

# Pumps for Catalytic Hydrogenation and Reactant Feed

## Application Note

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### The Application

Catalytic hydrogenation and related continuous-flow reactions are central to a great deal of chemical and energy research — from upgrading biomass-derived compounds and producing bio-based solvents to developing and screening catalysts and evaluating process chemistry before scale-up. In these systems, a pump meters liquid reactants or solvents into a packed-bed, trickle-bed, or flow reactor held at elevated temperature and pressure, where they react over a catalyst, often in the presence of hydrogen or another gas.

Whether the goal is to study a reaction network, measure turnover rates, or produce material for further work, the result depends on feeding exactly the right amount of reactant at exactly the right rate. The pump faces several demands:

- **Precise, continuous low-flow delivery.** Reactant concentrations and residence times must be held constant for the reaction to give the intended conversion and selectivity. That calls for accurate metering at low flow rates — often well below a milliliter per minute — sustained without interruption.
- **Pulse-free flow.** Pulsation changes instantaneous reactant delivery and can disturb a packed or trickle bed. Smooth, pulse-free feed keeps the reaction conditions steady and the data clean.
- **Pressure and temperature.** Hydrogenations commonly run at elevated pressure and temperature, so the pump must deliver reliably against back-pressure and, where the reactant must be kept warm or cool, control the temperature of the fluid it delivers.
- **Programmed and multi-reactant dosing.** Many studies sweep flow rate or feed ratio, or co-feed several reactants at controlled proportions, which requires programmable rate or pressure profiles and coordinated multi-pump operation.
- **Safety.** Hydrogen is flammable and the reactors run hot and pressurized, so pump pressure limits and reliable, leak-free fittings matter.

### Why Vindum Pumps

Vindum VP-Series metering pumps are well suited to reactant feed: they deliver continuous, pulse-free liquid flow with high precision in a compact package, and have been used in catalyst, biofuels, and process chemistry research by major oil companies, catalyst and petrochemical producers, and universities for more than three decades. For higher flow rates or compressible and liquefied-gas reactants, the VIPR-Series syringe pump covers the same duties.

- **Continuous, pulse-free flow from one pump.** Vindum's patented constant-volume valves eliminate pulses at cylinder switchover, so a single compact VP-Series pump delivers truly continuous flow — no pulse dampener and no interruption to refill. For reactions that run for hours or days, that means steady reactant delivery throughout.
- **Precision at low flow and pressure.** Ball-screw drives, zero-hysteresis gearing, and millisecond motor control give accurate volumetric delivery down to 0.1  $\mu\text{L}/\text{min}$ , while a high-accuracy transducer (0.1% error) and 0.1 psi servo control hold pressure precisely against reactor back-pressure.

- **Programmable dosing.** VPware lets you build multi-step ramping sequences — changing rate or pressure as a function of time or volume — so a full feed profile can be programmed in advance. Volume- or time-based dispensing delivers a precise quantity of reactant.
- **Coordinated multi-reactant feed.** When a reaction needs several reactants in fixed proportions, VPware’s pump-group and rate/pressure-following features let multiple pumps deliver a combined feed at set ratios, all from one PC.
- **Temperature control.** An optional temperature-control jacket or heated barrel conditions the fluid in the pump cylinder, and VP-Series HT models operate with fluids up to 160 °C — useful when a reactant must be kept molten, warm, or cool on its way to the reactor.
- **Built for corrosive chemistry.** Optional Hastelloy C-276 wetted parts — backed by matching Hastelloy needle valves and Hastelloy C-276 tubing — handle corrosive reactants and products, with the whole wetted flow path available in the same alloy.
- **Easy scale-up.** Scaling a process can be as simple as adding pumps in parallel; a single PC running VPware controls up to 16 VP-Series and VIPR-Series pumps at once, so a bench study and a parallel or larger setup use the same familiar controls.
- **Designed to fit the bench.** The VP-Series has the smallest footprint of any continuous-flow pump of its kind, which matters on a reactor skid already crowded with heaters, mass-flow controllers, back-pressure regulators, and analysis equipment.

## Recommended Configuration

A typical setup uses one VP-Series metering pump to feed the liquid reactant or solvent into the reactor, with gas (such as hydrogen) supplied separately through mass-flow controllers, and a back-pressure regulator setting the reactor pressure. Additional pumps can be added for co-feeds or for scale-up. Vindum pumps cover the roles below.

Need	Recommended Vindum solution
Continuous liquid reactant or solvent feed	A single VP-Series metering pump — continuous, pulse-free flow from one compact unit
Precise low-flow delivery into a packed- or trickle-bed reactor	VP-Series accuracy to 0.1 µL/min, with 0.1 psi servo pressure control
Programmed gradient or ramped dosing	VPware ramping sequences (change rate or pressure as a function of time or volume)
Heating or cooling the pumped reactant	Temperature-control jacket or heated barrel; VP-Series HT models operate with fluids to 160 °C
Higher flow rates or compressible/liquefied-gas reactants	VIPR-Series syringe pumps (single, or paired for continuous flow)
Corrosive reactants or products	Optional Hastelloy C-276 wetted parts, Hastelloy needle valves, and Hastelloy C-276 tubing
Feeding several reactants at controlled ratios	Multiple pumps under VPware, with pump-group and rate/pressure-following control

Need	Recommended Vindum solution
Scaling up a process	Add pumps in parallel — VPware controls up to 16 from a single PC
Integrating with reactor automation	USB and RS232 ports; Modbus, OPC UA, DDE, DLL, LabVIEW, and analog/digital control (Ethernet via a serial-to-Ethernet converter)

VPware and all of our pump-control software — including Modbus, DDE, a DLL, and a LabVIEW Instrument Driver — are provided free with every pump. The same VPware software controls up to 16 Vindum pumps from a single PC, and the pumps also support OPC UA and analog/digital control at no extra charge. The pumps communicate over USB and RS232, and the RS232 port can be placed on an Ethernet network using a serial-to-Ethernet converter, so they integrate cleanly into custom and automated reactor and pilot-plant systems.

## In the Field

Vindum pumps are used to feed reactants and catalysts in catalyst-screening, biofuels, and process-chemistry research, including high-throughput experimentation systems. They are in service at major oil and petrochemical companies, catalyst producers, national user facilities, and university research labs worldwide — a track record that spans more than three decades.

*“... precise and versatile dosing of a wide range of liquids and liquefied gases is essential. The VP pump meets these requirements.”* — Andreas Lagotzki, hte GmbH. [Read the testimonial](#)

## Talk to Us About Your Reactor Feed

Every reactor system is a little different. Tell us your reactants, your flow rates, your pressure and temperature range, whether you need to co-feed or scale up, and how you'd like to control the system, and we'll help you select the right pump configuration — and, where available, arrange a loaner pump so you can evaluate Vindum performance in your own lab.

**Contact:** [sales@vindum.com](mailto:sales@vindum.com) · +1 281-782-8312, ext. 1 · [vindum.com/contact-us](http://vindum.com/contact-us)