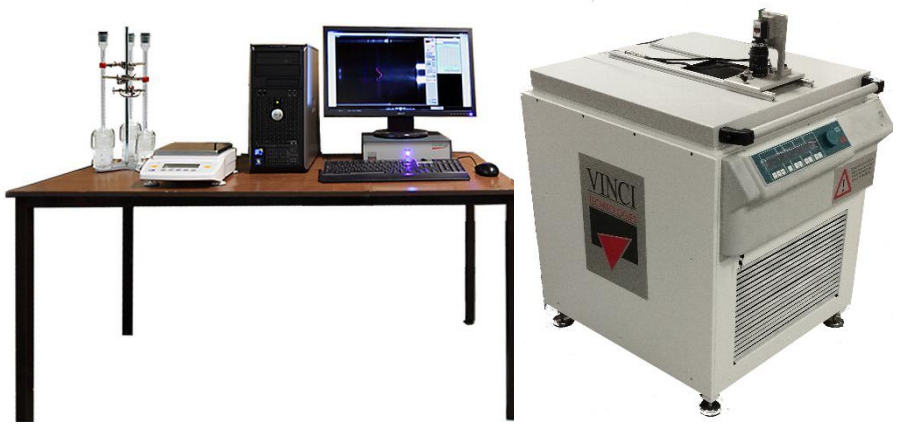
Determination of Capillary pressure & relative permeability curves

With Refrigerated Centrifuge

Multi speed centrifuge experiments



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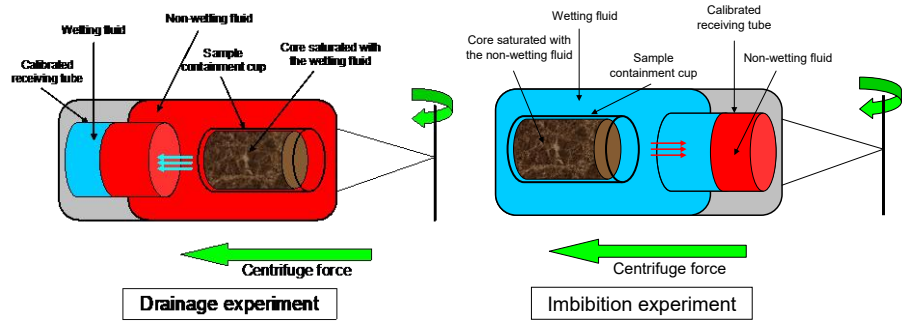
Introduction

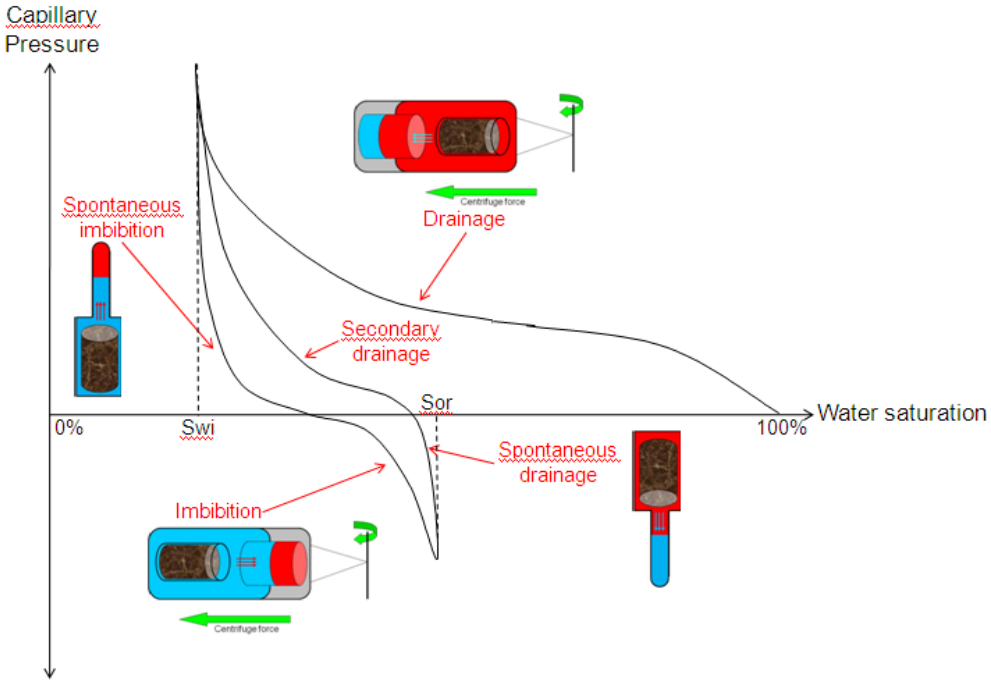
As an alternative to the porous diaphragm method (see Vinci's CAPRI), the centrifuge technique is commonly used to determine **capillary pressure properties** of reservoir rocks.

In essence, a core sample fully saturated with one phase (brine or oil) is immersed in the other phase inside a centrifuge tube. A set of different speeds is selected to obtain different capillary pressures. At each step, a constant angular velocity is maintained until phase stabilization. In tandem, an image capturing system monitors and records the interface level in a receiving tube.

Both drainage and imbibition experiments can be carried out, as shown in the pictures below.



The centrifuge can also be employed to determine relative permeability-fluid saturation profiles.

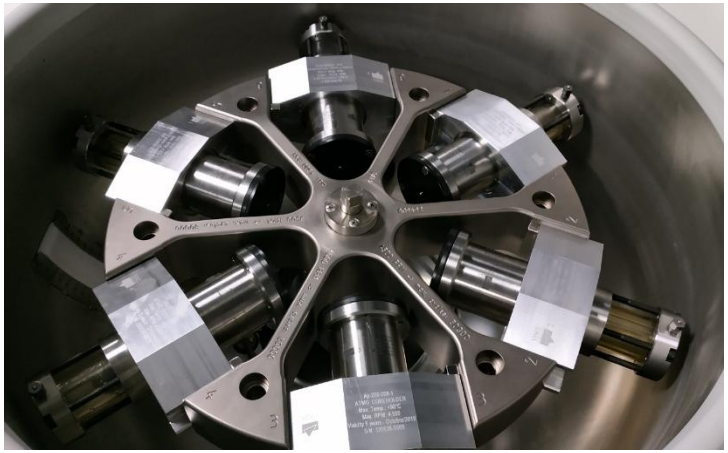


The effluent volume over time for each speed is utilized to construct the relative permeability curves.

Data collection is therefore no more complicated than for the capillary pressure case except that the sampling frequency is greatly increased, particularly in the transition between two rotation speeds.

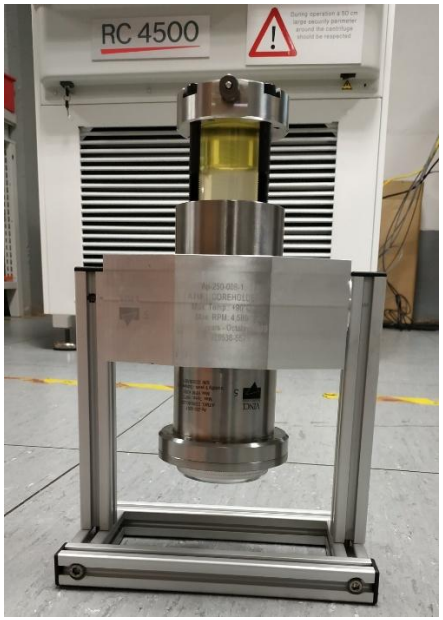
Refrigerated centrifuge (RC)

The RC is a refrigerated centrifuge that performs forced drainage and imbibition experiments (Spontaneous Imbibition and drainage experiments are performed with Amott cells or the OSID). The latter enable the automatic determination of capillary pressure & relative permeability curves on up to six core samples simultaneously.



Carefully designed core holders warrant a safe and meticulous operation. They encompass a sample container and a calibrated receiving tube.

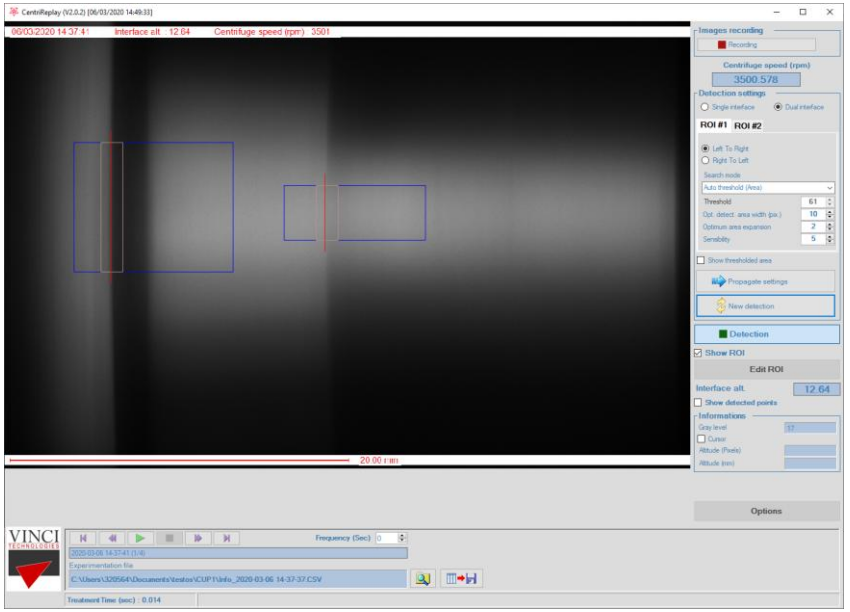
Notable features of Vinci's design include the ability to accommodate either 1 or 1.5'' diameter cores and a unique core holder for both drainage and imbibition experiments.



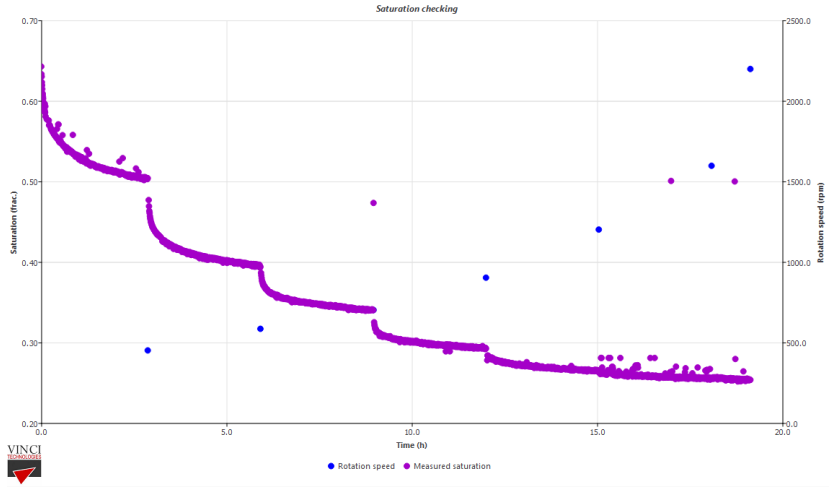
Drainage / Imbibition Core Holder / Amott cell

The centrifuge is equipped with a high resolution digital camera system that monitors displaced fluid volumes in each core holder. By virtue of a 1360 x 1024 pixel resolution, the interface level is detected with an error of less than 0.01 cc for a 10 cc receiving tube.

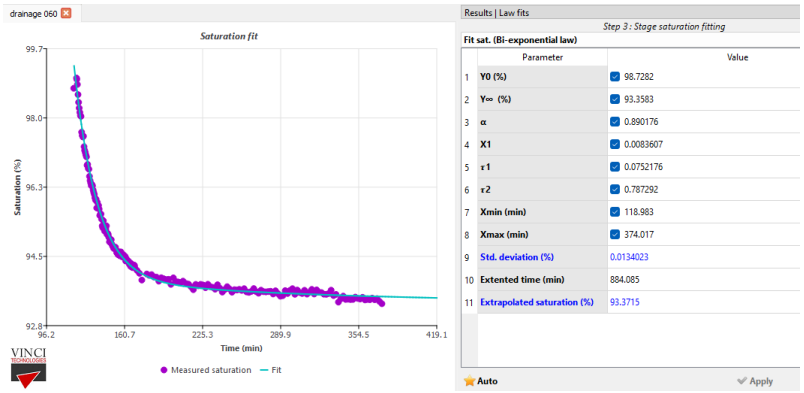
A Vinci proprietary software automatically detects the fluid interface and converts it to volume produced.



Due to its long rotor arms, the RC achieves high capillary pressures at relatively low rotation speeds. Consequently, the set rotation speed is stable even at high capillary pressures and the interface detection remains perfect throughout the equipment's operating range.



The great stability and accuracy of the RC yields high quality production curves.



Overburden core holder

For overburden experiments, at reservoir conditions of pressure (5,000 psi), dedicated core holders can be provided.

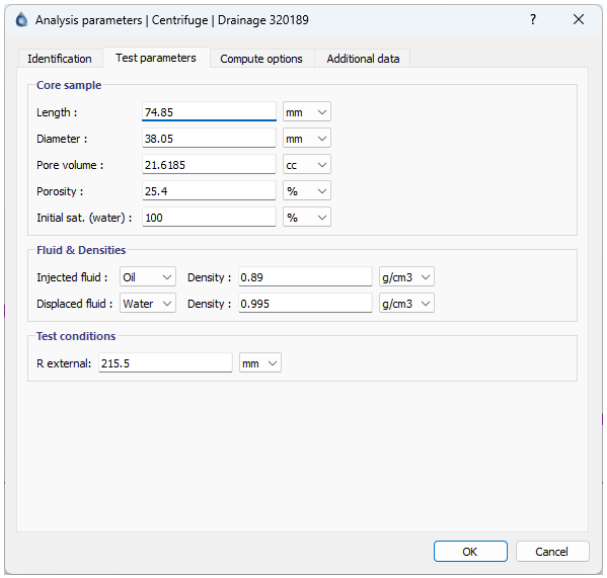
Confining pressure can be applied prior to testing using a manual pump.

The loading mode is hydrostatic, implying equal axial and radial pressure confining pressures.

Moreover, the confining pressure does not have to be released when switching from drainage to imbibition.

Simulation package

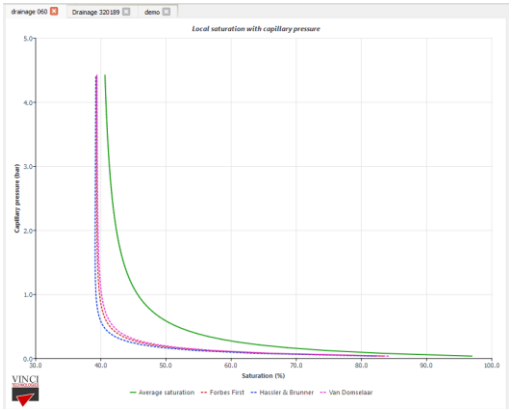
RC is provided with a dedicated simulation package. The latter includes a special module for centrifuge data acquisition which automatically constructs the production curve while calculating instantaneous average saturation and capillary pressure.

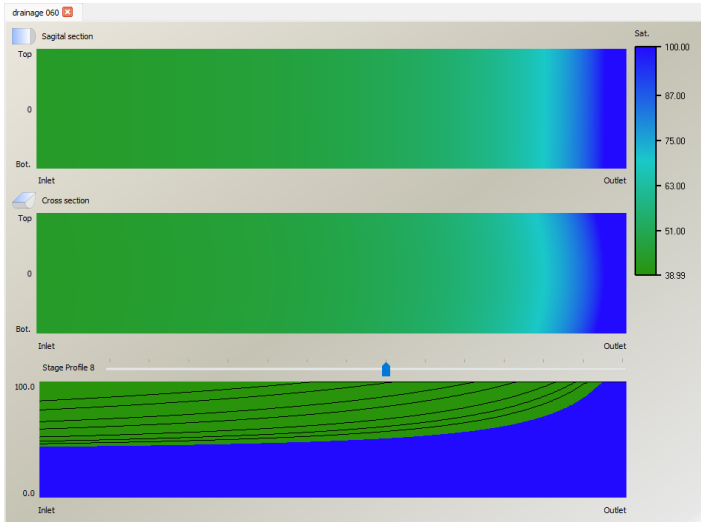


This simulation package has been developed in collaboration with core analysis specialists to be accurate and powerful, yet user-friendly.

The simulation package uses the latest research methods published in the Society of Core Analysis yearly proceedings.

For each experimental curve, different fits (linear, splines, bi-exponential, etc.) are proposed. Kr and Pc are obtained via numerical history matching. The modules permit classical calculations (Hassler & Brunner, Forbes, etc.) as well as accurate simulations.





Technical Specifications

Item	Type / model / specification	
Core holder:	Number of Core Holder:	6
	Core Ø:	1”, 30 mm or 1.5”
	Core length:	Up to 4 ” for atm. coreholder Up to 2.5” for overburden core holder
	Receiving tubes	13 and 28 cc Options for 3; 4 and 20 cc
Capillary pressure (for atm. Core holder)	Oil-water drainage:	0.0 to 14.9 bar (0.03 to 216 psi)
	Oil-water imbibition:	**– 0.0 to – 18.6 bar** (–0.03 to – 269 psi)
	Air-water drainage:	**0.0 to 44.6 bar** (0.1 to 647 psi)
	Air-water imbibition:	**– 0.1 to – 55.6 bar** (–0.1 to – 806 psi)
Speed:	Speed:	from 50 to 4,500 rpm
	Speed regulation:	± 1 rpm
	Speed ramp:	Available
Temperature:	From RT to +90°C	
Larger radius:	26 cm	
Accuracy on reading:	0.01cc	