Pump It Up

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Lesson Plan - Page 1

INTERMEDIATE STUDENTS

Topic

Getting the oil out

Source

Oil and Natural Gas, pages 32-33, 34-35, 36-37

Objective

Students will learn 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).

Lesson Preparations

1. Gather materials for experiments.
2. Read over Lesson Plan
3. Make copies of lab handouts

Elaboration materials

Cardboard box with dimensions 12 inch x 12 inch x 9 ½ inch (a wine box works great)

Plastic bag to line the cardboard box

4 Pieces of 2 inch thick blue Styrofoam (sized to fit within cardboard box)

1 Piece of 1inch white Styrofoam (sized to fit within cardboard box)

3 Pieces of cardboard

1 Measuring spoon (tablespoon size)

Baking soda

Vinegar

Soy sauce

Black Dust Free Powder Paint made by RichArt

3/8 inch steel drill bit for 3/8 inch chuck hand drill

Electric hand drill

Wood glue

Rasp file

Materials

Engagement

- One carbonated beverage
- Paper towels (to clean)

Exploration Activity One

- One quart-size plastic freezer bag per group
- Two single-hole plastic stirring straws per group
- Water
- One pan per group
- Paper Towels
- Scissors per group

Exploration Activity Two

- One 500ml clear Erlenmeyer flask
- One two-hoe #7 rubber stopper
- One 250ml clear beaker
- Two 30cm sections of vinyl tubing to fit rubber stopper
- 150 ml vegetable oil
- 350 ml water
- Red oil-soluble dye
- One 60 cc plastic syringe
- Petroleum jelly

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Engagement

Shake a bottled carbonated beverage and open it to begin class. Explain to students 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.

Exploration

Activity One

1. Split the student into groups of four. Assign each student in the group a job from the list below.

   Recorder: the student who writes down the information from the experiment

   Reporter: the student who presents their group's findings to the class

   Material Getter: the student who gathers and puts away the materials for the experiment

   Facilitator: the student who oversees the experiment and ensures their group stays on task.

2. Give the students the Primary Recovery lab worksheet.
3. Have the students clean up the experiment, and turn in their lab worksheets
4. The following are questions each student will answer at the end of the lab. Students will be prepared to share their answers in a class discussion following the completion of this experiment.

   - What happened when you blew through one of the straws? (Possible answer: Water is pushed out the other straw.)

   - How do you think this experiment relates to getting petroleum out of the ground? (Possible answer: It shows how petroleum can be forced out of a rock formation.)

Exploration

Activity Two: This activity is recommended as a teacher demonstration.

1. Pour 350 ml of water into a flask.
2. 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.
3. Insert stopper, and with your fingers covering the holes, shake vigorously. Allow this to settle.
4. 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.
5. 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.
6. Observe and as a class discuss what was just observed. Compare and contrast the first activity with the second activity.

7. Ask how do you relate each part of the experimental setup to the process of getting petroleum out of the ground? (Possible answer(s): This experiment shows how pumping water into a formation retrieves petroleum. This experiment shows how more petroleum is forced from a well when water is injected in the same formation in a different well.)

8. Ask the students to distinguish between the two methods of retrieving petroleum: gas drive and waterflood. (Possible answer(s): In a gas drive, natural gas is forced into the formation. In a waterflood, water is forced into the formation.)

Explanation

Teacher 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. Secondary 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."

Read to students 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 or concrete into the newly drilled how 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.

Read to students from *Oil and Natural Gas*, 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.

Read to students from *Oil and Natural Gas*, 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.

Evaluation

Students should complete the Exit Questionnaire.

Elaboration

Oil Well Drilling Experiment

This activity was developed to provide children an opportunity to drill an oil well and produce "Black Gold", "Texas Tea" or a "Dry Hole". It is based on a chemical reaction between bicarbonate and acetic acid which effervesce when mixed.

1. Split the students into groups of four and pass out the Oil Well Drilling Experiment Handout.

2. During this experiment the students need to be closely supervised.

Exit Questionnaire Answer Key

1. The recovery of oil which utilizes only the natural pressures of the reservoir is called:

   Answer: A. Primary Recovery

2. The injection of steam or chemicals to improve oil recovery is called:

   Answer: B. Secondary Recovery

3. True/False. In a gas drive, natural gas is forced into the formation. In a waterflood, water is forced into the formation.

   True

4. What is the first step in extracting oil? _____

   Answer: Locating a suitable site

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Lab Packet

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Lab Packet - Page 1

INTERMEDIATE STUDENTS

Names:

_____

_____

_____

_____

1. Gather all materials needed for this experiment from the list below.
   Cardboard box with dimensions 12 inch x 12 inch x 9 ½ inch (a wine box works great)
   Plastic bag to line the cardboard box
   4 Pieces of 2 inch thick blue Styrofoam (sized to fit within cardboard box)
   1 Piece of 1 inch white Styrofoam (sized to fit within cardboard box)
   3 Pieces of cardboard
   1 Measuring spoon (tablespoon size)
   Baking soda
   Vinegar
   Soy sauce
   Black Dust Free Powder Paint made by RichArt
   3/8 steel drill bit for 3/8 inch chuck hand drill
   Electric hand drill
   Wood glue
   Rasp file

2. Place a plastic bag into the cardboard box to act as a lining. The lining is to prevent spills. Remember the dimensions of the cardboard box need to be 12 inch X 9 ½ inch. See Figure 1.

Figure 1

3. Place 1 inch thick white Styrofoam into base of box. See Figure 2. Place two, 2 inch thick blue Styrofoam on top of the 1 inch white Styrofoam. See Figure 3. Place 2 pieces of cardboard on top of the 2 inch thick blue Styrofoam. See Figure 4.

Figure 2

Figure 3

Figure 4

4. Using the metal spoon, carve out 12 circular cone shaped cups about 2 inches in diameter and 1 inch thick into another piece of 2 inch thick blue Styrofoam. Place this Styrofoam on top of the 2 pieces of cardboard. See Figure 5.

Figure 5

5. Determine which of the cups will contain "Black Gold", "Texas Tea" or "Dry Holes". Select 4-5 cups for "Black Holes", 4-5 cups for "Texas Tea" and 2-3 cups for "Dry Holes". Place 1 teaspoon of baking soda into each of the cups that have been designated as "Black Gold" or "Texas Tea". See Figure 6.

Figure 6

6. After determining which cups are "Black Gold", "Texas Tea", and "Dry Holes" construct a map on a separate sheet of paper so that you know what is in each cup. It is very important in the following steps that you know exactly what you have determined each cup to be.
7. Using the metal spoon, carve out 12 circular cone shaped cups about 2" in diameter and 1 inch thick into the last remaining 2 inch thick blue Styrofoam. Using the map, mark the corresponding cups on the top layer of the blue Styrofoam with a BG for "Black Gold" and a TT for "Texas Tea". The remaining cups will be "Dry Holes".
8. Place this blue Styrofoam layer on top of the bottom blue Styrofoam that has the baking soda in each cup or no baking soda in the case of a "Dry Hole".
9. On the top piece of blue Styrofoam place 1 tablespoon of vinegar into the cups that will have "Black Gold" and ½ Tablespoon for those cups that have "Texas Tea". See Figure 7.

Figure 7

10. Next, to create "Black Gold" place 1 teaspoon of Tempera Dust Free Black Powder Paint into each cup contains the 1 tablespoon of vinegar. Fill the remaining "Black Gold" cups with the Black Powder Paint. See Figures 8-9.

Figure 8

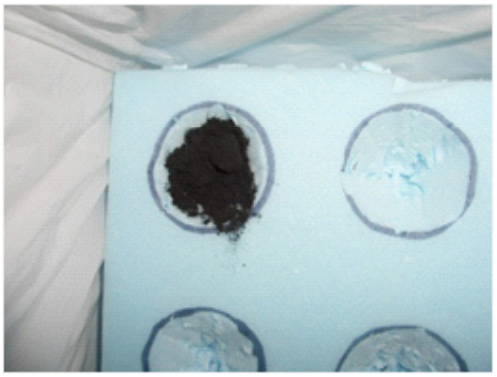

Figure 9

11. To create "Texas Tea" add ½ Tablespoon soy sauce to the existing ½ Tablespoon vinegar in the appropriate cup on the top layer of the blue Styrofoam. See Figure 10. In Figure 11 Soy sauce is being measured out (½ Tablespoon) for "Texas Tea". The soy sauce is used to create the brown color for "Texas Tea".

Figure 10

Figure 11

12. Fill all the remaining "Texas Tea" cups with the soy sauce.
13. Place the last piece of cardboard on top of the blue Styrofoam. Place an x on the top of each drilling site. This will complete the inside of the experiment. See Figure 12.

Figure 12

14. Outside of the box. Create geologic layers that surround the entire box using color paper in a series of layers and tape these to the wine box as shown in Figure 13.

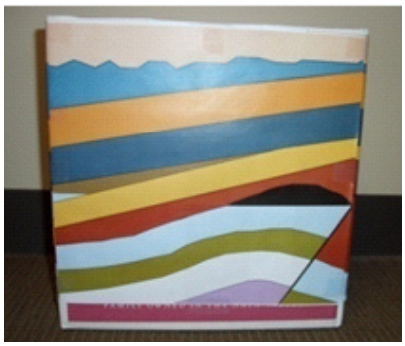

Figure 13

15. Before drilling begins place safety goggles on as well as an apron. Place plastic on the bottom of the floor in case there is a spill.
16. The teacher will assist you in drilling. Using the Hand Drill and the 3/8 inch drill bit. See Figure 14.
17. In this example, "Black Gold" has oozed out of the drill hole when the drill bit has been removed. It really looks like oil! See Figure 15.
18. In this example, "Texas Tea" has oozed out of the drill hole when the drill bit has been removed. See Figure 16.

Figure 14

Figure 15

Figure 16

19. A "dry hole" will occur when nothing comes out after removing the drill bit. The blue Styrofoam also provides a "squeaky" sound when drilling which makes the experience more realistic.
20. Concluding Remarks: After all group members have had the opportunity to drill at least two times, compile statistics on the number of "Black Gold", "Texas Tea" and "Dry Holes". Compile results and make a chart of the percentage of successfully drilled oil wells (which will depend of course on the number of cups that were selected to be "Black Gold", "Texas Tea" or "Dry Holes")

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Exit Questionnaire

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INTERMEDIATE STUDENTS

Name:_____

Questions

1. The recovery of oil which utilizes only the natural pressures of the reservoir is called:

   A. Primary recovery

   B. Fractured recovery

   C. Tertiary recovery

   D. Production

2. **The injection of steam of chemicals to improve oil recovery is called:**

   A. Primary recovery

   B. Secondary recovery

   C. Fractual recovery

   D. Both B and C

3. True/False. In a gas drive, natural gas is forced into the formation. In a waterflood, water is forced into the formation.

4. What is the first step in extracting oil? _____
   _____