SPECIALISTS IN
DESIGNING AND BUILDING
CUSTOM MADE
PILOT PLANTS
AND LABORATORY REACTORS
PID Eng&Tech has devoted its activity since 1989 to the development of technologies dedicated to improving design, construction and operation mode of laboratory-scale reactors and micro-scale pilot plants, and their data acquisition, supervisory and control systems.

These systems with high degree of complexity, their high number of operating variables and the interrelationship among them requires an exhaustive study of the instrumentation and control in order to attain results provided by these systems that are representative and reproducible.

In this catalog you will find a sample of different laboratory-scale pilot plants for the study of different processes carried out at industrial scale.

The Four Runs Microactivity Test Unit MAT ASTM D3907-03 is a fully automatic, controlled and computerized laboratory reactor for the analysis of Fluid Catalytic Cracking (FCC), using as feedstock petroleum oils or renewable sources such as bio-oil:

- Allows studying the catalyst activity and selectivity based on the ASTM D3907 method
- Performs continuous and automatic control of up to four independent, programmed and consecutives FCC tests
- Versatile operation modes
  - Fixed and normalized conditions based on the ASTM D3907-03
  - Conditions determined by the operator for each independent run and independent step during the experiment
    - Catalyst/oil ratio
    - Gas flow rate
    - Injection flow rate
    - Injection time
    - Temperatures
  - Quasi-zero dead volume using a perfectly engineered reactor size, precise pipe lengths and distances
  - The standard unit can be adapted to meet specific requirements with extra-equipment (mass flow controllers, liquefied gas feeding system, simultaneous dosing pumps, special materials of construction...)

With an excellent reaction temperature control and making use of a precise syringe pump for gasoil feeding, even for a very short reaction time, this unit carries out reaction and regeneration in-situ and consecutives stages, including coke quantification. The four liquid products obtained are collected in a cooled receiver until the end of the experiments while gases can be analyzed online in a gas chromatograph.
Due to the renewed interest in innovative ways to convert the existing fuel reserves with improved technologies such as gasification and pyrolysis, PID Eng&Tech has worked in collaboration with important researchers in the field of biofuels in order to develop the most versatile pilot plant existing in the market nowadays. Its versatility and complete automatization, allows determining optimal experimental conditions and detecting possible operational problems in industrial gasification or pyrolysis reactors.

**Feeding system**
Continuous and non-fluctuation solid feeding (0.5 - 2.0 kg/h) system consists of a 16 L hopper and two screw for solid feedstock feeding and injection, avoiding thermal cracking of the feed outside the reactor. Nitrogen flow is continuously flushing the dosing screw, promoting the motion of the solids and non-return of process gases.

**Gasifying agent inlets**
Gases streams (air, O₂, steam, N₂...) to fluidize the bed and/or gasify are preheated up to 400 °C.
Water for steam generation is fed by means of an alternative positive displacement pump and vaporized up to 400 °C.
Secondary air is introduced in the middle of the reactor if required for tar reduction only when gasification occurs.

**Fluidized bed reactor**
The reactor is divided into the reactor zone and freeboard zone. The operating homogeneous temperature is up to 850 °C for gasification plant and up to 650 °C for pyrolysis.
The pressure drop is measured inside the reactor, for fluidization speed determination.
The radiant type furnace reaches 1000 °C and has three zones to improve temperature profile.

**Cyclones and filter**
Two heated cyclones connected in series and a high temperature filter to remove solid particles from gas stream, reducing ash content in the final product.

**Products condenser**
A SS316 shell and tube heat exchanger to cool the hot gases and condense tar and steam.

**Bubblers**
A system of two switchable bubblers is installed to clean gas stream, allowing continuous operation during long reaction times.

**Optional features**
Electrostatic precipitator (recommended for pyrolysis), automatic gas sampling system (includes GC), tar collection system, burner, scrubber and gas meter totalizer.
All the lines are heated up to 450 °C to avoid tar’s dew point before condensation stage.

**Micro gasification & micro pyrolysis pilot plant**
Smaller scale pilot plant to carry out both gasification and pyrolysis processes, employing the same technology as applied for Pyrolysis and Gasification Pilot Plant, for feed rates from 20 to 200 g/min, depending on the characteristics of the raw material.
STIRRED TANK REACTORS

This computerized and automatic pilot plant is based on a stirred tank reactor for operation in continuous, batch or semi-batch mode. The plant is high pressure certified according to current regulations and customer can design his own pilot plant by using as many options as required.

MAIN FEATURES

Gases
- Up to six continuous gas feed lines to reactor as standard
- Flow control system by thermal mass flow controllers (Bronkhorst High-Tech)
- Gas line preheating system including temperature control loop can be installed

Liquids
- Up to two liquid feed lines can be installed as standard
- Pumps can be selected for micro-flow or standard process pumps for different pressures and flows
- Liquid lines preheating/evaporating systems can be selected
- Inertized vessels, heat tracing systems and other usual features can be installed

Phase separator at high pressure
- A L1/L2/G patented separator system with very low dead volume, allows L/G separation even when water and hydrocarbons are obtained simultaneously at reactor outlet. Level control system includes liquid control valve for each liquid outlet
- Two models (L/G or L1/L2/G) can be selected by the user

POLYMERIZATION

The Polymerization Pilot Plant, developed by PID Eng&Tech, is designed for continuous production at microscale. PID Eng&Tech in co-operation with important research and technology centers in different collaboration projects has developed a pilot plant to produce polyolefins. The plant consists of two continuous stirred-tank reactors that operate in series and it also includes a pre-treating raw material area. PID Eng&Tech computerized process control system allows direct control of temperature, level, pressure and gas composition in the reactors. Micro-Pilot Plant is fully automated and all of the process parameters, such as gas and liquid flows, operating pressure and temperature, residence time per reactor, etc., can be selected by the user, or modified within a wide range.

MAIN FEATURES

Feed and conditioning of gas and liquid feed stocks
- Up to five independent gas lines for both monomer and co-monomer feeding into each reactor and a nitrogen line for inertization purposes
- Two solvent lines. A common stream is divided in two, feeding the solvent into each reactor at real time
- A catalyst line for catalyst addition in slurry phase into the first reactor
- A co-catalyst line for its addition in a homogeneous solution into the first reactor

Reactors and flashes
- The plant consists of three SS316 stirred tanks with high pressure closure system
- Each one is provided with a magnetically coupled stirred head, a heating jacket, a cooling coil, valves and accessories
- In addition to temperature and pressure control, monomers composition ratios are measured continuously, near-real time.
- In this way, the integrated control pressure/relation loop allows the user to work maintaining simultaneously a stable desired pressure and a stable desired monomers ratios during the reaction time
A supercritical fluid (CO₂ as standard) is fed as a solvent to separate a component (extract) from a solid or liquid sample, with the advantage of the behaviour of supercritical fluids: it is simultaneously as a gas (high diffusion trough sample) and a liquid (high solvating power). PID Eng&Tech supercritical extraction pilot plant is a modular and computerized unit built with SS 316L materials and high pressure specifications from Autoclave Engineers, Gyrolok, Swagelok, Classic Filters and others.

Advantages
• Safe
• "Green"
• Mild conditions
• Recyclable
• No residue
• Inexpensive
• No surface tension

The Membrane Bioreactor (MBR) has been specifically designed to carry out waste water treatment studies under controlled conditions. Its compact and modular design makes the MBR an easy operable lab scale unit for biological water treatment
• Continuous operation for several months (until membrane saturation)
• Continuous waste water with suspended solids influent, treated water (permeate)
• Withdrawal and gas recycle with compressor and sparge tube
• Possibility of chemical cleaning step implementation without dismantling
• Built in poly methyl methacrylate (PMMA) as standard
• Easily detachable
• Inerting system
• Lighting system over sliding rails for optimal distance selection for photocatalytic process
• Temperature, pressure, level, pH and conductivity measurement
• Several sampling points
• A membrane as standard, with the possibility of multiple membranes in parallel configuration
• Atmospheric pressure
• Ambient temperature as standard, possibility of temperature control under request

Each PID Eng&Tech Desalination Pilot Plant is designed according to specific requirements of each research group, employing the accumulated knowledge during years of experience
• High capacity tanks (100 – 200 L) for brine water and treated water storage with heated elements and temperature control if required
• Corrosive and temperature resistant materials (PVC, PP, PVDF, PPH...)

The Supercritical Water Oxidation (SCWO) is one of the most promising technologies to convert waste water to innocuous product. PID Eng&Tech SCWO Pilot Plant is a modular flexible unit which allows the researches to explore different possibilities with the aim of applying their findings in a larger scale equipment or industry
• High pressure (up to 250 barg as standard)
• High temperature (up to 400 °C as standard)
• Waste water flow rate of 15 L/h as standard
• Resistant materials for the operating conditions
• Designed for continuous operation
• Compressor system for oxygen

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**PID Eng&Tech** is an engineering company focused on the design and construction of “Customized Pilot Plants”. Our main target is customer satisfaction and we achieve it by working closely with customers to convert process ideas in R&D equipment.

Using pre-designed modular components, **PID Eng&Tech** is able to diminishing at least one factor of 2 existing in projects: “construction time” and “cost”, including the latest advances in process control technology.
PID Eng&Tech pilot plants are designed for safe and continuous operation. The alarm system includes several independent safety levels:

- Automatic switch off in case of any emergency condition
- Pressure, level, temperature and gases (hydrocarbons, hydrogen sulfide, carbon monoxide...) concentration security systems

The alarm system is based on the PLC and all the alarms system actions are registered by software on the PC, including an automatic report of the alarms. Besides, it is designed under complete consultation with the customer, fixing the appropriate safety levels and safety actions for each variable.

Process@ Software

Process@ is an user-friendly SCADA software developed by PID Eng&Tech with LabVIEW for data acquisition and remote process control through a PC, that can be placed up to 50 m away from the pilot plant.

- Intuitive and easy graphic system with dynamic data
- Exportable data to spreadsheets
- Historical and real time trending
- Daily / hourly report generation
- User configurable run sequences, including both conditional and temporal jumps, to easily automatize the experiments
- Integration and management of both online and offline data analysis (when analytical equipment is included)
- Automatic mass balance calculations with integration of gas chromatography software and results (when analytical equipment is included)
**Scrubber**

A scrubber can be used to remove pollutants from a gas stream to meet the emission regulations. PID Eng&Tech unit is designed specifically for each process requirements and it can be installed both in our pilot plants and at the final step of the customer process.

- Tower dimensions: 1000 mm, Ø 200 mm
- Treated water tank: 200 L
- Tank dimensions: 600 mm, Ø 550 mm
- Recirculation magnetic pump: power 1/2 CV
- Gas flow: 200 NL/min
- Gas pressure: 0.5 barg

**Liquid-liquid extraction column**

Liquid-liquid extraction is a well-known basic operation used to separate a component from a liquid mixture employing a solvent with high chemical affinity for this component. Apart from supercritical extraction pilot plants (see page 8), PID Eng&Tech designs and supplies extraction columns to efficiently integrate the unit into a main process.

- Magnetic agitation system to avoid leaks when high pressure is involved
- High surface contact
- Sight ports at different column heights to visualize the separation process
- Level control system (total and interface level)
- Jacketed column with temperature control for high temperature applications

**Distillation column**

Distillation is one of the most studied basic operations in Chemical Engineering, both at educational level and research centers to optimize new or conventional processes with promising chemicals. PID Eng&Tech can design and commission distillation columns according to customer requirements.

- Tailored to specific requirements of each process
- Packed column
- Operation in continuous or batch mode
- Stainless steel as standard material of construction
- Controlled by PLC and touch screen

The stream conditioning system is a compact equipment to adapt different process gas lines for online GC analysis.

- Up to four different gas lines as standard
- Reduction of pressure for high pressure product lines
- Increase of pressure for low pressure product lines
- Temperature conditioning system
- Dehumidification system for water elimination
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