Description :

The Chemical Reactors Teaching Equipment, featuring a Tubular Reactor, is designed for educational use, providing students with hands-on experience in understanding chemical reactor principles. The transparent tubular design allows for observation of reactions, while control elements like flow regulators and temperature sensors enable students to

manipulate and monitor operating conditions. This compact system is equipped with safety features, making it an ideal tool for teaching fundamental concepts in chemical engineering, reactor design, and industrial processes.

The CHEMICAL REACTORS TEACHING EQUIPMENT includes a Base Unit—a self-contained, compact benchtop service unit designed to accommodate various chemical

reactors: Continuous Stirred Tank Reactor, Tubular Reactor, Transparent Batch Reactor, Plug Flow Reactor, and Laminar Flow Reactor. The unit is configured for complete computer

control and remote accessibility via third-party collaboration software such as Microsoft Teams, offering a versatile and Thunderbird 1 of 5 effective educational resource.

Specification:

1. CHEMICAL REACTORS BASE UNIT:

The service unit, designed for convenient reactor interchangeability without tools, features transparent vessels for optimal experiment visibility. It incorporates two 3-roller

peristaltic pumps with a maximum flow rate of approximately 110mL/min and 4.8mm hose dimensions, ensuring smooth reagent delivery to the reactors. The unit includes a water pump with a maximum flow rate of 10L/min. For temperature control, a PID-controlled hot

water vessel with a power of 2kW, a thermostat range of 0-75°C, and a hot water tank of

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approximately 3L is provided. Reactant bottles with a capacity of 2x3L are

accommodated in the unit. Technical specifications also include an integral USB interface for full computer control, standard data logging, and educational sotiware specific to each reactor type. The software enables customization of feed pump speeds, flow rates, heater

power, PID control loop for temperature stability, hot water pump control, and stirrer speed on applicable reactors. Additionally, compatibility with third-party software is ensured through supplied drivers.

2. Tubular Reactor:

The Tubular Reactor is a compact unit designed for controlled temperature reactions,

enclosed in a transparent tank with a spiral-wrapped tube. Reagents are separately piped to the reactor, preheated in stainless steel coils within the water tank, and then mixed

in the reactor coil. Key features include a 20m long reactor coil in a clear acrylic vessel, a 0.4-liter coil volume, and two stainless steel heat exchanger coils. The reactor utilizes the saponification reaction and conductivity for measuring progress. Technical

Thunderbird 2 of 5 01-06-2024, 10:11 specifications include pre-heat coils with a total length of 1.2m, internal diameter of 4.9mm, and a total volume of

0.02L. The reactor coil has a total length of 20.9m, internal diameter of 5.0mm, and a total volume of 0.466L. The borosilicate glass and PVC reactor vessel has a volume of 13L. Experimental capabilities cover direct mass transfer rate measurement, gas law application for concentration differences, Fick's Law for diffusion coefficients, temperature effect on diffusion, and using laboratory instruments for accurate data measurements in industrial process design. The unit's dimensions are approximately 500mm (H) x 250mm (W) x 300mm (D) when removed from the service unit.

3. The Con﷽nuous S﷽rred Tank Reactor (CSTR) :

is a versatile, small-scale demonstration unit designed for educational purposes and is commonly found in various industries. This reactor allows for both continuous and batch reactions, featuring an adjustable volume between 0.4 and 1.5 liters using an adjustable standpipe. The temperature probe and conductivity probe can be easily positioned within the reactor vessel. Temperature control is achieved through a stainless-steel coil connected to either the hot water supply on the service unit or cold water from a Chilled Water Circulating Unit. The unit includes a variable-speed mixer/agitator with baffles for enhanced mixing. Key features include the use of the saponification reaction and conductivity to measurereaction progress, as well as a step input change experiment to obtain the residence time distribution. Thevessel is equipped with a variable-speed square blade turbine agitator and is constructed from borosilicate glass and PVC, with a stainless steel heat transfer coil and removable reactor baffle. When in use, the unit is wholly

contained on the service unit. Experimental capabilities of the CSTR cover a range of studies, including the effect of residence time on conversion, determination of reaction rate constants, residence time distribution, empirical rate expressions from experimental data, effect of temperature on reaction rate, effect of mixing on reaction rate, and the effect of flow rate on conversion.

4. The Transparent Batch Reactor:

is a compact and small#scale batch reactor designed to connect to a common desktop service unit. This reactor is particularly suitable for relatively slow reactions lasting several hours, minimizing down time for filling and emptying larger

equipment. The reactor utilizes agitation to maintain homogeneity and enhance heat transfer. Monitoring of reactions is facilitated by a conductivity probe, detecting

Thunderbird 3 of 5 01-06-2024, 10:11 changes in solution conductivity due to the conversion of reactants to products, and visually through the use of indicators. Key features include a 1.5-liter internal working volume, a jacket for passing hot or chilled water through the vessel, and a variable-speed agitator for efficient heat transfer. The glass vessel provides full visibility of the contents, and for adiabatic operation, the

unit allows the use of dyes to visually monitor chemical reaction rates by color changes at different degrees of conversion. Glands in the clear acrylic lid accommodate conductivity and temperature probes for real-time reaction monitoring. Technical specifications detail the borosilicate glass construction of the double-skinned reactor vessel with four fixing nuts and a volume of 1.5 liters. The stirrer motor operates at 0-230 RPM with steel gearing. Experimental capabilities of the Transparent Batch Reactor cover the determination of reaction rate constants, investigation of the effect of reactant concentration on the reaction rate, exploration of the effect of temperature on conversion, and the study of temperature variation in an exothermic reaction during adiabatic operation.

5. The Plug Flow Reactor,:

Designed for use with the Base Unit, is a clear acrylic tubular packed column mounted

on a steel frame. It showcases both flow pattern characterization and steady-state conversion, featuring a static premixer for improved reagent pre-mixing. Reagents are fed by Base Unit pumps, and a six-port injection valve enables step or pulse changes. The

reactor, 1044mm long with a 1L working volume, uses 3mm glass beads. It includes a sensor block for Base Unit conductivity and temperature sensors. Experimental

capabilities encompass determining residence time distribution, studying reactor responses to different perturbations, and visually monitoring flow patterns and steady-state conversion. The reactor performs flow visualization using color and true reactions recorded with the Base Unit conductivity sensor, compared with theory.

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