Core Flooding Pumps for EOR and Reservoir Research

Application Note

The Application

Core flooding (also called rock core analysis or coreflooding) is one of the most demanding fluid-injection workflows in petroleum and reservoir research. A cylindrical rock sample cut from a reservoir is sealed inside a core holder, brought to representative reservoir pressure and temperature, and then flooded with a working fluid — brine, crude oil, surfactant or polymer solutions, or a miscible gas such as CO_2 — to study how that fluid displaces oil from the pore network.

The data from these experiments tells producers which enhanced oil recovery (EOR) method and formulation will recover the most oil from a given reservoir, and underpins related work in CO_2 sequestration, relative-permeability measurement, and formation-damage studies.

Core flooding places an unusual set of demands on the injection pump:

- **Long duration.** A single flood can run for hours, days, or weeks of uninterrupted injection. The pump cannot pause to refill.
- **Very low, very stable flow rates.** Displacement fronts are studied at rates down to microliters per minute, where any flow instability corrupts the measurement.
- **High, precisely controlled pressure.** Tests are run at reservoir conditions, often many thousands of psi, with pressure held to tight tolerances and logged continuously.
- **Challenging fluids.** Brines, viscous oils, polymers, corrosive chemical formulations, and liquefied or supercritical gases all appear in the same lab.
- **Trustworthy data.** Because the pump's own behavior is part of the measurement, pressure and volume must be recorded accurately throughout.

Why Vindum Pumps

Vindum VP-Series metering pumps and VIPR-Series syringe pumps were designed for exactly this class of work, and have been used in core flooding and reservoir research by major oil companies, catalyst and petrochemical producers, national laboratories, and universities for more than three decades.

- **Continuous, pulse-free flow.** This is the single most important requirement for core flooding, where pressure is monitored and logged and the pump must not introduce pressure variations of its own. Vindum's patented constant-volume valves eliminate pulses at cylinder switchover, so a VP-Series pump delivers truly continuous flow from a single, compact unit — no pulse dampener required, and no gap in the data. Two VIPR-Series syringe pumps can be paired to achieve the same continuous, pulse-free delivery for higher-volume or highly compressible fluids, running for days or months without stopping.
- **Precision at low flow and high pressure.** Ball-screw drives, zero-hysteresis gearing, and millisecond motor control give accurate volumetric delivery down to 0.1 µL/min,

while a high-accuracy transducer (0.1% error) and 0.1 psi servo control hold pressure precisely — at pressures up to 25,000 psi on select VP-Series models.

- **Deliver or receive, in rate or pressure mode.** Like most laboratory pumps, Vindum pumps run in constant-rate or constant-pressure mode — but they take that a step further: each pump can either deliver or receive fluid in either mode. That is exactly what a downstream pump must do to hold back-pressure or accept produced fluid while the upstream pump injects, which makes a two-pump core-flood setup clean and straightforward. A pressure-bi-directional mode goes further still, automatically switching between delivering and receiving fluid — without stopping — to hold a target pressure even as the system pressurizes or relaxes on its own. Pressure- or rate-following, multi-step ramping sequences, and a total of 13 to 15 pumping modes round out the control options included with every pump.
- **Automatic confining-pressure control (master/follower).** A core flood uses one pump to inject fluid into the core (the pore pressure) and another to hold the confining pressure on the outside of the core. VPware's master/follower feature ties the two together automatically: you designate an injection pump as the master and a confining pump as the follower, then set the confining pressure as a function of the core pressure — either as a fixed differential or a percentage — and the follower tracks the master without manual intervention. It is a feature core-flood customers particularly appreciate.
- **Recirculation software for relative permeability.** Our optional Recirculation add-on is purpose-built for core flooding: it is used to determine relative permeability curves, including 2-phase (oil-water) and 3-phase (oil-water-gas) relative permeability. Recirculation is sold separately from the included control software.
- **Challenging-fluid capability.** Optional Hastelloy C-276 wetted parts handle corrosive brines and chemical formulations; high-temperature EXT and HT models pump at up to 160 °C (320 °F) for thermal-EOR and reservoir-condition work; and the VIPR-Series, with its liquefied-gas piston seal and optional temperature-control jacket, is purpose-built for CO_2 and other compressible or supercritical fluids.
- **Built to handle concentrated brines.** Core flooding often uses concentrated brines, which create a particular challenge: at very low flow rates, water in the thin micro-layer of brine on the piston can evaporate, leaving a hard salt deposit that leads to seal leaks. VP-Series pumps address this with an optional wash kit that keeps salt from building up on the piston, while VIPR-Series pumps use a vacuum-driven wash system that draws distilled water into the cylinder barrel below the piston to help prevent salt buildup on the cylinder surface.
- **Data you can trust.** VPware logs any pump parameter at intervals as fast as 50 milliseconds, with real-time graphing and full data export, so the injection record sits right alongside your core measurements.
- **Designed to fit the bench.** The VP-Series has the smallest footprint of any continuous-flow pump of its kind — much smaller than typical single-cylinder syringe pumps — which matters in crowded core-analysis rigs and pilot skids.

Recommended Configuration

A typical core flooding setup uses one injection pump upstream of the core holder and, for many tests, a second pump downstream to provide back-pressure or to receive produced fluid. Vindum pumps support both roles.

Need	Recommended Vindum solution
Continuous low-rate liquid injection (brine, oil, chemical floods)	A single VP-Series metering pump — continuous, pulse-free flow from one compact unit
Injection at reservoir pressures to 25,000 psi	High-pressure VP-Series model sized to your pressure range
CO_2, supercritical, or highly compressible fluid injection	Paired VIPR-Series syringe pumps with liquefied-gas seal and temperature-control jacket
Corrosive brines or chemical formulations	Hastelloy C-276 wetted parts (VP or VIPR)
Concentrated brines at low flow rates	VP-Series optional wash kit, or the VIPR-Series built-in vacuum-driven wash system, to prevent salt buildup on the piston/cylinder
Relative permeability measurement (2- or 3-phase)	Optional Recirculation software add-on
Thermal EOR / elevated-temperature cores	VP-Series EXT or HT high-temperature models (to 160 °C)
Two-sided flooding or back-pressure control	A second Vindum pump in pressure- or rate-following mode
Automatic confining (overburden) pressure	VPware master/follower control, with confining pressure set as a differential or percentage of pore pressure

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 VP-Series and VIPR-Series 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 Vindum pumps integrate cleanly into custom and automated core-analysis systems.

In the Field

Researchers building high-end reservoir and core-analysis equipment have relied on Vindum pumps precisely for this combination of pulseless flow, microliter-per-minute precision, high pressure, and small footprint. The pumps are in service at national user facilities, major oil and petrochemical companies, and university research labs worldwide — a track record that spans more than thirty years.

> *"We have been using Vindum pumps since 2015 … in core flooding studies to investigate the flow properties of coal cores."* — Prof. Ryan Armstrong, University of New South Wales. Read the testimonial

Talk to Us About Your Core Flooding Setup

Every core flooding rig is a little different. Tell us your fluids, your pressure and temperature range, your flow rates, 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.

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