Core Analysis

TELEDYNE ISCO
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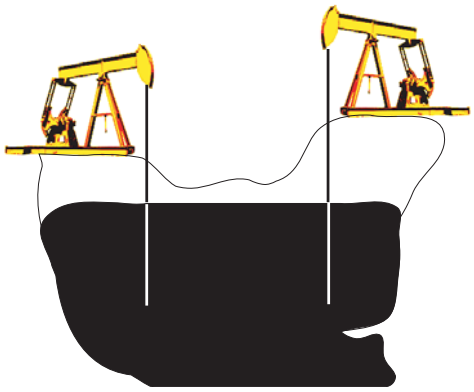
Syringe Pump Application Note AN3

Introduction

When oil reserves are first discovered and oil recovery begins, production rates usually start high and then drop off over time. Over the lifetime of an oil well, petroleum engineers continually look for new ways to prevent these production rate drops and maintain maximum profitability. By employing various techniques known as enhanced oil recovery (EOR), the life of an oil well can be increased and profits preserved. In some cases, EOR techniques must be applied to new wells in order to make them profitable from the beginning. Teledyne Isco pumps are used in laboratory testing of these EOR techniques.



Theory

Early in the life of an oil well, pressure from gases in the oil helps push the oil toward the well inlet and out. Oil of this type is often called “live oil”. However, over time, these gases become depleted, thereby creating a condition called “depleted oil”. Depleted oil is much more difficult to recover without help. With much of the oil still in the ground, there is still money to be made. EOR techniques are then brought into play to keep oil and cash flows high.

EOR techniques usually involve pumping steam, salt water, CO_2, or other various fluids into the ground around the perimeter of the oil field. These fluids will force oil toward the oil well, thereby increasing production.

To determine which EOR techniques are best, tests are conducted to see how easily various fluids can flow through the reservoir rock.

Rock Core Flooding

Core Flooding is a common test to determine rock permeability, and how well various fluids, including oil, will flow through it. First, a cylindrical rock sample or core is cut from the oil reservoir. The core is placed in a rock core holder, and the outer surface is pressurized to simulate the loads, or 3-axis stresses, that the core was under when it was removed. Of these loads or stresses, some are caused by the weight of the material above the core, which is known as the “overburdened” pressure. Loads on the rock will affect the core’s permeability to fluids, so it is important to duplicate them during testing. A test fluid is then pumped through the core, and the flow rates and pressure drops across the core are measured. From this data, the resistance to flow is evaluated.

Core Flooding Test Setup

A typical rock core flooding schematic is shown below.

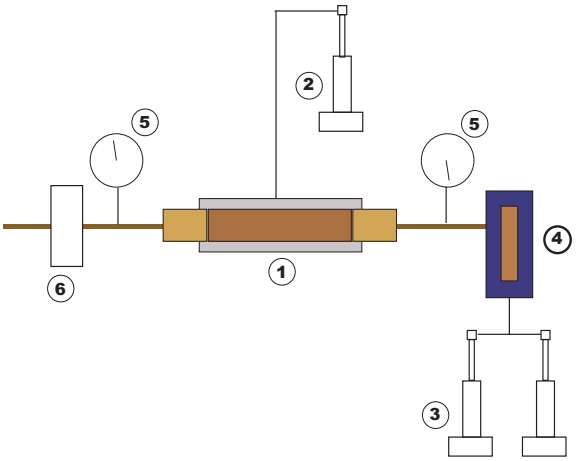


Figure 1: Schematic Basic System Components:

1. Core Holder
2. Overburden pump (Teledyne Isco Single Pump)
3. Flow pump (Teledyne Isco Dual Pump System)
4. Accumulator
5. Pressure gauges or differential pressure gauge
6. Back pressure regulator

The purpose of the system above is to recreate the conditions from which the core was removed, and then to pump fluids through the rock core to determine permeability. A Teledyne Isco syringe pump running in “constant pressure mode” is used to duplicate the loads and stresses. A Teledyne Isco dual pump system, run-

ning in “constant flow mode”, is used to introduce fluid into the rock core holder and monitor the flow rates.

If the fluid is considered corrosive or potentially damaging to the pump, an accumulator or transfer cylinder is sometimes used. An accumulator has a bladder; a transfer cylinder uses a sliding piston. Both devices function by pumping a clean fluid into one end, thereby forcing the corrosive fluid out the other end without the fluids coming into contact with each other.

It takes a least several hours at high pressures and low flow rates for the newly introduced fluid to displace the oil from the rock sample. From the data obtained from rock core flooding, companies doing enhanced oil reservoir recovery can derive the best way to recover the maximum amount of oil.

Potential Users

Throughout the world, petroleum and chemical engineers are using Teledyne Isco syringe pumps for rock core flooding. These researchers work for:

- Production research divisions of oil companies
- Contract labs doing enhanced oil recovery research
- Universities doing rock and petroleum studies

Companies doing core flooding may be found in oil producing nations like the US, Canada, China, Russia, The UK, Mexico, and Venezuela. They can also be found in technology exporting nations like Japan, France, The Netherlands, Belgium, and Germany.

Why Teledyne Isco pumps?

Teledyne Isco pumps are highly accurate and reliable, and have pulseless flow. Flow rate accuracies are +/- 0.5% or better. Pumps are competitively priced and are very versatile. Academic customers find this particularly attractive, as the pump can be used for other types of research.

Recommendations for Teledyne Isco Pumps

While all of Teledyne Isco pumps are suitable for core flooding applications, engineers typically buy the Model 500D pump system, due to its favorable volume size and pressure rating. Other models can be used if high pressures are required. The Model 65D is especially suited when conducting tests on core samples from offshore wells, since the overburden pressures reach up to 1,360 Bar (20,000 psi).

Table 1: Recommended Core Flooding Pumps

	Model	Wetted Materials Option	Pressure Transducer Option	External Control Option
Overburden Pump	500D	Hastelloy	0.1% transducer	Labview Driver
Flow Pump	A500	Hastelloy	0.1% transducer	Labview Driver

Table 2: Other Pump Models Available

	1000D	500D	260D	100DX	100DM	65D
Flow Range (ml/min)	0.100 - 408	0.001 - 204	0.001 - 107	0.00001 - 60	0.00001 - 30	0.00001 - 25
Pressure Range (psi)	0 - 2,000	0 - 3,750	0 - 7,500	0 - 10,000	0 - 10,000	0 - 20,000

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