Reluctant Oil Well Quick Start Guide

What's it all about then?

This experiment is all about oil. In this experiment you will be extracting glycerol (which represents oil) from a two dimensional oil well called a Hele-Shaw cell (after the British ship engineer who invented it). You can also create fractal patterns with the glycerol, which always impresses the students.

It's a messy experiment, but it's a great one to get all the students involved in.

The kit

- The Hele-Shaw cell. Two transparent Perspex plates with a thin gap between. The cell has 5 valves that can be used for injecting or extracting air or glycerol.
- Syringes
- Beakers
- Paper towels
- Lab coats. This is a particularly messy experiment so everyone does have to wear a lab coat.

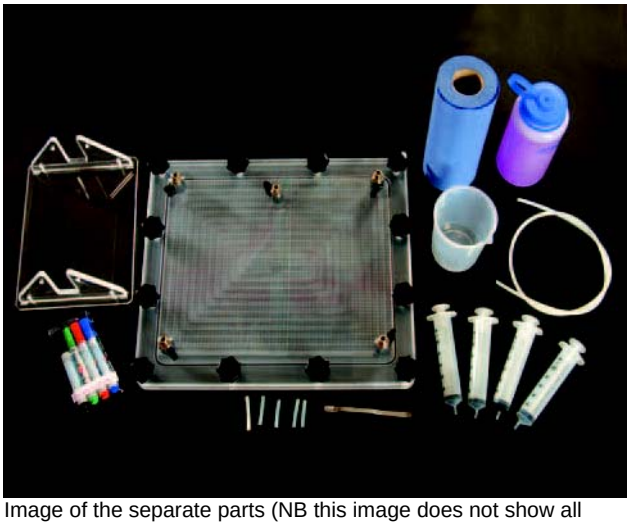

Image of the separate parts (NB this image does not show all the pieces of the kit).

How to present this

This is a guide to presenting the experiment. You do not have to follow it exactly and you can expand or shorten the experiment to fill the time allocated.

Remember - the emphasis here is to ensure the students interact with the equipment, try things out for themselves and above all - have 'fun'.

There is a more detailed version of this doucument avilable which provides background information on the experiment. This is available from the Operations Coordinator or from the Lab in a Lorry website: http://www.labinalorry.org.uk/volunteer_information/downloads.cfm

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Introduction

Start by asking students what oil is, where it comes from and how it's made. Always remember to keep it simple. Something along the lines of "Oil is made from dead sea creatures which lived millions of years ago. They get squashed and heated up and then, over time, turn into oil"

Why do we need oil?
What do we use oil for?
Highlight to the students the various uses of oil, typically things like fuels, plastics, bitumen etc.

Where do we get oil from?
In short we find oil in reservoirs underground. Contrary to popular belief oil is generally not found as a big lake - it is inside sedimentary rocks! The rocks have tiny spaces between the grains - called pores (like your skin) which store the oil.

Part 2: Simulation of oil extraction

2.1 Start off with the cell1/2 full of glycerol. After your introduction ask the students to extract the 'oil' from the cell. This is a great hands-on experiment and it really does work best if you let the students investigate it themselves and experiment with the kit.

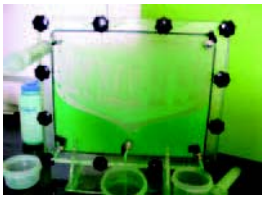
2.2 When the students start to extract the glycerol they may open some of the bottom valves and wait for the glycerol to drip out, however, there will be a point when there will be glycerol in the cell, but it will not drip out as the pressure on the inside of the cell becomes lower than atmospheric pressure.

What do we need to do to change this? Opening the top valves will allow more air into the cell and equalize the pressure.

To extract the glycerol more quickly encourage the students to use the available syringes.

2.3 Often the students will use the syringes to pull the glycerol out from one of the bottom valves. When they do this the glycerol will dip down into a V shape. Ask the students why they think this may be happening. You could introduce the concept of viscosity here.

This shape is known in the oil industry as the greed curve because it occurs if you attempt to extract the oil too quickly.



A greed curve

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2.4 The most efficient way to extract the glycerol is by pushing air in through the top valves with the glycerol coming out though the bottom valves. In a real oil well they extract the oil in a similar way, pushing water into the well and forcing the oil out but even with using this method a large amount of oil remains in the ground and oil companies can only extract around 30–40% of it.

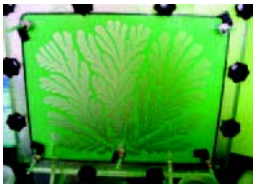
When the students have explored oil extraction refer back to your introduction and relate what they have found to the real life example of an oil well.

What is happening when you create a fractal?

As you let the air back into the cell the plates move apart. As the plates move the air fills the gap created faster than the glycerol, creating a fractal pattern. This is due to the variations in the flow velocity of the glycerol within the cell. Fractals are repeating patterns which occur over a range of scales. They appear a lot in nature and we have a DVD on board which will give you some examples such as leaves or trees.

Part 3: Creating fractals

3.1 Fill ⅓ of the cell with glycerol and ask some of the students to extract the air from the top valves. As the air is extracted the glycerol which is remaining becomes a thin layer and almost transparent. Once the air has been removed ask the students to open one of the bottom valves. As the air rushes back into the cell a fractal pattern will form.



A fractal

Lab in a Lorry
Institute of Physics
76 Portland Place
London W1B 1NT

T +44 (0)20 7470 4800
F +44 (0)20 7470 4848
E labinalorry@iop.org
W www.labinalorry.org.uk

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