freeslate®

SPR
Screening Pressure Reactor

Q. How can I dramatically increase catalyst screening throughput leading to more and better discoveries?
By using the Freeslate SPR.

Accelerating catalyst discovery requires screening more catalysts and capturing and organizing data to drive knowledge based decision making. The Freeslate Screening Pressure Reactor[1] (SPR, **Fig. 1**) was designed with this in mind, enabling catalyst discovery and optimization via high throughput primary screening. Its simple-to-use design allows for the facile testing of hundreds of catalysts per week, far more than any other screening tool on the market. The SPR dramatically increases the experimental space available for testing allowing you to make breakthrough discoveries that would be very difficult to achieve using conventional methods.

The Freeslate SPR enables up to 96 experiments per run with operational temperature up to 400 °C and pressure up to 200 bar[2] (3,000 psig). The reactor has been successfully used by a number of Freeslate's customers and has provided measurable value to all of them. For example, researchers at the Pacific Northwest National Lab stated that they have been able to run "over 120 unique catalyst/temperature combinations... in just under 1 week (including analytical). Had this work been done using traditional techniques it would have taken the same person nearly 4 months, due to the multiple heating and treatment steps required."

Key Features

- Wide process window: Temperature up to 400 °C with pressure up to 200 bar[2] (3,000 psig)
- Automated operation: Temperature, pressure, and flow profiles controlled automatically based on a user-defined recipe
- Array-based screening approach: Test catalysts in parallel and examine multiple variables simultaneously for rapid and high information content screening
- Powerful mixing: High intensity vortexing provides for good solid/gas/liquid contacting during reaction and limits mass transfer issues
- Simple turnaround: Clam-shell reactor design with a single high pressure seal for easy and rapid reaction set-up (**Fig. 2**)
- Flexible reaction formats: Multiple vial and rack formats allow for testing at different scales
- Integrated informatics: Freeslate LEA provides a comprehensive solution for experiment design, reactor control, and data capture and analysis (**Fig. 3**)

Applications

- Hydrogenation/dehydrogenation
- Oxidation
- Acid/base reactions
- Hydroprocessing of naphtha, diesel, and VGO
- Sugars and other biorenewable feedstocks
- Petrochemicals, fine chemicals

References

- Zhao, et al. Metal Chlorides in Ionic Liquid Solvents Convert Sugars to 5-Hydroxymethylfurfural Science **2007**, 316, 1597-1600.
- Su, et al. Single-step conversion of cellulose to 5-hydroxymethylfurfural (HMF), a versatile platform chemical Applied Catalysis A: General **2009**, 361, 117-122.

[1] Patented Technology - US7754165B2, US7556966B2, US7018589B1, US7172732B2, US7141218B2, US7045358B2, US6692708B2, US7122159B2, EP1174185.

[2] See Functional Requirements for full pressure specifications.

Fig. 1: Temperature control and mixing provided by the vortexer unit.

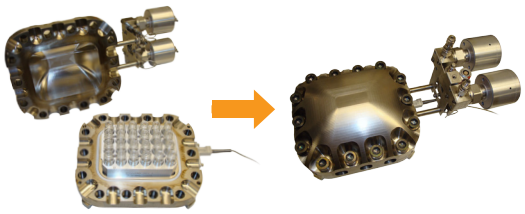

Fig. 2: Easy reactor loading.

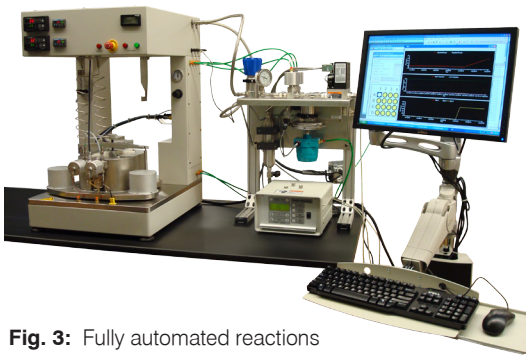

Fig. 3: Fully automated reactions including data capture and analysis.

Specifications

Functional Requirements

Process Conditions

Temperature range:
- Ambient to 250 °C with PTFE o-ring seal
- Ambient to 400 °C with metallic c-ring seal

Heating Control: Computer-controlled, ramp capability and manual over ride

Over-temperature control: Separately monitored and controlled

Pressure:
- EU: Ambient to 172 bar (2500 psig)
- Non-EU: Ambient to 200 bar (3000 psig)

Pressure control: Computer-controlled back-pressure regulator with condensable knock-out vessel

Mixing: Orbital shaker
- Speed range: 100 rpm to 800 rpm
- Control: Computer-controlled, ramp capability

Heating: Electric heaters

Optional gas supply system: 3 mass flow controllers, computer-controlled

Mass flow controllers:
- Model: Brooks SLA5850s
- Maximum flow rate: 1 L/min
- Gases: Nitrogen, hydrogen, and one customer configured process gas

Reactor Vessel

Leak rate: < 1% of setpoint per hour

Temperature control and monitor: Thermocouple in base

Valves: Computer-controlled gas Inlet/Outlet valves mounted on reactor

Pressure measurement: Sensor located near valves

Overpressure protection: Rupture disk

Vial rack types:
- 24 x 6 mL stainless steel vial
- 48 x 3 mL stainless steel vial
- 24 x 4 mL glass vial
- 48 x 2 mL glass vial
- 96 x 1ml glass vial

Well diffusion barrier: Pin-hole cover plates and gaskets for 24, 48, and 96 well formats

Wetted Materials

Reaction vial: Glass or stainless steel

SPR reactor: Nitronic 60

Valves: Stainless steel, vespel, TFE

Tubing: Stainless steel

Vial rack: Aluminum

Seals: PTFE, inconel, silver

Safety

CE and NRTL certified

Main circuit breaker: Main circuit breaker on side

EMO: EMO button on front panel and remote connector

Ventilation hood: To be provided by customer

Overpressure protection: Burst disc rated at 3330 psig and CE approved

Design: Reactor safety factors per ASME pressure vessel design guidelines

Facilities Specifications and Requirements

Envelope

SPR: 20" W x 23" D X 33" H

Gas Panel: 21" W x 6.5" D x 21" H

Weight

SPR: 300 lbs

Gas panel: 45 lbs

Power

SPR: 208 to 240 VAC, 50/60 Hz, 20A

Computer: 115/240 VAC, 50/60 Hz, 8/4 A

Gas panel: 90 to 260 VAC, 50/60Hz, 70W max

Computer

115/240 VAC, 50 to 60 Hz, 8/4 A

Gases

House nitrogen, clean dry air, high pressure process gases (per customer-specified MFCs)

freeslate
www.freeslate.com

Headquarters
415 Oakmead Parkway
Sunnyvale, CA 94085
United States
T 408.773.4000
F 408.773.4002
E customercontact@freeslate.com

EU Field Office
4-6 Avenue industrielle
CH 1227 Carouge - Genève
Switzerland
T +41 (0)22 884 13 30
F +41 (0)22 560 64 98
E support@freeslate.com