. pellet catalysts for oxidation reactions.
26. **Modeling CO Oxidation on Platinum Surface**
    Use Langmuir–Hinshelwood kinetics to fit data from CO + O_2 reaction on Pt catalyst.
27. **Reaction Engineering of Fischer–Tropsch Synthesis**
    Study how temperature and H_2/CO ratio affect hydrocarbon chain length distribution.
28. **Continuous Polymerization in Tubular Reactor**
    Simulate residence time distribution and product molecular weight in a flow polymerization setup.
29. **Catalytic Transfer Hydrogenation**
    Use formic acid as hydrogen donor over Ru catalyst to hydrogenate nitrobenzene, measuring selectivity.
30. **Modeling Exothermic Reaction Runaway**
    Build a thermal safety model for an exothermic reaction and determine safe operating limits.

Separation Processes (31–60)

31. **Distillation Column Design for Ethanol–Water**
    Design and simulate a multi-stage distillation column to separate ethanol and water to 95% purity.
32. **Liquid–Liquid Extraction of Caffeine**
    Test how solvent choice (e.g., dichloromethane vs. ethyl acetate) affects extraction efficiency from tea.
33. **Membrane Separation of Saline Water**
    Study reverse osmosis membrane flux and salt rejection under different pressures and temperatures.
34. **Adsorption of Dyes on Activated Carbon**
    Measure how contact time and adsorbent dose affect dye removal from wastewater.
35. **Pressure Swing Adsorption for CO_2 Capture**
    Simulate a PSA cycle to capture CO_2 from flue gas, monitoring breakthrough curves.
36. **Supercritical Fluid Extraction of Essential Oils**
    Use supercritical CO_2 to extract oils from plant material, measuring yield at different pressures.
37. **Pervaporation for Alcohol–Water Separation**
    Test pervaporation membrane performance in separating water from isopropanol mixtures.
38. **Cryogenic Air Separation**
    Design a simple chart-based process to separate O_2 and N_2 by fractional distillation at low temperatures.
39. **Ultrafiltration of Protein Solutions**
    Study membrane fouling and flux decline when filtering bovine serum albumin solutions.
40. **Ion Exchange for Water Softening**
    Measure hardness reduction using Na^+-form resin, tracking exchange capacity over cycles.

41. **Foam Fractionation for Protein Purification**
Investigate how gas flow and surfactant affect protein recovery in a foam column.
42. **Vacuum Drying of Pharmaceuticals**
Measure drying rate of a heat-sensitive drug powder under different pressures and shelf temperatures.
43. **Hydrocyclone Separation of Solid Particles**
Test how feed pressure and cyclone geometry affect particle separation efficiency.
44. **Gas Absorption of SO_2 in Alkaline Solution**
Measure SO_2 removal from simulated flue gas using NaOH scrubber and track pH change.
45. **Electrodialysis for Desalination**
Build a lab-scale electrodialysis cell and measure salt removal at different voltages.
46. **Rotary Evaporation of Solvent Mixtures**
Study how bath temperature and vacuum level affect solvent removal rate.
47. **Molecular Sieve Separation of Water–Ethanol**
Test zeolite 3A performance to dehydrate ethanol, measuring water content by Karl Fischer titration.
48. **Simulated Moving Bed Chromatography**
Model separation of two compounds using SMB and validate with simple lab column runs.
49. **Packed Tower Gas Absorber for Ammonia**
Design and test a small packed column to remove NH_3 from air using acid solution.
50. **Photocatalytic Membrane Reactor**
Combine membrane separation and photocatalysis to degrade and remove organic pollutants.
51. **Rotating Disk Contactor for Liquid–Liquid Extraction**
Study mixing efficiency and mass transfer during solvent extraction in a rotating disk setup.
52. **Gas–Liquid Two-Phase Flow in Packed Bed**
Measure pressure drop and mass transfer when gas and liquid flow together through packing.
53. **Falling Film Evaporator for Brine Concentration**
Test film thickness and evaporation rate for concentrating salt solutions.
54. **Bubble Point Measurement of Binary Mixtures**
Determine bubble point curves of ethanol–water mixtures using a simple ebulliometer.
55. **Superfine Filtration of Colloidal Suspensions**
Study membrane cake build-up when filtering fine silica suspensions.
56. **Melt Crystallization of Benzoic Acid**
Investigate crystal size and purity as a function of cooling rate in a simple crystallizer.
57. **Spiral Wound Module Performance**
Compare flux and rejection in spiral RO vs. hollow fiber membranes for desalination.
58. **Thermal Swing Solvent Extraction**
Test how heating regenerates a solvent loaded with extracted solute in a two-phase system.
59. **Foaming Behavior in Distillation**
Study how different liquids create foam in a small distillation column and how antifoam helps.
60. **Agitated Thin-Film Dryer**
Measure drying rate and particle size change when drying wet granules in an ATFD.

Transport Phenomena (61–90)

61. **Laminar Flow Heat Transfer in a Pipe**
    Measure temperature profiles and calculate Nusselt number for water flow in a heated tube.
62. **Turbulent Flow Pressure Drop**
    Study how Reynolds number affects pressure loss in a pipe with rough and smooth surfaces.
63. **Natural Convection around a Vertical Plate**
    Measure heat transfer coefficient by heating a flat plate and recording air temperature.
64. **Mass Diffusion of Salt in Water**
    Monitor concentration spread in a tank to calculate diffusion coefficient of NaCl.
65. **Combined Convection–Diffusion in a Channel**
    Study how flow rate and diffusion interact by injecting a tracer dye in a water channel.
66. **Transient Heat Conduction in a Slab**
    Heat one side of a metal slab and record temperature versus time to fit Fourier's law.
67. **Rotating Cylinder Flow Visualization**
    Use dye to see flow patterns between concentric rotating cylinders and compare to theory.
68. **Packed Bed Void Fraction Measurement**
    Determine void fraction by measuring bed weight and volume of packing.
69. **Shell-and-Tube Heat Exchanger Efficiency**
    Build a small exchanger and measure inlet/outlet temperatures to calculate overall heat transfer coefficient.
70. **Falling Sphere Viscosity Measurement**
    Drop a ball in fluid and use terminal velocity to find viscosity via Stokes' law.
71. **Boundary Layer Thickness in Air Flow**
    Measure velocity profiles near a flat plate using a hot-wire anemometer.
72. **Hydrodynamics of Fluidized Bed**
    Observe minimum fluidization velocity for sand in an air column and relate to Ergun equation.
73. **Electroosmotic Flow in Microchannels**
    Measure fluid velocity when applying voltage across a microchannel surface.
74. **Evaporation from a Liquid Surface**
    Track mass loss of water in an open pan to calculate mass transfer coefficient.
75. **Mixed Convection over a Heated Cylinder**
    Record temperature and flow patterns around a heated cylinder in crossflow.
76. **Diffusion through a Porous Membrane**
    Measure how solute concentration changes across a porous barrier over time.
77. **Transient Flow in Pipelines**
    Simulate water hammer by rapidly closing a valve and record pressure surge.
78. **Non-Newtonian Flow in a Capillary**
    Study how a polymer solution's viscosity changes with shear rate in a narrow tube.
79. **Heat Pipe Thermal Performance**
    Build a simple heat pipe and measure effective thermal conductivity.
80. **Mass Transfer in a Spray Tower**
    Spray water into air and measure moisture content to find mass transfer coefficient.
81. **Thermocouple Calibration and Response Time**
    Heat a thermocouple in a step-change environment and record its time constant.
82. **Conduction in Composite Walls**
    Measure heat flux through layered materials and compare to theoretical resistance network.
83. **Taylor–Couette Instability Study**
    Observe flow patterns between rotating cylinders at different speeds and compare to

stability maps.

84. **Evaporative Cooling Efficiency**
Measure temperature drop of water in a wetted pad as air flows through.
85. **Lumped vs. Distributed Capacitance**
Heat small and large blocks and compare lumped-parameter model to detailed conduction solution.
86. **Bubble Growth Dynamics in Boiling**
Visualize and measure bubble size vs. time on a heated surface in boiling water.
87. **Transient Solute Transport in Packed Bed**
Pulse a tracer through packing and record breakthrough curve to find dispersion coefficient.
88. **Natural and Forced Convection Combined**
Heat a vertical tube in a crossflow and separate natural from forced convection contributions.
89. **Viscous Heating in High-Shear Mixer**
Measure temperature rise due to viscous dissipation in a rotor–stator mixer.
90. **Radiative Heat Transfer in Furnace Walls**
Build a small furnace and use thermocouples to separate convection from radiation losses.

Process Control & Instrumentation (91–120)

91. **PID Control of Liquid Level**
Implement a PID loop on a tank to keep liquid level constant despite disturbances.
92. **Temperature Control in a Jacketed Reactor**
Tune a control valve and PID to hold reactor temperature steady under varying heat input.
93. **Flow Control with Smart Valves**
Use a flow transmitter and control valve to maintain constant flow rate, logging performance.
94. **pH Control in Neutralization Process**
Add acid/base via PID to keep pH at setpoint during addition of reactive streams.
95. **Online Viscosity Measurement**
Use a rotational viscometer in a line and display real-time viscosity for quality control.
96. **Level Measurement with Ultrasonic Sensor**
Calibrate an ultrasonic level sensor on a tank and compare to float measurements.
97. **Conductivity Monitoring in Water Treatment**
Track conductivity as ions are removed, and use feedback to adjust dosing of resin.
98. **Gas Chromatography Process Monitoring**
Automate sampling and GC analysis to control a continuous reaction's feed ratio.
99. **DCS Simulation for Simple Process**
Build a distributed control simulation of mixing, heating, and level control in software.
100. **Soft Sensor Development for Concentration**
Use temperature and density data to infer solute concentration via regression model.
101. **Cascade Control for Distillation Column**
Implement inner flow control loop and outer level loop to stabilize bottom product level.
102. **Model Predictive Control of Heat Exchanger**
Use a dynamic model to predict outlet temperature and adjust flow rates proactively.
103. **Alarm Management in Control Systems**
Analyze alarm logs and redesign alarm setpoints to reduce nuisance alerts.

104. **Wireless Sensor Network in Plant**
Deploy wireless transmitters for temperature and pressure and evaluate data reliability.
105. **Smart Actuator Performance Testing**
Compare response time and hysteresis between pneumatic and electric control valves.
106. **PID Tuning Methods Comparison**
Test Ziegler–Nichols, Cohen–Coon, and trial-and-error for level control and compare overshoot.
107. **Safety Instrumented Systems (SIS) Design**
Design a simple SIS to shut down a reactor if temperature exceeds safe limit.
108. **Control of pH Swing Adsorption**
Adjust pH to load and unload adsorbent in a cyclic process and monitor breakthrough.
109. **Dynamic Modeling of a Heat Exchanger**
Develop and validate a transfer function model for a shell-and-tube exchanger.
110. **Neural Network Control for Nonlinear Process**
Train a basic neural controller to regulate temperature in a highly nonlinear reactor.
111. **Fault Detection in Control Loops**
Introduce faults (e.g., sensor drift) in a level control loop and detect them using residuals.
112. **Human–Machine Interface (HMI) Design**
Create a clear HMI screen for a mixing process, focusing on usability and alarms.
113. **Control of Crystallization Process**
Use temperature and supersaturation control to maintain crystal size distribution.
114. **Multivariable Control of Distillation**
Coordinate reflux and boil-up controls using decoupling techniques.
115. **Dynamic Simulation of Batch Process**
Model batch heating, reaction, and cooling steps in a control simulator.
116. **Advanced Process Control with Fuzzy Logic**
Design a fuzzy logic controller for a temperature-control loop and compare to PID.
117. **Flowmeter Calibration and Linearity**
Calibrate orifice plate, turbine, and Coriolis meters and plot calibration curves.
118. **Control Valve Characterization**
Test valve flow coefficient (Cv) vs. stem position and derive valve equation.
119. **Alarm Prioritization Study**
Classify alarms by risk and frequency, then propose priority scheme for operators.
120. **Digital Twin for Simple Process Unit**
Build a real-time model twin of a reactor using sensor data and validate predictions.

Environmental & Sustainable Engineering (121–160)

121. **Photocatalytic Water Purification**
Use TiO_2 under sunlight to break down organic pollutants, measuring COD removal.
122. **Bioreactor for Wastewater Treatment**
Build a small aerobic bioreactor and monitor BOD removal with varying retention times.
123. **Adsorption of Heavy Metals on Biochar**
Test rice husk biochar for Pb^{2+} and Cd^{2+} removal from water, measuring adsorption isotherms.
124. **Algal Biofuel Production in Open Ponds**
Grow microalgae on wastewater and extract lipids, measuring growth rate and oil yield.

125. **Constructed Wetland Design**
Simulate a small wetland cell to remove nutrients from agricultural runoff and track TN and TP.
126. **Anaerobic Digestion of Food Waste**
Measure biogas yield and methane content from kitchen waste in a lab digester.
127. **Electrocoagulation for Turbidity Removal**
Use iron electrodes to remove suspended solids, measuring turbidity decline over time.
128. **Solar Still for Purifying Brackish Water**
Build a simple solar still and measure fresh water output under different insolation.
129. **Constructing a Small-Scale Biogas Plant**
Design and test an upflow anaerobic sludge blanket (UASB) reactor for biogas production.
130. **Carbon Capture with Amine Solutions**
Study CO_2 absorption in MEA scrubber and measure energy needed for regeneration.
131. **Green Synthesis of Nanoparticles**
Use plant extracts to produce silver nanoparticles and test antibacterial activity.
132. **Life-Cycle Analysis of a Process**
Compare environmental impacts of two routes to produce a common chemical, using LCA software.
133. **Run-of-River Microhydro Power Plant Design**
Estimate power output and environmental impact for a small river site.
134. **Electrochemical Removal of Nitrates**
Use a lab cell to reduce nitrates to nitrogen gas and measure efficiency vs. current.
135. **Membrane Bioreactor for Sewage Treatment**
Combine activated sludge and membrane filtration, monitoring flux and effluent quality.
136. **Photovoltaic-Thermal Hybrid Collector**
Build a small PVT panel and measure electrical and thermal efficiencies concurrently.
137. **Green Solvent Screening for Organic Reactions**
Compare toxicity and performance of traditional vs. bio-based solvents in a simple synthesis.
138. **Urban Air Quality Monitoring Network**
Deploy low-cost sensors for $PM_{2.5}$ and NO_2, logging data and mapping pollution hotspots.
139. **Zero-Liquid Discharge System Design**
Integrate evaporation, crystallization, and recycling to eliminate wastewater from a process.
140. **Biodegradation of Plastics by Enzymes**
Test enzyme blends on PET samples and measure weight loss over time.
141. **Solar-Powered Desalination Using CPC**
Build a compound parabolic collector still and measure freshwater output under sun.
142. **Green Ammonia Synthesis via Electrolysis**
Produce H_2 by water electrolysis and combine with air in a small Haber reactor, measuring NH_3 yield.
143. **Life Cycle Water Footprint Analysis**
Calculate water usage of bottled water vs. tap, including production and transport stages.
144. **Biofilter for Volatile Organic Compounds**
Pack a column with compost and pass VOC-laden air, measuring removal efficiency.
145. **Sustainable Cement Alternatives**
Test fly ash and slag blends for strength, comparing to ordinary Portland cement.

146. **Algal Removal of Heavy Metals**
Grow algae in metal-contaminated water and measure metal uptake per biomass.
147. **Rainwater Harvesting System Design**
Size roof catchment and storage for household use, analyzing water savings.
148. **Electrochemical Oxidation of Organic Pollutants**
Use BDD electrodes to degrade phenolic compounds, measuring TOC decline.
149. **Greenhouse Gas Emission Audit**
Perform an audit for a small plant to quantify CO_2, CH_4, and N_2O outputs and propose reduction steps.
150. **Solar Thermal Energy Storage**
Test phase-change materials for storing heat from a solar collector and monitor melting/freezing cycles.
151. **Microbial Fuel Cell for Wastewater**
Build a single-chamber MFC and measure voltage and power density from real wastewater.
152. **Biochar-Amended Constructed Wetland**
Add biochar to wetland soil and compare nutrient removal to a standard wetland.
153. **Photovoltaic-Powered Electrocoagulation**
Drive an electrocoagulation cell with PV panels to remove turbidity, measuring energy use.
154. **Solar Drying of Agricultural Products**
Build a solar dryer for fruits, tracking drying rate and final moisture content.
155. **Anaerobic Membrane Bioreactor**
Combine anaerobic digestion and membrane separation, monitoring biogas yield and permeate quality.
156. **Wet Scrubber Design for SO_2**
Test different packing materials for removing SO_2 from gas stream, measuring removal percent.
157. **Conducting Polymers for Environmental Sensing**
Fabricate a PEDOT sensor for detecting heavy metals, calibrating sensitivity and selectivity.
158. **Solar-Driven Photoelectrocatalysis**
Use a dye-sensitized electrode under sunlight to remove dyes from water, tracking degradation.
159. **Green Production of Hydrogen Peroxide**
Explore electrochemical routes to make H_2O_2 directly from O_2 in a flow cell, measuring concentration.
160. **Carbon Nanotube Adsorbents for VOCs**
Test CNT powder for benzene removal from air, measuring breakthrough time and capacity.

Biochemical & Food Process Engineering (161–200)

161. **Fermentation Optimization for Ethanol**
Use yeast strains to ferment sugarcane juice, varying pH and temperature to maximize yield.
162. **Enzymatic Synthesis of Invert Sugar**
Use immobilized invertase to convert sucrose to glucose/fructose, measuring conversion over time.
163. **Spray Drying of Probiotic Cultures**
Test inlet/outlet temperatures for best cell survival and powder yield.

164. **Microencapsulation of Flavors**
Encapsulate vanilla in whey protein, studying capsule size and release rate in water.
165. **High-Pressure Processing of Fruit Juice**
Measure microbial inactivation and nutrient retention under different pressures.
166. **Ultrasound-Assisted Extraction of Antioxidants**
Use sonication to extract polyphenols from fruit peels, comparing yield to conventional methods.
167. **Continuous Cultivation of Algae for Omega-3**
Grow microalgae in a photobioreactor, optimizing light and nutrient feed for fatty acid production.
168. **Osmotic Dehydration of Fruits**
Soak mango slices in sugar solution, then measure water removal and solid gain kinetics.
169. **Membrane Filtration for Milk Clarification**
Use micro- and ultrafiltration to remove fat and proteins, monitoring flux decline.
170. **Bioplastic Production from Starch**
Produce PLA from corn starch via fermentation and polymerization, testing tensile strength.
171. **Biosensor for Glucose Detection**
Fabricate an enzyme electrode with glucose oxidase and measure response time and sensitivity.
172. **Continuous Beer Fermentation**
Model and run a chemostat for beer fermentation, monitoring alcohol concentration and biomass.
173. **Enzyme Immobilization on Magnetic Nanoparticles**
Attach lipase to particles, test activity and reusability in oil hydrolysis.
174. **High-Shear Emulsification of Dressings**
Use rotor–stator mixer to make stable oil-in-water emulsions, measuring droplet size.
175. **Supercritical CO_2 Extraction of Caffeine**
Extract caffeine from coffee beans, comparing yield to Soxhlet extraction.
176. **Biopolymer Films from Chitosan**
Cast chitosan films with glycerol plasticizer, testing mechanical and barrier properties.
177. **Continuous Cheese Production Modeling**
Simulate coagulation, curd cutting, and drainage in a continuous cheesemaking line.
178. **Lactic Acid Fermentation Kinetics**
Study Lactobacillus growth and lactic acid production from lactose at different pH.
179. **Vacuum Frying of Potato Chips**
Compare oil uptake and crispiness at reduced pressure versus atmospheric frying.
180. **Ultrasonic Sterilization of Liquid Foods**
Use high-power ultrasound to inactivate microbes in milk, measuring microbial count and nutrients.
181. **Encapsulation of Probiotics by Freeze Drying**
Freeze-dry probiotic cultures with protectants and test viability after storage.
182. **Enzymatic Clarification of Fruit Juices**
Use pectinase to reduce viscosity, measuring turbidity and juice yield.
183. **Continuous Spray Chilling of Chocolate**
Model and test cooling of chocolate droplets in a spray chamber to form shells.
184. **Antimicrobial Packaging Films**
Incorporate silver nanoparticles into biopolymer film and test against E. coli and S. aureus.
185. **Microbial Fuel Cell with Wastewater Feed**
Build an MFC using grape juice waste and measure power density and COD removal.

186. **Fermentation of Soy Milk to Yogurt**
Compare classic and probiotic cultures for texture and acidity development.
187. **Cold Plasma Treatment of Grains**
Treat wheat with plasma to reduce microbial load and measure germination rate post-treatment.
188. **3D-Printed Food Structures**
Use paste extrusion to print sugar structures and study rheology needed for stability.
189. **Edible Coatings for Fruit Preservation**
Apply chitosan-based coating to strawberries and track shelf life and weight loss.
190. **Photobioreactor Design for Spirulina**
Model light distribution and mixing in a tubular PBR for high algae productivity.
191. **Continuous Microfiltration of Juice**
Run continuous MF and monitor fouling rates and juice clarity over time.
192. **Ultrafiltration of Whey Proteins**
Separate whey proteins from lactose using UF, measuring protein rejection and flux.
193. **Supercritical Fluid Microencapsulation**
Encapsulate fish oil in polymer using SCF, then test particle size and oxidation stability.
194. **High-Pressure Homogenization of Emulsions**
Study droplet size reduction of oil emulsions at different pressures and passes.
195. **Biosurfactant Production by Bacteria**
Grow Pseudomonas on waste oil and measure rhamnolipid yield and surface tension reduction.
196. **Probiotic Drying by Fluidized Bed**
Dry probiotic beads in a fluidized bed, comparing viability to freeze drying.
197. **Continuous Extraction of Plant Oils**
Use counter-current extraction in a lab column, measuring oil concentration profiles.
198. **Light-Driven Enzymatic Reactions**
Couple a photoreactor with enzyme catalysts to drive reactions using visible light.
199. **Scale-Down Model of Food Pasteurization**
Build a small-scale HTST unit, measuring microbial kill and nutrient retention.
200. **Biorefinery Simulation in Aspen Plus**
Model a full biorefinery converting biomass to fuels and chemicals, optimizing energy use.

Computational & Modeling (201–220)

201. **Dynamic Simulation of Distillation Startup**
Objective: Predict vapor–liquid profiles during column startup. Methodology: Build a dynamic model in Aspen HYSYS and run time-based simulations. Expected Outcome: Time to reach steady state and control settings. Equipment: Computer with process simulation software.
202. **CFD Analysis of Mixing in a Stirred Tank**
Objective: Visualize flow patterns and mixing time. Methodology: Create a 3D tank model in ANSYS Fluent and simulate at different impeller speeds. Expected Outcome: Velocity contours and mixing efficiency. Equipment: CFD software and workstation.
203. **Process Optimization using Genetic Algorithms**
Objective: Optimize reaction yield and energy use. Methodology: Define decision variables in MATLAB, run GA optimization with process model. Expected Outcome: Optimal operating conditions and yield improvement. Equipment: MATLAB with Optimization Toolbox.
204. **Heat Exchanger Network Synthesis**
Objective: Minimize utility consumption in a plant. Methodology: Use pinch analysis

and MILP solver in Excel or Python. Expected Outcome: Heat integration network and energy savings. Equipment: Spreadsheet software, Python.

205. **Risk Analysis with Monte Carlo Simulation**
Objective: Quantify uncertainty in process outputs. Methodology: Model key variables in Python and run Monte Carlo trials. Expected Outcome: Probability distributions for product purity and cost. Equipment: Python with NumPy.
206. **Virtual Plant Design in Digital Twin**
Objective: Mirror a lab reactor in real time. Methodology: Link sensor data to a simulation model in MATLAB/Simulink. Expected Outcome: Real-time prediction of temperatures and concentrations. Equipment: Data acquisition hardware, MATLAB.
207. **Machine Learning for Yield Prediction**
Objective: Predict product yield from raw data. Methodology: Train regression models (e.g., random forest) on historical batch data. Expected Outcome: A model with >90% prediction accuracy. Equipment: Python with scikit-learn.
208. **Neural Network Modeling of CSTR**
Objective: Capture nonlinear reactor dynamics. Methodology: Collect input–output data and train an ANN in TensorFlow. Expected Outcome: Neural model predicting concentration vs. time. Equipment: Python, TensorFlow.
209. **Optimization of Membrane Process Parameters**
Objective: Maximize flux and rejection. Methodology: Use response surface methodology in Design-Expert or Python. Expected Outcome: Optimal pressure and temperature settings. Equipment: Statistical software.
210. **Economic Evaluation of Biorefinery**
Objective: Assess profitability of biomass-to-fuel plant. Methodology: Build cash-flow model in Excel, run sensitivity analysis. Expected Outcome: Net present value and payback period. Equipment: Spreadsheet software.
211. **Simulation of Reactive Distillation**
Objective: Combine reaction and separation in one column. Methodology: Model reactive stages in Aspen Plus with RStoic reactors. Expected Outcome: Conversion, purity, and energy use. Equipment: Aspen Plus.
212. **Data-Driven Fault Detection**
Objective: Detect process faults early. Methodology: Apply PCA on sensor data in Python to find anomalies. Expected Outcome: Alarm threshold settings and fault classification accuracy. Equipment: Python with data libraries.
213. **Computational Screening of Ionic Liquids**
Objective: Find best IL for CO_2 capture. Methodology: Use COSMO-RS in TURBOMOLE to predict solubility. Expected Outcome: Ranking of IL candidates by capacity. Equipment: Quantum chemistry software.
214. **Multi-Objective Optimization of Reactor**
Objective: Balance yield and selectivity. Methodology: Use NSGA-II algorithm in MATLAB to optimize temperature and catalyst load. Expected Outcome: Pareto front of optimal solutions. Equipment: MATLAB.
215. **Dynamic Modeling of Batch Crystallization**
Objective: Predict crystal size distribution over time. Methodology: Develop population balance model in MATLAB/Simulink. Expected Outcome: Time-based crystal size predictions. Equipment: MATLAB.
216. **Process Control Loop Tuning via Virtual Commissioning**
Objective: Tune PID without plant trials. Methodology: Simulate control loops in a digital twin and apply tuning rules. Expected Outcome: PID parameters ready for implementation. Equipment: Simulink.
217. **Sensitivity Analysis of Gas–Liquid Reactor**
Objective: Identify key parameters affecting conversion. Methodology: Vary

parameters in simulation and plot sensitivity indices in Python. Expected Outcome: Ranking of impactful variables. Equipment: Python.

218. **Machine Vision for Foam Detection**
Objective: Automatically detect foam in reactors. Methodology: Train image classifier using OpenCV and Keras on camera images. Expected Outcome: Real-time foam alarms. Equipment: Camera, Python.
219. **Simulation of CO_2 Transport in Pipelines**
Objective: Predict pressure drop and phase behavior. Methodology: Use pipeline module in OLGA or custom code. Expected Outcome: Safe operating window and pressure profiles. Equipment: Pipeline simulation software.
220. **Digital Optimization of Batch Plant Scheduling**
Objective: Minimize idle time and changeover cost. Methodology: Formulate MILP in Python (PuLP) and solve for scheduling. Expected Outcome: Optimized batch schedule and cost savings. Equipment: Python with optimization libraries.

Polymers & Materials (221–240)

221. **Synthesis of Conductive Polymer Composites**
Objective: Make plastics that conduct electricity. Methodology: Mix polyaniline with epoxy resin and cure, then test conductivity. Expected Outcome: Composite with specified resistivity. Equipment: Oven, multimeter.
222. **Mechanical Testing of 3D-Printed Polymers**
Objective: Measure strength of printed parts. Methodology: Print test bars in PLA, perform tensile tests on UTM. Expected Outcome: Stress–strain curves and tensile strength. Equipment: 3D printer, UTM.
223. **Thermal Analysis of Polymer Blends**
Objective: Understand melting and glass transitions. Methodology: Run DSC scans on mixed polymers at different ratios. Expected Outcome: Tg and Tm values vs. blend composition. Equipment: DSC instrument.
224. **Chemical Resistance of Coatings**
Objective: Test protective paint against acids. Methodology: Apply coating, expose to acid bath, measure weight loss. Expected Outcome: Coating life and degradation rate. Equipment: Balance, acid solutions.
225. **Nanoclay Reinforced Polymer Films**
Objective: Improve barrier properties. Methodology: Disperse nanoclay in PE resin, cast films, test gas permeability. Expected Outcome: Permeability reduction percentage. Equipment: Film casting unit, permeability tester.
226. **Biodegradation of Polymer Samples**
Objective: Measure how fast plastics break down. Methodology: Bury samples in compost, periodically measure weight loss. Expected Outcome: Degradation curve over weeks. Equipment: Scale, compost bin.
227. **Rheology of Polymer Melts**
Objective: Study flow behavior under shear. Methodology: Use capillary rheometer on molten polymer at various shear rates. Expected Outcome: Viscosity vs. shear rate plot. Equipment: Rheometer.
228. **Electrospinning of Nanofibers**
Objective: Create ultra-thin fibers. Methodology: Prepare polymer solution, electrospin at set voltage, collect fibers, view under SEM. Expected Outcome: Fiber diameter distribution. Equipment: Electrospinning setup.
229. **Thermal Conductivity of Composite Panels**
Objective: Measure heat transfer in sandwich panels. Methodology: Use guarded hot

plate on layered materials. Expected Outcome: Overall thermal conductivity. Equipment: Hot plate apparatus.

230. **Self-Healing Polymer Testing**
Objective: Evaluate healing ability. Methodology: Scratch polymer sample, heat to activate microcapsules, measure restored strength. Expected Outcome: Percentage of strength recovery. Equipment: Oven, UTM.
231. **Synthesis of UV-Curable Resins**
Objective: Make fast-curing coatings. Methodology: Mix acrylate monomers with photoinitiator, expose to UV, test hardness. Expected Outcome: Curing time and film hardness. Equipment: UV lamp, hardness tester.
232. **Fire Retardant Polymer Composites**
Objective: Lower flammability of plastics. Methodology: Add flame retardant additives, perform UL-94 tests. Expected Outcome: Flammability rating improvement. Equipment: Flammability tester.
233. **Dielectric Properties of Polymer Films**
Objective: Measure insulation ability. Methodology: Apply AC voltage across film, measure capacitance and loss tangent. Expected Outcome: Dielectric constant vs. frequency. Equipment: LCR meter.
234. **Hydrogel Synthesis for Drug Delivery**
Objective: Create water-swollen networks. Methodology: Crosslink polyvinyl alcohol, load dye as drug model, measure release kinetics. Expected Outcome: Release profile vs. time. Equipment: UV–Vis spectrophotometer.
235. **Magnetic Polymer Beads for Separation**
Objective: Make beads that can be magnetically separated. Methodology: Embed iron oxide in polymer matrix, test separation in magnetic field. Expected Outcome: Separation efficiency. Equipment: Magnet, balance.
236. **Surface Modification of Polypropylene**
Objective: Improve adhesion properties. Methodology: Treat PP sheets with corona discharge, measure contact angle. Expected Outcome: Wettability change data. Equipment: Contact angle goniometer.
237. **Barrier Films from Biopolymers**
Objective: Make eco-friendly packaging. Methodology: Cast films from chitosan–glycerol mix, test oxygen permeability. Expected Outcome: Barrier performance vs. plastic. Equipment: Permeation tester.
238. **Nanocomposite Mechanical Behavior under Impact**
Objective: Test impact resistance. Methodology: Embed graphene in epoxy, perform Izod impact tests. Expected Outcome: Energy absorbed at break. Equipment: Impact tester.
239. **Polymer Electrolytes for Batteries**
Objective: Create solid-state ion conductors. Methodology: Blend PEO with Li-salt, measure ionic conductivity via EIS. Expected Outcome: Conductivity vs. temperature. Equipment: Potentiostat.
240. **3D Printing of Functional Ceramics**
Objective: Print ceramic parts with fine features. Methodology: Use slurry-based printer, sinter parts, test hardness. Expected Outcome: Dimensional accuracy and strength. Equipment: 3D printer, furnace.

Process Safety & Economics (241–260)

241. **Hazard Identification with HAZOP**
Objective: Find potential process hazards. Methodology: Conduct HAZOP study on a

small plant, document guideword deviations. Expected Outcome: List of hazards and safeguards. Equipment: Piping & instrumentation diagrams.

242. **Layer of Protection Analysis (LOPA)**
Objective: Quantify risk in high-pressure reactor. Methodology: Identify scenarios and assign probability reduction factors. Expected Outcome: Risk graphs and required protection layers. Equipment: Risk analysis software or spreadsheets.
243. **Safety Relief Valve Sizing**
Objective: Protect vessel from overpressure. Methodology: Calculate required orifice size using API formulas. Expected Outcome: Valve spec sheet. Equipment: Calculator, API standards.
244. **Economic Analysis of Solvent Recovery**
Objective: Determine payback for a recovery unit. Methodology: Compare capital and operating costs vs. solvent purchase cost in Excel. Expected Outcome: NPV and ROI numbers. Equipment: Spreadsheet software.
245. **Dispersion of Toxic Gas Release**
Objective: Model worst-case scenario for accidental leak. Methodology: Use Gaussian plume model in MATLAB. Expected Outcome: Concentration contours and hazard zones. Equipment: MATLAB.
246. **Safety Audit of Lab Processes**
Objective: Improve lab safety culture. Methodology: Use checklist to audit procedures, interview staff, and recommend changes. Expected Outcome: Audit report with action items. Equipment: Audit templates.
247. **Fire and Explosion Risk Assessment**
Objective: Evaluate flammable dust hazard. Methodology: Perform dust explosion testing and assess KSt value. Expected Outcome: Safe handling guidelines. Equipment: Dust explosion tester.
248. **Economic Sizing of Storage Tanks**
Objective: Minimize tank cost and footprint. Methodology: Optimize diameter and height in Excel cost model. Expected Outcome: Cost vs. capacity curve. Equipment: Spreadsheet.
249. **Evaluation of Emergency Venting**
Objective: Design vent system for compressor. Methodology: Calculate vent rate for relief scenarios per API 521. Expected Outcome: Vent stack and SDV specifications. Equipment: API standards.
250. **Cost–Benefit Analysis of Energy Retrofit**
Objective: Justify installing waste heat recovery. Methodology: Compare fuel savings to capital cost, compute payback. Expected Outcome: Energy and cost savings report. Equipment: Excel.
251. **Blast Overpressure Modeling**
Objective: Predict structural damage from vessel rupture. Methodology: Use TNT equivalence in MATLAB to find overpressure vs. distance. Expected Outcome: Safe distance guidelines. Equipment: MATLAB.
252. **Quantitative Risk Assessment of Mixing Operation**
Objective: Assess inhalation risk. Methodology: Compute exposure levels with PPE vs. without. Expected Outcome: Risk curves and PPE recommendations. Equipment: Exposure modeling spreadsheet.
253. **Economic Optimization of Batch Scheduling**
Objective: Reduce changeover losses. Methodology: Model scheduling cost in Python, optimize sequence. Expected Outcome: Schedule with minimal downtime. Equipment: Python with optimization libraries.
254. **Safety Instrumented System SIL Verification**
Objective: Ensure control system meets SIL requirements. Methodology: Evaluate

PFDavg using reliability data. Expected Outcome: SIL level confirmation. Equipment: Reliability block diagram tool.

255. **Cost Estimation for Pilot Plant**
Objective: Budget for a small demonstration unit. Methodology: Scale down costs from literature using factorial method. Expected Outcome: CAPEX and OPEX estimates. Equipment: Cost correlation formulas.
256. **Analysis of Utility Distribution Network**
Objective: Prevent overloading of steam lines. Methodology: Map pressure drops and load profiles in software. Expected Outcome: Network modification plan. Equipment: Piping simulation tool.
257. **Human Reliability Analysis**
Objective: Quantify operator error probability. Methodology: Use THERP method on a control procedure. Expected Outcome: HEP values and training needs. Equipment: HRA guidelines.
258. **Economic Impact of Catalyst Deactivation**
Objective: Calculate loss due to downtime. Methodology: Model catalyst life vs. replacement cost and production loss in Excel. Expected Outcome: Optimal replacement interval. Equipment: Spreadsheet.
259. **Modelling Flooding in Packed Towers**
Objective: Prevent operational shutdowns. Methodology: Use empirical correlations to predict flooding velocity. Expected Outcome: Safe gas–liquid flow rates. Equipment: Calculator or spreadsheet.
260. **Firewater Demand Calculation**
Objective: Size firewater pumps for a plant. Methodology: Sum hydrant and sprinkler demands per NFPA guidelines. Expected Outcome: Pump capacity specifications. Equipment: NFPA standards.

Nanotechnology & Advanced Materials (261–280)

261. **Synthesis of Gold Nanoparticles by Citrate Reduction**
Objective: Produce uniform gold NPs. Methodology: Heat $HAuCl_4$ solution, add citrate, monitor SPR by UV–Vis. Expected Outcome: Particle size vs. peak wavelength. Equipment: UV–Vis spectrometer.
262. **Characterization of Graphene Oxide**
Objective: Analyze GO sheets. Methodology: Prepare GO via Hummers' method, examine by XRD and TEM. Expected Outcome: Layer count and interlayer spacing. Equipment: XRD, TEM.
263. **Carbon Nanotube Reinforced Composites**
Objective: Improve mechanical strength. Methodology: Disperse CNTs in epoxy, cure, test tensile strength. Expected Outcome: Strength increase percentage. Equipment: UTM, sonicator.
264. **Photonic Crystal Fabrication**
Objective: Make materials with bandgaps for light. Methodology: Self-assemble colloidal silica spheres and sinter. Expected Outcome: Reflectance spectra showing stop band. Equipment: UV–Vis.
265. **Self-Assembled Monolayers on Metal Surfaces**
Objective: Modify surface chemistry. Methodology: Immerse gold in thiol solution, measure contact angle. Expected Outcome: Wettability change. Equipment: Goniometer.
266. **Nanoporous Catalysts for CO Oxidation**
Objective: Enhance catalytic activity. Methodology: Synthesize mesoporous silica with

embedded Pt, test conversion in flow reactor. Expected Outcome: CO conversion vs. temperature. Equipment: Flow reactor, GC.

267. **Magnetic Nanoparticles for Drug Delivery**
Objective: Control release with magnets. Methodology: Load drug on Fe_3O_4 NPs, apply magnetic field, measure release by UV–Vis. Expected Outcome: Release profile modulation. Equipment: Magnet, spectrophotometer.
268. **Quantum Dot Synthesis and Optical Study**
Objective: Create luminescent QDs. Methodology: Hot-injection method for CdSe QDs, record PL spectra. Expected Outcome: Emission wavelength vs. size. Equipment: Fluorimeter.
269. **Layered Double Hydroxide for Anion Exchange**
Objective: Remove nitrates from water. Methodology: Synthesize LDH, batch adsorption tests, measure residual NO_3^- by ion chromatography. Expected Outcome: Adsorption isotherms. Equipment: IC instrument.
270. **Piezoelectric Nanogenerator Fabrication**
Objective: Harvest mechanical energy. Methodology: Electrospin PVDF nanofibers, apply cyclic stress, measure voltage. Expected Outcome: Voltage output vs. force. Equipment: Oscilloscope.
271. **Nanoplasmonic Sensor for Mercury Detection**
Objective: Detect trace Hg^{2+} in water. Methodology: Functionalize gold nanoshells, monitor LSPR shift by UV–Vis. Expected Outcome: Calibration curve for Hg^{2+}. Equipment: UV–Vis spectrometer.
272. **Synthesis of Zeolite Nanoparticles**
Objective: Make small zeolite crystals. Methodology: Hydrothermal synthesis at controlled temperature, analyze by SEM. Expected Outcome: Particle morphology and size. Equipment: Autoclave, SEM.
273. **Nanofluid Thermal Conductivity Measurement**
Objective: Improve coolant performance. Methodology: Disperse Al_2O_3 NPs in water, measure conductivity with transient hot-wire. Expected Outcome: Conductivity vs. concentration. Equipment: Hot-wire apparatus.
274. **Block Copolymer Micelle Formation**
Objective: Study self-assembly. Methodology: Dissolve PS–PEO in solvent, observe micelles by DLS. Expected Outcome: Micelle size distribution. Equipment: DLS instrument.
275. **Nanostructured TiO_2 for Photocatalysis**
Objective: Degrade organic dye under UV. Methodology: Synthesize P25, run degradation tests with Rhodamine B, track by UV–Vis. Expected Outcome: Degradation rate constant. Equipment: UV–Vis.
276. **Graphene Aerogel for Oil Spill Cleanup**
Objective: Absorb oil selectively. Methodology: Freeze-dry GO hydrogel, test oil uptake capacity. Expected Outcome: g oil/g aerogel capacity. Equipment: Freeze dryer.
277. **Nanoceria as Antioxidant in Cells**
Objective: Protect cells from ROS. Methodology: Expose cultured cells to H_2O_2 with/without CeO_2 NPs, assay viability. Expected Outcome: Cell survival rate. Equipment: Cell culture lab, viability assay kit.
278. **Superhydrophobic Coating Development**
Objective: Create water-repellent surfaces. Methodology: Spray silica–fluoroalkyl silane mix on glass, measure contact angle. Expected Outcome: $\theta > 150°$. Equipment: Goniometer.
279. **Conductive Ink from Silver Nanowires**
Objective: Print flexible circuits. Methodology: Disperse Ag NWs in solvent, print on

PET, sinter at low temperature, test conductivity. Expected Outcome: Sheet resistance vs. sintering temp. Equipment: Printer, multimeter.

280. **Nanostructured Electrode for Lithium-Ion Batteries**
Objective: Improve capacity and cycle life. Methodology: Coat Si NPs on Cu foil, assemble coin cell, run charge–discharge cycles. Expected Outcome: Capacity retention over cycles. Equipment: Glovebox, battery tester.

Energy & Fuels (281–300)

281. **Methane Steam Reforming Kinetics**
Objective: Measure H_2 production rate. Methodology: Pass CH_4+H_2O over Ni catalyst in tubular reactor, analyze outlet by GC. Expected Outcome: Reaction rate vs. temperature. Equipment: GC, tubular reactor.
282. **Solid Oxide Fuel Cell Performance**
Objective: Test power output. Methodology: Fabricate SOFC cell, supply H_2 and air, record V–I curve. Expected Outcome: Peak power density. Equipment: Fuel cell test station.
283. **Bioethanol Production from Cellulose**
Objective: Convert biomass to ethanol. Methodology: Pretreat lignocellulose, enzymatic hydrolysis, ferment sugar, distill product. Expected Outcome: Ethanol yield per kg biomass. Equipment: Distillation setup.
284. **Oxy-Fuel Combustion for CO_2 Capture**
Objective: Study flue gas composition. Methodology: Burn fuel with O_2 in small furnace, analyze CO_2 and O_2 levels. Expected Outcome: Flue gas concentration and heat release. Equipment: Gas analyzer.
285. **Thermochemical Water Splitting**
Objective: Produce H_2 using heat. Methodology: Cycle metal oxide in reactor under concentrated solar simulator, measure H_2 evolution. Expected Outcome: H_2 yield per cycle. Equipment: Solar simulator.
286. **Pyrolysis of Plastic Waste**
Objective: Convert plastics to fuel oil. Methodology: Heat mixed plastic in batch pyrolyzer under N_2, collect condensate, analyze by GC–MS. Expected Outcome: Oil yield and composition. Equipment: Pyrolyzer, GC–MS.
287. **Fuel Cell–Battery Hybrid System Modeling**
Objective: Optimize power management. Methodology: Build dynamic model in MATLAB/Simulink, simulate load profiles. Expected Outcome: State-of-charge and efficiency plots. Equipment: MATLAB.
288. **Photovoltaic Module Performance Under Dust**
Objective: Measure power loss from soiling. Methodology: Expose PV panels to dust for set periods, measure I–V curves. Expected Outcome: Efficiency drop vs. dust thickness. Equipment: I–V tracer.
289. **Hydrogen Storage in Metal Hydrides**
Objective: Test absorption capacity. Methodology: Expose $LaNi_5$ alloy to H_2 at pressure, measure uptake by pressure drop. Expected Outcome: H_2 storage wt%. Equipment: Sieverts apparatus.
290. **Algal Bioreactor for Biodiesel**
Objective: Grow microalgae for oil. Methodology: Run tubular PBR under controlled light, harvest biomass, extract lipids. Expected Outcome: Lipid productivity (mg/L·day). Equipment: Photobioreactor.
291. **Microchannel Reactor for Fischer–Tropsch**
Objective: Improve CO conversion. Methodology: Fabricate microreactor with Co

catalyst, run syngas, measure hydrocarbons by GC. Expected Outcome: Conversion and selectivity data. Equipment: Microreactor setup.

292. **Thermal Energy Storage with Molten Salt**
Objective: Store solar heat. Methodology: Heat salt mixture in lab tank, record temperature vs. time during charging/discharging. Expected Outcome: Storage efficiency. Equipment: Furnace, thermocouples.
293. **Catalytic Pyrolysis of Biomass**
Objective: Enhance bio-oil quality. Methodology: Mix biomass with zeolite, pyrolyze, analyze oil acidity and composition. Expected Outcome: Reduced oxygen content. Equipment: Pyrolyzer, GC–MS.
294. **Electrochemical CO_2 Reduction**
Objective: Convert CO_2 to value-added chemicals. Methodology: Use Cu electrode in electrochemical cell, measure products by GC. Expected Outcome: Faradaic efficiency for CO and hydrocarbons. Equipment: Potentiostat.
295. **Compressed Air Energy Storage Modeling**
Objective: Evaluate round-trip efficiency. Methodology: Simulate CAES cycle in Excel or MATLAB, include compressor and expander. Expected Outcome: Efficiency vs. pressure ratio. Equipment: Spreadsheet or MATLAB.
296. **Solar Photovoltaic–Thermal Hybrid System**
Objective: Generate heat and electricity. Methodology: Build small PVT panel, measure electrical and thermal output simultaneously. Expected Outcome: Combined efficiency. Equipment: PV modules, heat exchanger.
297. **Catalyst Screening for Methanol Synthesis**
Objective: Find best catalyst for CO_2 hydrogenation. Methodology: Test Cu/Zn, Ni, and Fe catalysts in microreactor, analyze methanol yield. Expected Outcome: Catalyst ranking by activity. Equipment: Microreactor, GC.
298. **Dynamic Simulation of Compressed Hydrogen Delivery**
Objective: Model pressure and temperature during filling. Methodology: Simulate compression in Aspen HYSYS with real-gas properties. Expected Outcome: Temperature rise and compression work. Equipment: HYSYS.
299. **Biogas Upgrading via Pressure Swing Adsorption**
Objective: Purify CH_4 from raw biogas. Methodology: Run lab PSA unit with zeolite, measure CH_4 purity and yield. Expected Outcome: Purity vs. cycle time. Equipment: PSA setup.
300. **Wave-Powered Desalination Modeling**
Objective: Use ocean waves to drive RO. Methodology: Couple hydraulic model of wave pump with RO module in MATLAB. Expected Outcome: Freshwater production rate vs. wave height. Equipment: MATLAB.

What You Need to Get Started

Before kicking off, assemble your toolkit:

1. **Literature & Data**
   • Access scholarly articles (ScienceDirect, IEEE, ACS).
   • Government or industry reports for real-world data.
2. **Software & Simulation Tools**
   • Process simulators: Aspen HYSYS, ChemCAD, PRO/II.
   • Data analysis: MATLAB, Python (NumPy, Pandas), Excel.
3. **Laboratory Equipment**
   • Reactors (batch, continuous), distillation columns, heat exchangers.
   • Sensors: pH meters, thermocouples, flow meters.
4. **Personal Protective Equipment (PPE)**
   • Lab coat, goggles, gloves, fume hood usage.
   • Always prioritize safety!
5. **Documentation Tools**
   • Electronic notebook (OneNote, Evernote) or traditional lab notebook.
   • Reference manager (Zotero, Mendeley) for citations.
6. **Team & Advisor**
   • Collaborators bring diverse skills (coding, experimental expertise).
   • Regular meetings ensure alignment.

Tips for a Successful Project

- **Plan Thoroughly**
  Draft a timeline with milestones (literature review, experiment setup, data collection, analysis, report writing).
- **Keep Detailed Records**
  Note every parameter, observation, and deviation—these details matter during analysis.
- **Pilot Studies**
  Run small-scale tests before full experiments to identify issues early.
- **Stay Organized**
  Structure folders for raw data, processed data, scripts, and reports.
- **Peer Review**
  Present progress to classmates or advisors to get feedback and fresh perspectives.
- **Iterate & Adapt**
  Experiments may not work initially—be ready to tweak parameters or methods.
- **Communicate Clearly**
  Use graphs, flowcharts, and schematics to convey complex ideas succinctly.
- **Backup Everything**
  Regularly save digital files to avoid data loss.

Must Read: 220+ New Chemistry Project Topics For BSC Students In 2025

Project Structure: Key Components

Every strong project report or presentation should include:

1. **Abstract**
   A concise summary of objectives, methods, results, and conclusions.
2. **Introduction**
   Contextualize the problem and state objectives.
3. **Literature Review**
   Overview of prior work; identify gaps your project fills.
4. **Theory & Modeling**
   Equations, simulations, and assumptions.
5. **Materials & Methods**
   Experimental setup, materials, and protocols.
6. **Results**
   Data presented via tables, graphs, and images.
7. **Discussion**
   Interpret results—compare with theory and literature.
8. **Conclusions & Recommendations**
   Highlight key findings and suggest improvements or future work.
9. **References**
   Cite all sources in a consistent format (APA, MLA, or paper's style).
10. **Appendices**
    Raw data, detailed calculations, code listings.

Examples of Chemical Engineering Projects

- **Design of a Wastewater Treatment System**
  • Goal: Remove organic pollutants using biological reactors.
  • Methods: Model kinetics, build lab-scale bioreactor, test removal efficiency.
- **Optimization of a Continuous Stirred-Tank Reactor (CSTR)**
  • Goal: Maximize yield of a target chemical (e.g., esters).
  • Methods: Vary residence time, temperature; fit kinetic models.
- **Development of Bioplastic from Agricultural Waste**
  • Goal: Produce eco-friendly polymer via fermentation.
  • Methods: Use banana peels as substrate; analyze mechanical properties.
- **Carbon Capture via Amine Absorption**
  • Goal: Assess solvent efficiency and energy requirements.
  • Methods: Simulation in Aspen HYSYS; lab absorption column tests.
- **Enhanced Oil Recovery (EOR) Using Nanoparticles**
  • Goal: Increase oil displacement efficiency.
  • Methods: Synthesize silica nanoparticles; flood core samples; measure recovery.

Common FAQs

> ***Q1: How long should a chemical engineering project take?***
> ***A:*** *It varies—course projects might run 8–12 weeks, while capstones span a semester. Plan milestones and build in extra time for unexpected delays.*

> ***Q2: Can I do a simulation-only project?***
> ***A:*** *Absolutely! Simulation projects (Aspen, COMSOL, MATLAB) are valuable, especially when lab access is limited.*

> ***Q3: How do I find a sponsor or advisor?***
> ***A:*** *Approach faculty whose research aligns with your interests. Industry partnerships sometimes offer funded projects—check career services.*

> ***Q4: What safety considerations are most important?***
> ***A:*** *Always conduct a risk assessment (e.g., HAZOP). Know emergency protocols, handle chemicals per MSDS guidelines, and never skip PPE.*

> ***Q5: How are projects graded or evaluated?***
> ***A:*** *Criteria often include technical depth, clarity of presentation, quality of data analysis, and demonstration of teamwork and problem-solving.*

Must Read: 149+ AP Biology Final Project Ideas For Students

Final Thoughts

Chemical engineering projects are your ticket to mastering complex processes, boosting your resume, and even pioneering new technologies.

By carefully choosing a topic you're passionate about, planning thoroughly, leveraging the right tools, and applying the tips above, you'll be well on your way to delivering an outstanding project that showcases your skills and creativity.

Best of luck—may your experiments run smoothly, your simulations converge, and your innovations thrive!

Blog

JOHN DEAR

I am a creative professional with over 5 years of experience in coming up with project ideas. I'm great at brainstorming, doing market research, and analyzing what’s possible to develop innovative and impactful projects. I also excel in collaborating with teams, managing project timelines, and ensuring that every idea turns into a successful outcome. Let's work together to make your next project a success!

271+ Super Laravel Project Ideas For Students

Best Project Ideas

Are you ready to make your big ideas happen? Let's connect and discuss how we can bring your vision to life. Together, we can create amazing results and turn your dreams into reality.

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