PUMP IT UP! CHALLENGE

Often when a petroleum or natural gas deposit is first tapped, the pressure on the fluid is sufficient to push it to the surface without any assisted pumping. However, as the well is accessed over time, the pressure in the well decreases and assisting devices, such as horse head pumps, are needed to draw the resource out of the ground. Greater pressure may need to be applied depending on the viscosity (thickness) of the fluid, and the distance from the surface.

This activity is based on *Getting the Oil Out*, an activity found in NEED's petroleum and natural gas curriculum guides. We have modified the activity to allow students to choose the diameter of the straw they use as well as how they connect straws together. This activity demonstrates how a partial vacuum created at the top of a straw allows atmospheric pressure to force a fluid up into the straw.

This challenge is much simpler than some of the others in this book. It can be a good introduction to design for your students without being too involved or requiring more than a class period or two.

Design Parameters

- The challenge is to pump "oil" (an edible dark liquid) from the "reservoir" (cup of liquid) using a "well" made of straws and one "pump" (a student).
- The "oil" must pass through two meters of straw.
- Only one "pump" can draw oil up at a time – no double-teaming allowed.

Testing Parameters

- Measure the amount of oil produced within a short time frame; we suggest 90 seconds, but you may need to extend this based on the strength of your students. Oil is measured by expelling it into a measuring cup or graduated cylinder. Alternatively, you may wish to fill all reservoir cups to the same level, mark it, and then mark on each how far the level of liquid went down.

Teachers' Cheats

- "Two meters of straw" does not mean the oil must be drawn up through a two meter, continuous length of straw. Two one-meter lengths might work well, too. (Unless you specify otherwise.)
- Wide diameter straws require more suction pressure than more narrow straws.
- Students must make sure their taped seams allow absolutely no air to seep into the straw. This disrupts the partial vacuum the student is trying to form above the column of fluid. You may need to have stickier tape or some clay on hand to plug air leaks.

Extensions and Enrichment

- Have a contest to see which student or student team can bring oil up the "deepest well".
- Have students build a well with multiple reservoirs and one pump to compare the pressure needed.
- Have students build a well with multiple pumps and one reservoir for comparison.
- Provide students with liquids of various viscosities to determine how their structural design may need to differ.
- Bring math skills into the activity by having students measure the mass, in kilograms, of the volume of liquid they produced from their well. Use F=ma, with a=9.8 m/s^2 (acceleration due to gravity), to determine the weight of the liquid in Newtons (N). Then divide by the area of the well in meters to find N/m^2, the pressure of the well they created. Compare this to standard atmospheric pressure, 101,325 N/m^2 or Pascals (Pa).

To calculate the area of the straw well, do the following:

1. Measure the diameter of the straw in centimeters.
2. Divide by 2. This is the radius.
3. Square the radius.
4. Multiply the radius by π. This is the area in cm^2.
5. Divide the area by 10,000. This is the area in m^2.

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