

Celero™

The Power of Numbers

16

8

24

24

16

16

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Zeton Altamira

Zeton Altamira

proudly introduces the

Celero™

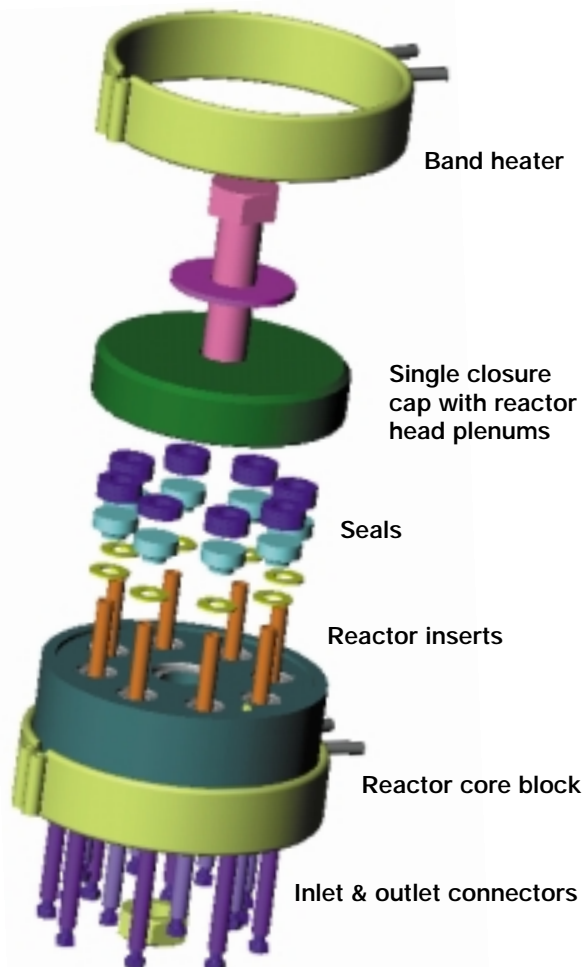


A Multi-Channel Fixed Bed Reactor for High Throughput Screening of Heterogeneous Catalysts

- Developed as a tool for combinatorial catalysis work and licensed to Zeton Altamira by Symyx Technologies, Celero is covered by patents and is designed for use in major oil and chemical company labs. The Celero technology is based on research & development involving more than 10,000 catalyst screening experiments.
- Celero is available as a stand-alone reactor device, designed to be retrofitted into existing bench-scale reactor systems, or as part of a comprehensive, ready-to-run, fully automated reactor system, driven by high performance Symyx Impressionist™ software.
- Celero has a single, high pressure closure, and is customizable, as to metallurgy, design pressure and temperature, reactor well volume, and flows.
- Zeton Altamira enables combinatorial performance in catalyst research since Celero is packaged with sub-licenses allowing customer access to important Symyx patents.
- Celero is an extension of Zeton Altamira's development work and market offering since 1999 of a 10-station HTS reactor system.

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From the Latin:
To accelerate,
to go faster.



Why test only one sample at a time when you could be testing 8, 16, 24 or more?

Enjoy the benefits of parallel processing!

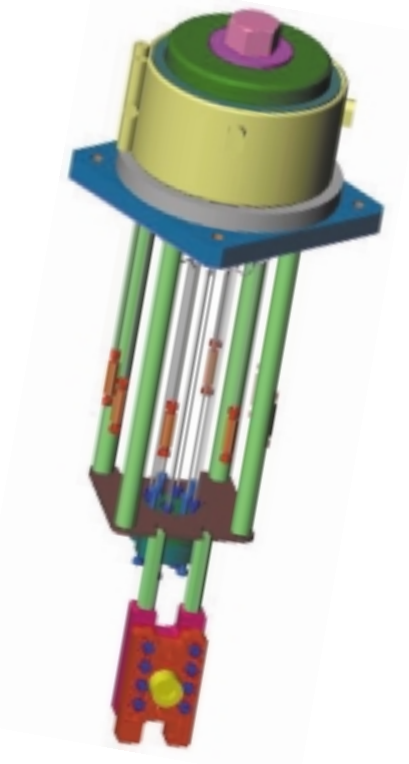
Just choose the number of reactors in your system.

Then choose the *Celero*[™] configuration that meets your needs. . .

Celero[™] *Basic*

An 8-Channel Fixed Bed Reactor for High Throughput Screening of Heterogeneous Catalysts

- Top-Loading, Single Fastener, High Pressure Closure
- Radial Reactor Arrangement for Even Temperature Distribution
- Removable Reactor Inserts for rapid reloading
- Knife-edge Spring Seals
- Flow-Equalization Capillaries
- Impressionist[™] Software from Symyx Technologies



Main System Control
Graphical User Interface (GUI)
of *Celero*[™] Software

Celero[™] *Plus*

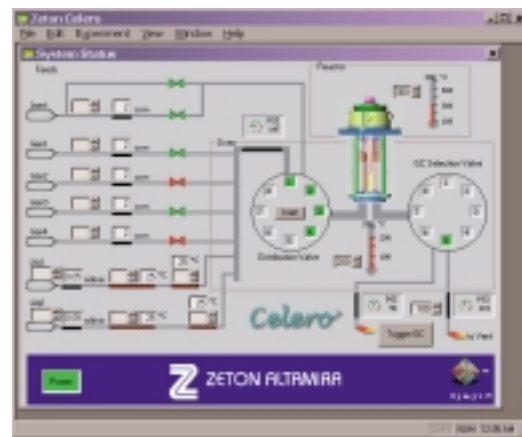
A Selection of Standard Options to Increase Functionality and Utility

- Reactor Size and Number Options
- Gas Feed and Liquid Feed Options
- Temperature and Pressure Options
- Selective Reaction Control
- Gas Chromatograph Options

Celero[™] *Custom*

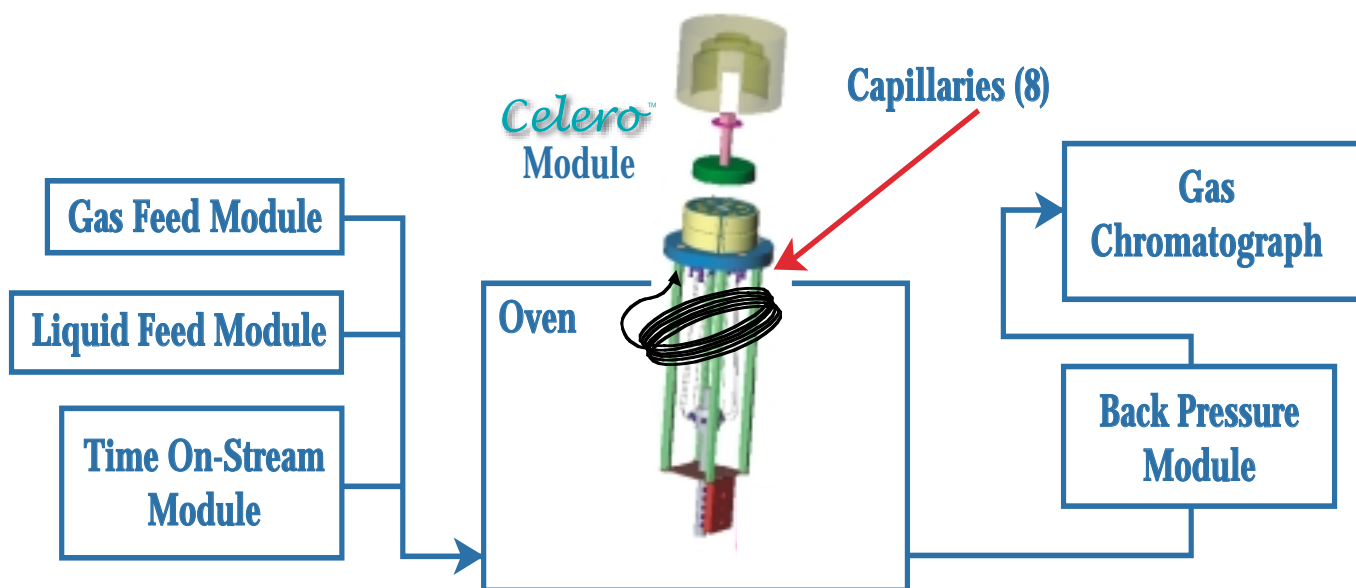
A Custom Engineered Solution Completely Tailored to Your Specific Needs

- Custom Reactor Designs and Configurations
- Custom Feed, Sampling and Discharge Options
- Custom Control Options
- Integrated System Automation



With the *Celero*[™] System, it's Your Choice!

Select a Reactor Module for Insertion into Your HTS System,
Or, Select Optional Add-Ons to Create a Complete HTS Reactor System.
Or, Specify a Custom Reactor System tailored to your Specific Needs.



Celero[™] General Specifications

Features	Basic	Options	Custom
Number of Reactors	8	16 or 24	Any Number
Reactor Well Volume	0.5 ml	Up to 7 ml	As Specified
Catalyst Weight	50 -300 mg	50 - 1000 mg	As Specified
Reactor Material	Stainless Steel	Hastelloy Titanium w/coating	As Designed
Reactor Temperature	Ambient to 600°C	Higher temps possible	As Specified
Oven Temperature	Amb - 200°C	Ambient - 200°C	As Specified
Reactor Pressure	Ambient	Up to 25 Bar	Up to 204 Bar
Reactant Feed	Single input, gaseous	Inputs - 5 gases plus 2 liquid (with vaporization manifold)	As Specified
Flow Rates	Up to 12 sccm / well	Up to 50 sccm / well	As Specified
Output Sampling	One well at a time (via Stream Selection Valve)	One well at a time (via Stream Selection Valve)	Multiple Well Sampling
Time On-Stream Control	All Channels On-Stream	Selective Reaction Control	As Specified
Analysis	Valve to GC	GC w/software trigger	

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General Specification & System Description

SUMMARY

- Eight parallel fixed bed, plug flow reactors in a single reactor core block are heated to the same temperature, receive the same flow and operate at the same pressure. User tests eight (8) different catalyst samples under common conditions.
- Testing productivity is increased eight-fold with a system costing about the same as a single station reactor.
- Reactor well volume at buyer's option, ranging from 0.5 mL to 7 mL
- Patented flow-splitting arrangement ensures even distribution to all reactor wells without individual flow controllers.
- All inlet flow distribution and effluent sampling piping and valving is contained in a heated oven capable of maximum temperatures of 200° C, eliminating cold spots in the process plumbing.
- Integral to the system is the stream-selection valve for individual sampling of each reactor well.
- Modular, bench-top design, with small footprint.
- Base scope of supply is one eight-channel Celero module in an oven, with inlet/outlet manifolds, stream sampling selection valve, Impressionist™ control and data acquisition software, and computer.
- Optional add-ons are (1) gas feed module (2) liquid feed module (3) back-pressure controllers (4) time on-stream selection valve; and (5) analytical instrument.
- Buyer can drop base Celero module into an existing micro-reactor system or buy a turnkey system with any or all listed options.

SYSTEM DESCRIPTION

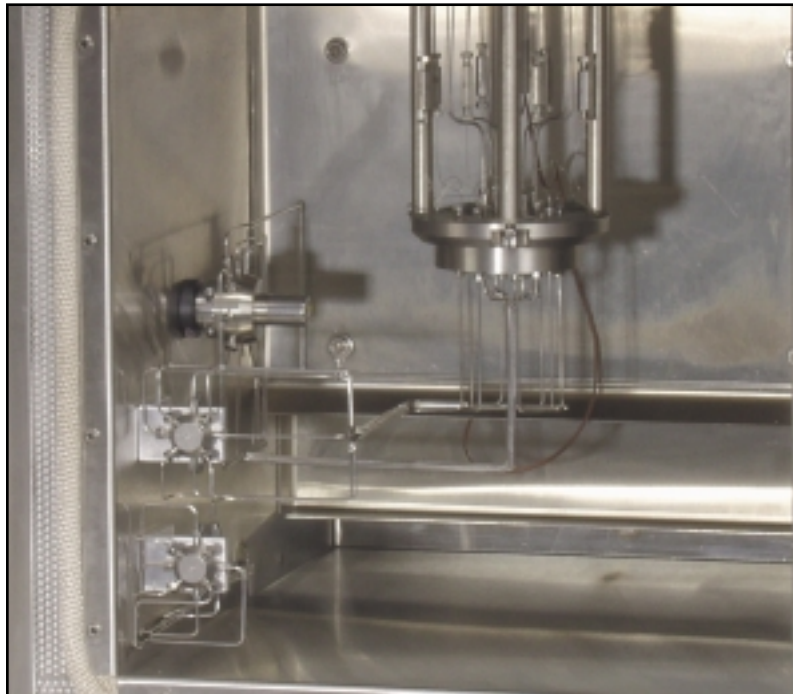
Feed Preparation And Distribution

Up to five mass flow controllers and three liquid pumps (optional add-ons) enable the operator to vary feed composition and reactor contact time independently. The combined gas stream from the mass flow controllers merges with the vaporized liquid streams to form a single gas phase feed stream. The feed stream flows through a heated transfer line to a distribution valve. The valve partitions the feed into eight identical capillaries connecting the manifolds to the 8 individual reaction wells. Because the capillaries are the primary resistance to flow within the system, flow distributes uniformly among the 8 wells even though the pressure drop may vary across the individual catalyst beds. Locating the capillaries and the distribution valve inside a temperature-controlled oven ensures that liquids do not condense prior to entering the reactor. For systems where time-on-stream is an important variable, an optional 8-port time-on-stream selection valve can sequentially route feed to each channel at timed intervals.

Reaction

Reactant gas flows through the capillaries into the reactor module with eight wells, where it contacts the catalysts and reactions occur. Band heaters around the module permit reaction temperatures from ambient up to 600°C, with the upper temperature limit dependent upon the reactor material of construction chosen for the desired chemistry. Each reactor cell consists of an inlet connection, an outlet connection, a sample vial, and a seal. Placing all the connections on the underside of the reaction block facilitates sample changing and minimizes loading and unloading time. Typical catalyst loadings are about 250 mg., and typical residence times are on the order of 1 second.

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The *Celero*™ Reactor Module installed in the Gas Conditioning Oven, which is designed to operate between Ambient and 200°C. The system operator uses the Impressionist™ Software to specify oven temperature depending on the experiment parameters.

Analysis

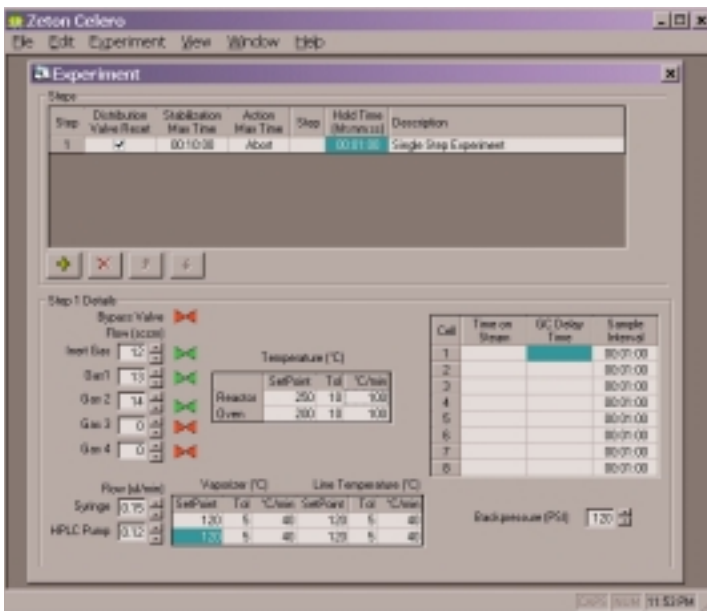
Downstream of the reactor is a stream selection valve that diverts one of the eight reactor effluents to a gas chromatograph (GC) for analysis. Using a GC for analysis permits determination of all side products and the total gas composition, so that conversion and selectivity may be determined directly. Typically, several analyses are performed on each catalyst over a four-hour run. A common choice would be a micro GC with analysis times of 2-3 minutes. The choice of GC is left to the buyer, as some users will prefer a mass spectrometer or an alternate analytical device.

Control

The Celero is controlled by a process computer in combination with several smaller controllers for pneumatics and temperature control. The control software is Symyx Impressionist platform and includes the ability to control the hardware, create and schedule experiments, collect data and trigger the GCs.

Computer Specifications:

- Brand Name PC
- Pentium Processor
- 900 Megahertz (Minimum)
- Windows NT
- 64 MB of RAM





DESCRIPTION OF OPTIONAL ADD-ONS

OPTION 1: GAS FEED MODULE

- The gas feed module is designed to allow delivery of five (5) gases, four (4) process and one (1) inert. Each one of these streams is monitored and controlled by a mass flow controller. An automatic valve follows each mass flow controller for positive shut down of gas flow.
- Each gas feed stream uses an inline filter to protect the mass flow controller from contaminants as well as a check valve to prevent backflow through the controller.
- This module is designed to fail in a safe mode where inert flushes through the reaction system in the event of an emergency shut-down.

OPTION 2: LIQUID FEED MODULE

- The liquid feed module is designed to vaporize and deliver two (2) independent liquid feeds. Liquid feed is controlled by an HPLC pump or a syringe pump.
- Each pump will be protected from particulate using an inline filter.
- The appropriate valving is included to allow for pump isolation and priming as well as a check valve to prevent back flow.
- Independent liquid vaporizers for each of the liquid feed are included in this module. The temperature of each of the liquid vaporizers can be independently controlled.

OPTION 3: BACK-PRESSURE MODULE

- The back-pressure module allows the user to control the pressure at which the reactors operate. This is done using an automated back-pressure controller on the vent line and the sampling line. Both of these lines are kept at the same pressure to avoid system imbalances when selecting the reactor being sampled.
- The maximum operating pressure of the system when this option is installed is 450 psig. When the system is operated at this maximum, the oven may be operated at a maximum temperature of 110°C. If the user wishes to operate the oven at its maximum of about 200°C, the system maximum operating pressure falls off to about 300 psig. These limitations are imposed by the 8-port stream selection valve.

OPTION 4: TIME-ON-STREAM MODULE

- This option is incorporated into the base Celero module and allows the user to bring each one of the reactors on-line in a timed sequence while an inert gas passes through the reactors waiting to be brought on-line. The reactors may also be brought off-line according to a timed sequence.
- When the reaction time is critical to an experiment, the timed sequencing of reactor channels permits sampling to be done at the same time in each reaction being screened.

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Technical Specifications:

Reactor Operating Parameters

- Gas line and mixing manifold temperature controlled from Ambient to 200°C
- Reactor Temperature controlled from Ambient to 600°C
- Reactor Temperature Accuracy: +/- 1°C from setpoint
- Reactor Temperature Uniformity: +/- 1°C well-to-well, within each 8-channel module

Certification & Safety Requirements

- CE Approval
- Emergency shut-off switch at key locations
- Pressure relief devices
- Hot surfaces clearly labeled
- Gas vents routed to an exhaust hood
- Thermal limiting device on reactor and heated auxiliary systems

Gas Supply System Parameters

- 5 MFC's, with flows from 3 sccm to 10 slm, NC, 50:1 turndown, <1 second response
- 500 psig pressure relief valves, 200°C minimum

Liquid Supply System

- HPLC Pump, 0.010-5 sccm, Positive Displacement, 1% accuracy (H₂O), 0-40°C

Celero™

is sold under license from. . .



Symyx Technologies

U.S. Patent No. 6,149,882. Use of this instrument may also be covered by one or more of the following U.S. patents: 5,985,356; and 6,004,617. Additional U.S. and foreign patents pending.

The systems described in the brochure include, in some cases, optional equipment that is provided on an application-specific basis. The design of equipment is subject to change without notice. Specific system and performance specifications are based on client applications and will be provided at the time of purchase.

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