

**Hydrogenation
& Catalysis
Tools**

Catalytic (stirred and flow) Pressure Reactors

High Pressure Chemistry



Hydrogenation and Catalysis

Product Selection Guide

HEL Group's top quality high pressure reactors and systems offer innovative, robust and flexible solutions to chemists working on various hydrogenation and catalysis applications.

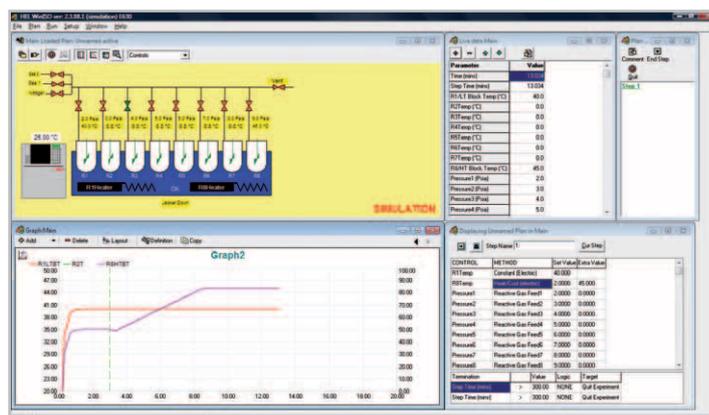
The following is a quick selection guide; if your application is not described here, contact us to discuss your requirements. Our systems are built to our customers' requirements and specifications, and our design team is able to offer creative and innovative solutions to most challenges!

APPLICATION	SOLUTION	COMMENTS
Low cost catalyst screening	CAT Units 1ml - 8ml working volume 7, 18, 24 or 96 vials 100bar/250°C Magnetic stirring	HEL CAT units deliver high throughput screening on a small but representative scale and at a fraction of the cost of traditional screening tools.
Catalytic screening and process development	HP ChemSCAN 16 or 75ml 8 reactors, independent -60°C to 200°C 200bar (+)	With eight parallel reactors and fully independent controls the HP ChemSCAN accelerates process development and allows process condition envelopes to be fully explored.
Custom process optimisation	AutoMATE II 4 or 8 reactor platform 16 to 500ml reactors -80°C to 250°C (+500 optional) 200bar (+)	A flexible platform that adapts to your changing needs. Individual control of a range of vessel options and integration of a wide range of controls.
Bench and kilo scale reactors	AutoLAB 50ml to 20 litre reactors -80°C to 250°C (+) 200bar (+)	The easy-to-use, indispensable, scale-up tool. Automation and integrated safety controls increase productivity and reduce manpower requirements.
Flow chemistry	FlowCAT 3ml, 10ml and 40ml maximum working volume 500°C (+) 200bar (+)	High pressure flow chemistry can be rapidly assessed. Useful for reaction screening, process development and small scale production.

Software Platform

HEL's WinISO software on PC, laptop or touchscreen device provides intuitive and chemist friendly interface, with features such as:

- | Real time graphical, tabular and mimic display of data
- | Real time editing of experiments
- | Alarms and safety shutdowns based on measured variables
- | Data files can be imported directly into standard software packages



HIGH THROUGHPUT CATALYST SCREENING

CAT

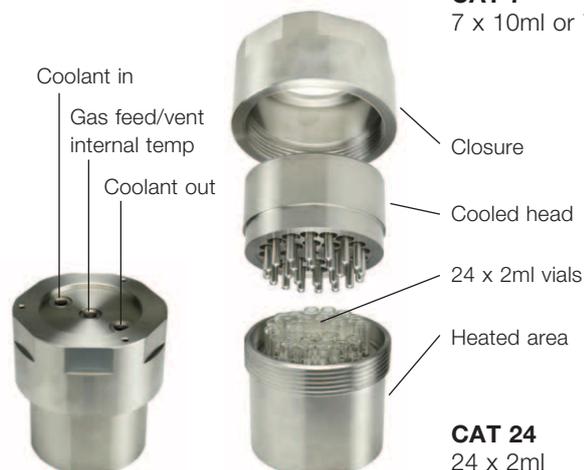
Complete units for hydrogenation and other high pressure reactions. CAT systems have been designed to provide a cost effective, simple and easy to use tool for high pressure reaction screening. They can be used directly on stirring hot plates or in oil baths.

Manual Systems

- | 100bar/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 minimize cross contamination



CAT 18

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



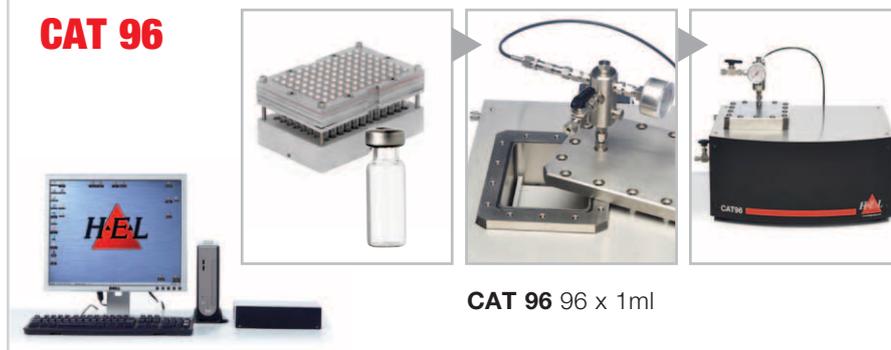
CAT 18
18 x 2ml

Automated System

Fully automated design based around 96 well Zinsser block

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

CAT 96



Increase productivity with HEL's CATalyst Screening Systems

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 200bar 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

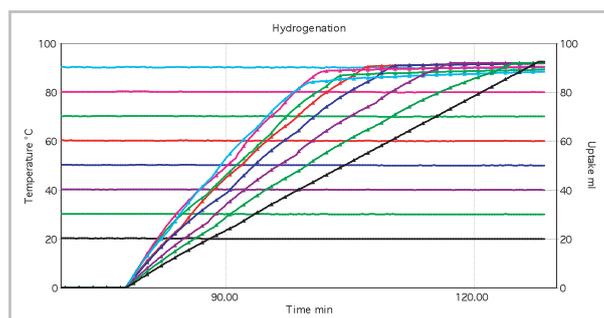
- | The HP ChemSCAN has a high pressure liquid feed option, which is fully automated, up to pressure of 200bar (3000psi), with an accuracy of around 0.05ml or better

Uptake Sensitivity

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



16ml 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	16ml vessels 75ml and 120ml also available	Minimum working volume 3ml. Available in 316SS or Hastelloy.
Pressure	100bar (200bar optional)	Individual pressure measurement and control in each reactor. Pressure difference between reactors in a single run can be up to 30bar (450psi).

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 to 300ml.



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



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



100ml and 300ml reactors (interchangeable), with overhead stirring



8 x high pressure, high temperature reactors with stirring

Demanding applications made simple and reliable

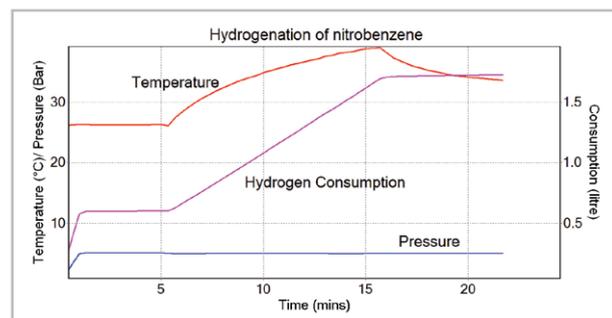
HIGH PRESSURE SCALE-UP

HP AutoLAB

Bench and pilot scale reactors for research and kilo-labs. Volumes over 20 litres, 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



Selection of internals for heterogeneous catalytic reactions



Complex Synthesis Reactions

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



Range of conventional stirrers



Helicoil stirrer for high viscosity



Pressurised feed vessel



Parallel reactors, independently controlled, for hydrogenation

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 200bar 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

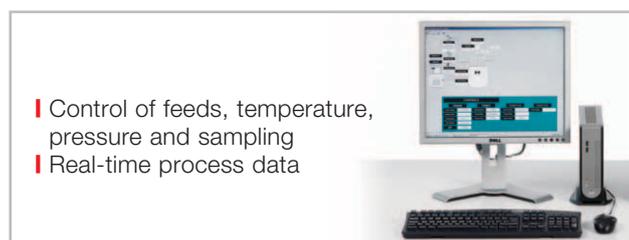
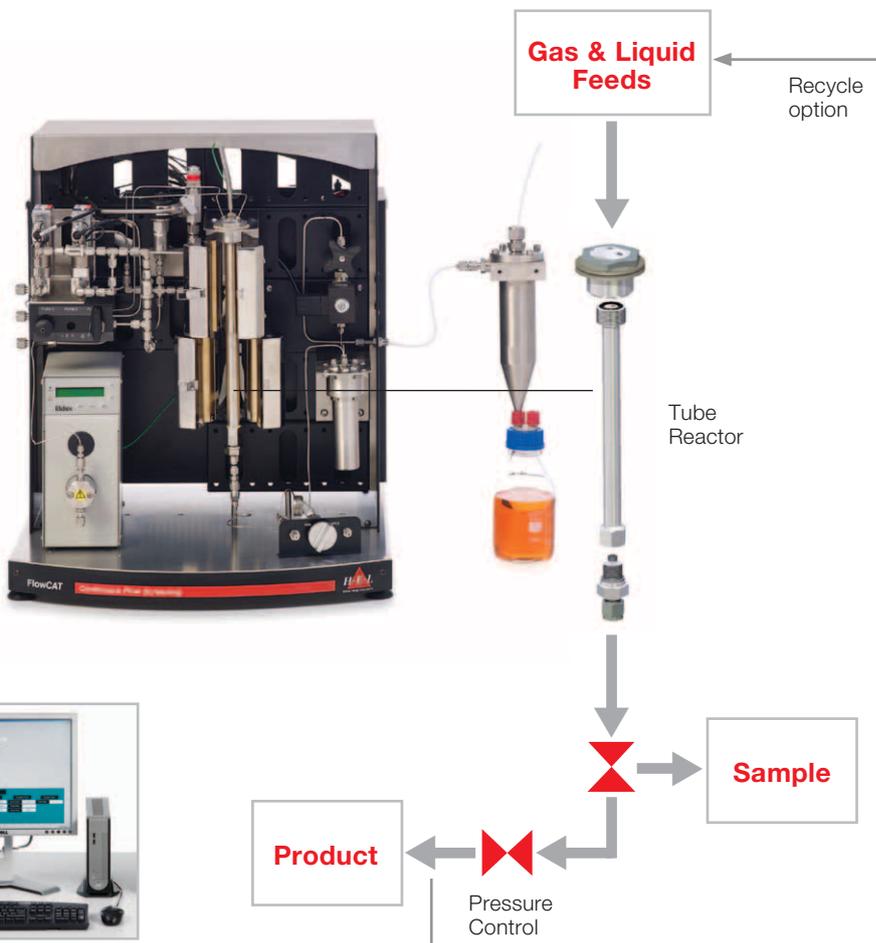
- | Full software control of pressure, temperature and feed rates of liquid/gas
- | Edit conditions any time without stopping

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
- | Optimize 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 6-24mm Reactor length 150-500mm	Available in 316SS or Hastelloy.
Pressure	100bar (200bar 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 research and pilot scale chemical reactors and related data logging/automation tools for process R&D in the pharmaceutical, fine chemical 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 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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better chemistry – faster

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