Carbon Dioxide Hydrogen Methanol Synthesis Educational Unit Operations Pilot Plant

Item Number: LPK-CEJH

Introduction

Hands-on educational pilot plant for methanol synthesis from carbon dioxide and hydrogen. Enables practical study of high-pressure catalysis, unit operations, and process control. Features real-time data acquisition, safety systems, and customizable experiment modules for undergraduate and graduate chemical engineering laboratories.

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Component / Parameter	Specification	Educational & Operational Value
Reactor Assembly	316L stainless steel tubular reactor; rated up to 6 MPa operating pressure	Demonstrates industrial tube-reactor design, material durability, and high-pressure sealing techniques.
Heating System	Three-stage temperature-controlled furnace with high-density insulation	Allows students to study non-isothermal temperature profiles along the catalyst bed.
Feed Control	High-precision thermal mass flow controllers (MFCs) for gas feeds	Teaches precise molar ratio control and stoichiometric calculations for reactant mixtures.
Process Monitoring	32-channel digital signal monitoring and control module	Demonstrates automated data acquisition, sensor calibration, and process safety interlocks.
Safety Features	Quick catalyst unloading mechanism, shock-resistant pressure gauges (0-10 MPa), and overpressure relief systems	Instills industrial safety protocols, hazard mitigation, and pressure relief sizing principles.

Experimental Module	Core Target Concepts	Connection to Classic Engineering Curricula
Catalytic Reactor Characterization	Space velocity, catalyst packing density, bed voidage, and pressure drop	*Unit Operations of Chemical Engineering* (Fluid flow through packed beds, Ergun equation application)
Reaction Kinetics & Thermodynamics	Reaction rate constants, activation energy, temperature dependence of equilibrium conversion	*Transport Processes and Unit Operations* (Chemical kinetics, heat effects in reactors)
Process Optimization & Yield Analysis	Selectivity, single-pass yield, carbon dioxide conversion efficiency under varying pressure and feed ratios	*Chemical Engineering Design* (Process optimization, material balance verification, green chemistry metrics)
Automation and Control Loop Tuning	Closed-loop flow control, multi-zone cascade temperature control, safety interlock programming	*Chemical Engineering Design* / Process Control (PID tuning, system dynamics, and safety management)