

**Hydrogenation
& Catalysis
Tools**

Catalytic (stirred and flow) Pressure Reactors

High Pressure Chemistry



HIGH THROUGHPUT CATALYST SCREENING

CAT

Complete units for hydrogenation and other high pressure reactions. CAT systems have been designed to provide a cost effective, simple and easy to use tool for high pressure reaction screening. They can be used directly on stirring hot plates or in oil baths.

Manual Systems

- | 100 bar/250 °C rated vessels (316SS or Hastelloy)
- | Valves and pressure gauge to manually purge (e.g. inert) and then pressurise with reacting gas (e.g. hydrogen)
- | Place on any hot plate for heating/stirring
- | "Pocket" for thermocouple to monitor operating temperature

CAT 7 and 24

- | Head fitted with coolant connection
- | "Cold fingers" condense vapours and minimise cross contamination



CAT 18

- | Uses 18 x 2 ml HPLC vials (with or without Septa) but without refluxing features

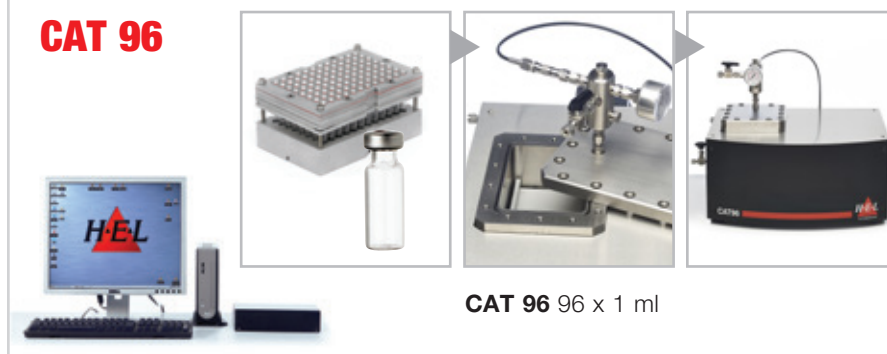


Automated System

Fully automated design based around 96 well Zinsser block

- | Up to 96 x 1 ml HPLC capped vials
- | 35 bar/200 °C
- | Magnetically stirred
- | Computer control for:
 - Gas feed/venting
 - Temperature
 - Agitation
 - Pressure

CAT 96



Increase productivity with HEL's CATalyst Screening Systems

PARALLEL SCREENING SOLUTIONS

DigiCAT

Process development for elevated pressures using mini-reactors

Modular high pressure system

The DigiCAT allows the control of temperature and stirring as well as the safe addition of gas (including hydrogen) for chemistries at high pressure (up to 200 bar) and temperatures (up to 300 °C). Reactor sizes up to 500 ml can be used in different combinations with minimal experience in the use of pressure tools.

Reactor Choice

Single or multiple reactors can be used with the same base system. Furthermore, two hotplate units can be operated in parallel giving the possibility of experiments with up to 6 high pressure reactors.



PolyCAT

A parallel 4 or 8 reactor system designed for the rapid screening of high pressure reactions and catalysts.

The PolyCAT has been designed to be an affordable entry level system into true, parallel catalytic screening - bridging the gap between simple manual units and high end, fully automated systems

Features

- | Individual stirred reactors at separate start pressures
- | Individual temperature control for each vessel (temperatures 25 °C to 250 °C)
- | A range/difference of over 100 °C between the reactors
- | Excellent stirring - individually controlled and measured
- | Compact manifold for easy manual purge and pressurisation
- | Hastelloy reactor option for aggressive chemistries



8 Reactor PolyCAT

CHOOSE YOUR REACTORS FROM TWO RANGES:

Mini-Range

- | 16 ml, 25 ml, 50 ml

Midi-Range

- | 75 ml, 125 ml, 300 ml, 500 ml
- | Available in Stainless Steel 316 or Hastelloy C276
- | Pressure rated 100 or 200 bar



RAPID PROCESS DEVELOPMENT

HP ChemSCAN II

A dedicated parallel reactor system for the rapid development of high pressure reactions and heterogeneous catalysis systems. **The High Pressure ChemSCAN (HPCS)** is an eight-reactor platform rated to 200 bar and +200 °C - each reactor is independently controlled and monitored with full computer management control. Based on HEL's PolyBLOCK platform, the system boasts flexibility and modularity. The sophisticated software controls, allow for quick and efficient screening and development of catalytic reactions.

The system's key features include:

- | Independent temperature control in each vessel
- | Individual pressure control, allowing tests at different pressure
- | On-line gas consumption calculation and display, in each reactor

Agitation

- | Excellent mixing – enabling heterogeneous and homogenous catalytic gas-liquid reactions. The mixing rate is such that gas uptake is mostly kinetic controlled, allowing scale up with confidence

Control system

- | Software control and data logging
- | Real time gas uptake display for each reactor
- | Automated control sequence includes all inert purges as well as reactive stages

High pressure liquid addition

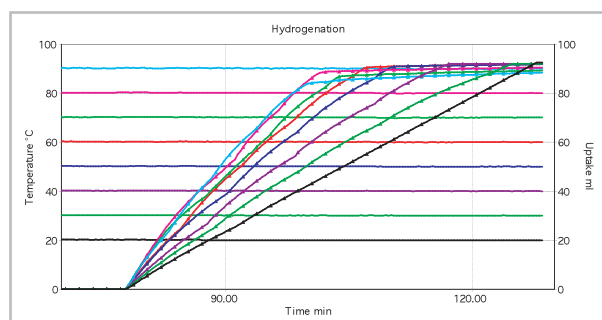
- | The HP ChemSCAN has a high pressure liquid feed option, which is fully automated, up to pressure of 200 bar (3000 psi), with an accuracy of around 0.05 ml or better

Uptake Sensitivity

- | Detects ~0.04 mmole gas consumption (0.1 bar pressure change in standard reactor)



16 ml reactor, available in 316SS or Hastelloy



Live monitoring of gas consumption in each reactor

| PARAMETER | STANDARD LIMITS | COMMENTS |
|------------------------|--|--|
| Temperature | -60 °C and up to 200 °C | Temperature difference of over 100 °C between reactors can be set. Independent control of each reactor. |
| Working volumes | 16 ml vessels 75 ml and 120 ml also available | Minimum working volume 3 ml. Available in 316SS or Hastelloy. |
| Pressure | 100 bar (200 bar optional) | Individual pressure measurement and control in each reactor. Pressure difference between reactors in a single run can be up to 30 bar (450 psi). |

Compact platform for rapid screening and development of catalytic reactions

CUSTOM PARALLEL PROCESS OPTIMISATION

PolyBLOCK or AutoMATE II

Flexible and customisable chemistry platforms. HEL's **PolyBLOCK** and **AutoMATE II** platforms are designed to offer cost-effective, compact and modular solutions to each customer's requirements. With in-house software, mechanical and electrical engineering capabilities as well as extensive chemistry and chemical engineering knowledge, we are able to provide our customers a flexible and innovative approach to their needs.

Highlights

- | Interchangeable reactors
- | Wide temperature range (-80 °C to 250 °C or higher)
- | Separate monitoring and control of each zone
- | Range of options for feed of gas and liquid
- | Fully integrated, compact designs

Process Development with independent pressure and temperature measurement and control. Available with gas, solid and liquid dosing options, using fully stirred reactors, volumes from 16 ml to 300 ml.



8 x 75 ml high pressure reactors with complete gas feed/venting manifold and suspended mechanical agitation



4 x 300 ml high pressure reactors, fully automated, with suspended mechanical stirring



200 ml and 1 L reactors (interchangeable), with overhead stirring. Complex range of probes and other features



8 x high pressure, high temperature reactors with stirring

Demanding applications made simple and reliable

HIGH PRESSURE SCALE-UP

HP AutoLAB

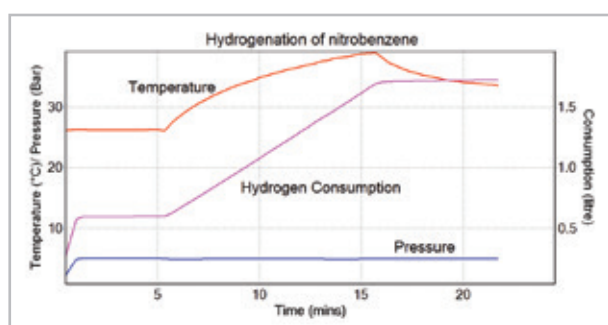
Bench and pilot scale reactors for research and kilo-labs. Volumes over 20 L, available as manually operated or computer controlled custom designs.

Gas liquid reactions under pressure

- | Liquid and gas dosing
- | Gas consumption online
- | Homogenous or heterogeneous catalysis
- | Single or parallel systems

Complex Synthesis Reactions

- | Research scale and complete pilot plants
- | High viscosity reactions
- | High temperature and pressure
- | Batch and continuous processes



1 L high pressure reaction calorimeter



2 L pressure reactors with complex feeds and sub-ambient temperatures



Multiple pressure reactors up to 30 L for explosion proof zone

Stirred reactors for a range of applications and budgets

CONTINUOUS FLOW CHEMISTRY

FlowCAT

A computer controlled platform for the development of continuous flow chemical processes, running up to 200 bar and 550 °C. The flexible design allows scale up of both homogenous and heterogeneous chemistries in the same unit and can incorporate a combination of gas and liquid feeds.

FEATURES & BENEFITS

Software

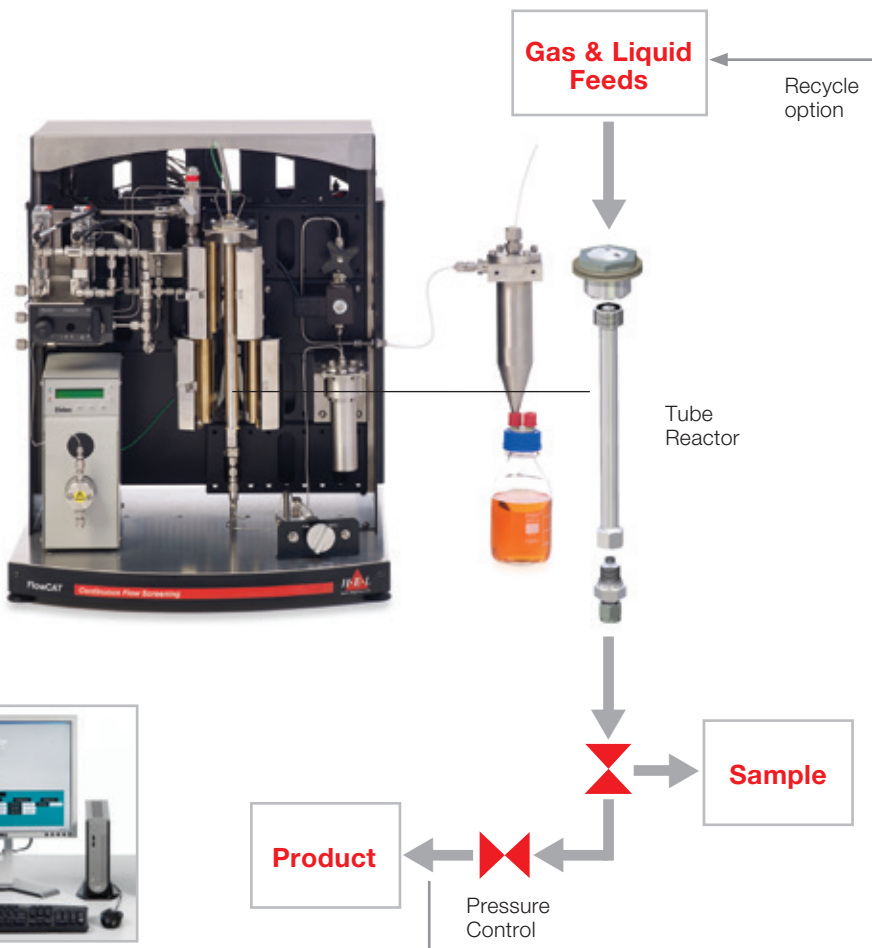
- | Full software control of pressure, temperature and feed rates of liquid/gas
- | Edit conditions any time without stopping

High Throughput Operation

- | Possible to write recipes to automatically cover a range of process conditions, running in sequence
- | At the end of each run, product is sampled and the next run initiated

Applications

- | Screen new chemistries, rapidly
- | Optimise yield, identify new catalysts
- | Use for small-scale production, quickly and safely
- | Also includes Carbonylation, Polymerisation, Bio-Fuel Research, Fischer-Tropsch, Refinery Unit Operations



- | Control of feeds, temperature, pressure and sampling
- | Real-time process data

| PARAMETER | STANDARD LIMITS | COMMENTS |
|----------------------|---|---|
| Temperature | 300 °C (Higher Optional) | Multiple heating zones to suit larger length reactors. |
| Reactor sizes | Reactor diameter 6-24 mm Reactor length 150-500 mm | Available in 316SS or Hastelloy. |
| Pressure | 100 bar (200 bar optional) | Robust and precise control valve, suitable for liquids, gases and two-phase mixtures, provides back pressure control. |
| Feeds | 1 gas 1 liquid | Optionally, any number of separate and independent feeds can be controlled. |

Novel engineering features provide ease of use and quality data



About HEL

HEL is an international company that specialises in chemical reactors, bioreactors and related data/logging tools for process R&D in the pharmaceutical, fine chemical, biotechnology and petrochemical industries. Established in 1987 and with clients worldwide our key strengths are:

Knowledgeable staff - highly qualified and experienced chemical engineers and chemists

Quality - underpinned by ISO9001 certification for over 16 years

Service - choice of service contracts backed by an established culture of unmatched client support

Range of products - both off-the-shelf and custom designs, manual and fully automated controls, low and high pressure/temperature applications, single and parallel/multi-vessel products



Consultancy & Testing Services

Over the past 20 years we have developed expertise and become industry leaders in:

- Reaction hazards, calorimetry, vent sizing
- Process development and optimisation
- Dust and powder flammability
- Other hazard consultancy services, including expert opinion, HAZOPS, DIERS, incident and accident investigation and professional training

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