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Lesson Plan – Page 1

Secondary Pupils

Topic: Methods of oil extraction

Topic Overview: Oil extraction is a complicated process which involves multiple steps and processes.

Activity Overview: Pupils will investigate how oil and natural gas are pumped or recovered from the earth. They will learn how oil flows from the well by its own pressure (primary recovery) or is pumped out is forced from a rock formation by a method of injecting natural gas or water into the formation (secondary recovery).

Core Experience and Outcome:

SCN 3-17b: I can participate in practical activities to extract useful substances from natural resources.

SCN 4-08b: Through experimentation, I can explain floating and sinking in terms of the relative densities of different materials.

Learning Intention:

I am learning how oil and gas can be extracted.

Success Criteria:

I can model and explain methods or oil and gas extraction.

Key Vocabulary

Density: a measure of a quantity such as mass per unit volume**.**

Primary recovery: oil obtained from natural pressures in the reservoir

Secondary recovery: the injection of steam or chemicals to improve recovery

Waterflooding: water is used to push more oil out of the reservoir

Resources

Primary Recovery Experiment Record

Oil Well Drilling Experiment Record

Book Reference:
Oil and Natural Gas,
pages 32-37

Materials for Introductory Activity:

- One Carbonated beverage

Materials per Group for Activity 1:

- Medium zip top freezer bag
- 2 straws
- Water
- Pan
- Paper towels
- Scissors

Materials for Activity 2:

- 500 ml conical flask
- 2 hole rubber bung to fit flask
- 250 ml beaker
- 150 ml vegetable oil
- 350 ml water
- Oil soluble colouring
- 60 cc syringe
- Petroleum jelly

Materials per Group for Elaboration Activity:

- 12 Egg carton
- 12 Balloons
- Pencil
- Skewer
- Access to tap
- 2 Straws
- Tray

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Teacher Information:

Read to pupils from Oil and Natural Gas, pages 32-33:
Locating a suitable site for drilling is just the first step in extracting oil. Before drilling can begin, companies must make sure that they have the legal right to drill, and that the impact of drilling on the environment is acceptable. This can take years. Once they finally have the go ahead, drilling begins. The exact procedure varies, but the idea is first to drill down to just above where the oil is located. Then they insert a casing of concrete into the newly drilled hole to make it stronger. Next, they make little holes in the casing near the bottom, which will let oil in, and top the well with a special assembly of control and safety valves called a "Christmas tree." Finally, they may send down acid or pressurized sand to break through the last layer of rock and start the oil flowing into the well.

pages 34-35:
Sometimes large reserves of oil are found deep beneath the ocean bed. To get the oil out, huge platforms are built far out at sea to provide a base for drilling rigs that bore right down into the rocks of the sea floor. After processing on the platform, oil is sent ashore via pipelines or held in separate floating storage facilities before being off-loaded into large tankers. Offshore oil rigs are gigantic structures. Many have legs that stretch hundreds of meters from the surface to the ocean floor. The Petronius Platform in the Gulf of Mexico, for example, is the world's tallest freestanding structure, standing some 2000ft (610 m) above the seabed. Rigs have to be immensely strong, able to withstand gale-force wind and relentless pounding by huge waves

pages 36-37:
'The first offshore well out of sight of land was drilled in 1947 in 15 feet of water. Just 30 years ago, deepwater operations meant exploring water depths up to 500 feet. Today, deepwater refers to a well in up to 5,000 feet of water, with ultra-deepwater exploratory drilling now occurring in water depths over 10,000 feet. A major new oil or gas floating production platform can cost billions of dollars and take up to three years to complete. Most of today's exploration is in frontier, deepwater, and ultra-deepwater areas. The challenges that have been overcome and those that remain-in the exploitation of deepwater and ultra-deepwater reserves can be more daunting than the challenges of exploring space.

Additional Information:

Once the oil producers are confident they have found the right kinds of underground rock formation, they can begin drilling production wells. When the well first hits the reservoir, some of the oil may come to the surface immediately due to the release of pressure in the reservoir. Pressure from millions of tons of rock lying on the oil and from the earth's natural heat build up in the reserve and expand any gases that may be in the rock. When the well strikes the reserve, this pressure is released, much like the air escaping from a balloon. The pressure forces the oil through the rock and up the well to the surface. Years ago, when the equipment wasn't as good, it was sometimes difficult to prevent the oil from spurting hundreds of feet out of the ground in a "gusher." Today, however, oil companies install special equipment on their wells called "blowout preventers" that prevents the gushers and helps to control the pressure inside the well.
When a new oil field first begins producing oil, the natural pressures in the reservoir force the oil through the rock pores, into fractures and up production wells. This natural flow of oil is called "primary production." It can go on for days or years. But after a while, an oil reservoir begins to lose pressure. The natural oil flow begins dropping off and oil companies must use pumps to bring the oil to the surface.
It is not uncommon for natural gas to be found along with the petroleum. Oil companies can separate the gas from the oil and inject it back into the reservoir to increase the pressure to keep the oil flowing. But sometimes this is not enough to keep the oil flowing and a lot of oil will be left behind in the ground. Recovery is then used to increase the amount of oil produced from the well.
Imagine spilling a can of oil on a concrete floor. You would be able to wipe some of it up, but a thin film of oil might be left on the floor. You could take a hose and spray the floor with water to wash away some of the oil. This is basically what oil producers can do to an oil reservoir during secondary recovery. They drill wells called "injection wells" and use them like gigantic hoses to pump water into an oil reservoir. The water washes some of the remaining oil out of the rock pores and pushes it through the reservoir to production wells. This is called "waterflooding."

Establishing Prior Knowledge

- What is pressure? Could you describe how pressure could make oil rise out of a well?
- What happens when you mix oil and water?
- Can you explain why oil and water do not mix?

Concept Introduction

Oil flows from the well by its own pressure (primary recovery) or is pumped out.
It can be forced from a rock formation by a method of injecting natural gas or water into the formation. This is known as secondary recovery

Introductory Activity

Shake a bottled carbonated beverage and open it to begin the lesson. Explain to pupils that today we are going to learn how pressure aids in the retrieval process of oil. Because oil, natural gas and water are under extreme pressure below the surface, these fluids typically flow up a well without assistance, much like when a soft drink has been shaken and then opened.

Activity 1: Primary Recovery

1. Split pupils into small groups, and have them assign the following roles:

    Recorder: the pupil who writes down the information from the experiment
    Reporter: the pupil who presents their group's findings to the class
    Materials Manager: the pupil who gathers and puts away the materials for the experiment
    Clarifier: the pupil who oversees the experiment and ensures their group stays on task.

2. Give each group a copy of the Primary Recovery Experiment Record

The following questions should be answered by each pupil at the end of the activity.

- What happens when you blow through one of the straws?
  Possible answer: Water is pushed out of the other straw.

- Why do you think blowing on one of the straws causes water to come out the other?
  Possible answer: Due to the increased pressure within the bag caused by adding more air.

- How do you think this experiment relates to getting petroleum out of the ground?
  Possible answer: It shows how changes in pressure can affect the flow of liquids like oil in rock formations.

Activity 2: Secondary Recovery (Teacher demo)

1. Pour 350 ml of water into a flask. Mix red dye with 150 ml of vegetable oil and pour on top of the water. This is showing how oil is less dense and floats.

2. Insert stopper, and with your fingers covering the holes, shake vigorously. Then allow time for settlement.

3. Insert both tubes into stopper (see example). One piece of tubing should reach into the oil layer. Place the opposite end of this tubing into the beaker.
The other piece of tubing should reach into the water layer.

4. Fill the syringe with water. Using the syringe, slowly discharge the water into the tubing that reaches into the water layer. Expect a short delay, allow for travel time of liquid.

Elaboration: Oil well Drilling Experiment

This activity was developed to provide pupils will and opportunity to drill an oil well and see 'oil 'gushing out under its own pressure

1. Arrange pupils into small groups
2. Hand out Oil Well Drilling Experiment Record and necessary equipment.

Answers for Assessment Questions:

1. What caused the 'oil' to come up out of the wells?
   Answer: the pressure exerted from the surrounding 'rocks' and other substances in this cause the balloon itself was under pressure.
2. What percentage of the wells drilled were successful?
   Answer: will vary depending on numbers of various wells created
3. The recovery of oil which utilizes only the natural pressures of the reservoir is called:
   Answer: a. Primary Recovery
4. The injection of water or chemicals to improve oil recovery is called:
   Answer: b. Secondary Recovery
5. True/False. In waterflooding, water is forced into the formation to increase the pressure.
   Answer: True

Extension Ideas:

- Explore current oil extraction techniques in the UK.

Home Links

- Ask pupils to think of other examples of pressure related systems.

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Primary Recovery Experiment Record

Secondary Pupils

Materials

- Medium zip top freezer bag
- 2 straws
- Water
- Pan
- Paper towels
- Scissors

Instructions

1. Using a pair of sharp scissors cut one end of each straw at an angle which will create a sharp point.

2. Fill the plastic bag with water. Then close the bag, allowing for NO air spaces. Place the filled and locked bag into the pan.

3. Working cooperatively, one pupil hold the bag steady in an upward position, while 2 other pupils insert the sharp end of each straw on opposite sides of the seal. See the picture above for clarification. Make sure that there is no leakage around the straw. If necessary, seal with tape.

4. Answer the following question: Predict what will happen when one student blows through one of the two straws?

5. Now, one student should blow through one of the straws. Observe what happens.

6. Discuss and answer the questions on the back of this page with your group and be prepared to discuss your finding with the class.

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Experiment Record

Secondary Pupils

Assessment Questions:

1. What happens when you blow through one of the straws?

2. Why do you think blowing on one of the straws causes water to come out the other?

3. How do you think this experiment relates to getting petroleum out of the ground?

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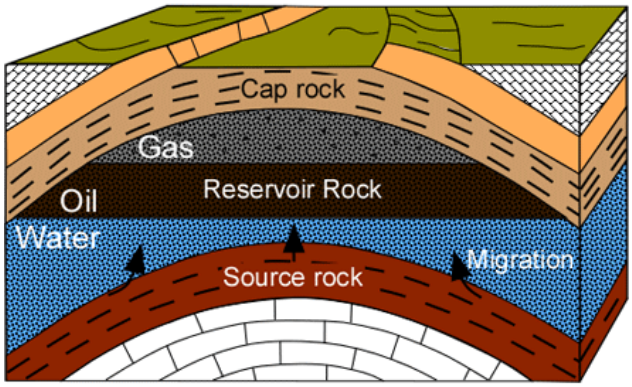
Oil Well Drilling Experiment Record

Secondary Pupils

Materials

- 12 Egg carton
- 12 Balloons
- Straws
- Access to tap
- Skewer
- Tray
- Pencil
- Lab coats
- Safety goggles
- Black food colouring (optional)
- Tape



Anticline Trap

Instructions

1. Put a few drops of the food colouring into a few balloons and fill with water from tap until slightly larger than egg sized. Fill the remaining balloons with air till approximately the same size.

2. Turn egg carton upside down and use pencil to poke a hole though the bottom of each egg cup.

3. Place the filled balloons in the egg cups at random, close and seal the egg carton with a bit of tape. It should be difficult to close if your balloons are filled appropriately; this creates the pressure, representing the weight of the rocks surrounding the oil deposit.

4. Decorate the outside of the egg carton to create geologic layers (shown above).

5. Don safety goggles and an apron or lab coat, you are now ready to commence drilling!

6. With your egg carton upside down in a tray (for catching mess), place a portion of straw into the hole made with the pencil (drill site), this represents the pipe casing in an oil well. Hold the straw in place firmly while your partner uses the skewer to drill through the cap rock (balloon), it is important to maintain a steady pressure on the straw.

7. Repeat the procedure for each drill site so that you have 12 wells.

If you hit ‘oil’ it should gush up out of the straw under its own pressure, if you hit a ‘dry hole’ only air will come out your straw.

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Oil Well Drilling Experiment Record

Secondary Pupils

Fill out the chart bellow and calculate the percentage of each type of oil well drilled.

Type of wells drilled	Number of wells Drilled	Percentage (%)
Dry Holes		
Gushers		
Total wells	12	100

Assessment Questions:

1. What caused the 'oil' to come up out of the wells?

2. What percentage of the wells drilled were successful?

3. The recovery of oil which utilizes only the natural pressures of the reservoir is called:
   a. Primary recovery
   b. Fractured recover
   c. Tertiary recovery
   d. Secondary recovery

4. The injection of water or chemicals to improve oil recovery is called:
   a. Primary recovery
   b. Fractured recover
   c. Tertiary recovery
   d. Secondary recovery

5. True/False. In waterflooding, water is forced into the formation to increase the pressure.