



The April 14, 2010 BP Gulf Oil Leak has been in the news for nearly one month, and experts predict that it may rank as one of the most environmentally costly accidents in recent history. Considerable debate continues as to the actual rate at which the leaky British Petroleum (BP) well is leaking oil. Initial estimates from the observed surface oil slick suggested 210,000 gal/day. Following the release of actual videos of the leak, experts now estimate from 3 to 4 million gallons/day.

The images to the left were extracted from the May 12, 2010 video between 23:33:57 and 23:33:58. The arrow shows how far a portion of the billowing oil moved during this time.

The diameter of the pipe fragment shown in the image is 21 inches.

Problem 1 - From the scale of the images, how many inches did the oil spot move in the time between the first and last images?

Problem 2 - What is the area of the open circular pipe in square-feet?

Problem 3 - If the oil is emerging at the same speed as you derived in Problem 1, how many cubic-feet of oil is leaving the pipe each second?

Problem 4 - If 1 cubic foot equals 7.5 gallons, what do you estimate as the rate in gallons/day at which oil is leaving the pipe if A) 100% of the dark material is oil? B) 50% is oil and 50% is gas?

Problem 1 - From the scale of the images, how many inches did the oil spot move in the time between the first and last images?

Answer: Using a metric ruler, the diameter of the 21-inch pipe is 18 millimeters, so the scale of the image is 1.2 inches/mm. The distance between the arrow in the top image and the bottom image is about 25 millimeters or $25 \times 1.2 = \mathbf{30 \text{ inches}}$.

Problem 2 - What is the area of the open circular pipe in square-feet?

Answer: Assuming a circular aperture, and a diameter of $21/12 = 1.8$ feet,

$$A = \pi (1.8/2)^2 = \mathbf{2.5 \text{ feet}^2}.$$

Problem 3 - If the oil is emerging at the same speed as you derived in Problem 1, how many cubic-feet of oil is leaving the pipe each second?

Answer: The speed of the flow is 30 inches/1 second or 30 inches/sec. This can be converted to feet/sec to get $S = 2.5$ feet/sec. Flow = Area x Speed so Flow = $2.5 \text{ feet}^2 \times 2.5 \text{ feet/sec}$ so **Flow = 6.3 feet³/sec**.

Problem 4 - If 1 cubic foot equals 7.5 gallons, what do you estimate as the rate in gallons/day at which oil is leaving the pipe if A) 100% of the dark material is oil? B) 50% is oil and 50% is gas?

Answer: A) $100\% \times 6.3 \text{ feet}^3/\text{sec} \times (3600 \text{ sec/hour}) \times (24 \text{ hour/day}) \times (7.5 \text{ gallons} / 1 \text{ feet}^3)$ so Rate = **4 million gallons/day**.

B) At a 50% mixture, by volume, of oil and gas, Rate = **2 million gallons/day**.

Note to Teacher: Students may view the actual video at:

http://www.necn.com/05/13/10/Video-Gulf-oil-leak-at-the-source/landing_scitech.html?blockID=234064&feedID=4213

There are many other websites that archive the BP oil leak video. Students may examine other portions of the videos to obtain additional estimates. They may also discuss the issue of the actual concentration of the oil in the outflowing material seen in the videos, and also how to obtain better speed estimates by following 'blobs' in the video. What are some of the problems with using this video? Are there any geometric effects that have to be taken into account because the camera/pipe/cloud are tilted relative to the image?

Comparing this daily flow rate with the rate estimated from the size of the surface oil seen by the Terra satellite, why do you think that scientists believe that there is a significant amount of oil below the surface of the ocean that has not been accounted for yet?