

BP OIL SPILL IN THE GULF OF MEXICO

When the leak of oil from BP well in the Gulf of Mexico was first revealed they claimed the spill was controllable with less than 1000 barrels per day spilling into the Gulf. It soon became clear, especially after the underwater films of the leak became available, that things were much worse than the initially announced. The estimated number crept up week by week to the present estimate of 60,000 barrels (2.5 million gallons) per day gushing into the water 5000ft below the sea surface. To give you a rough estimate of how much leakage will actually occur during an oil well blowout of the type we have been experiencing with BPs Deep Horizon well, we look at things from a fluid mechanics viewpoint.

The pressure at the Gulf floor is about 170 atm(5000ft/30ft/atm) and at the oil reservoir some 13,000 ft below the pressure is about 1300 atm (13,000ft/10ft/atm) higher. In this calculation I am assuming a rock density three times that of water. Because of the weight of the oil in the pipe, the net upward pressure between the reservoir and the water exit will be somewhat less at about 650 atm (9,555psi). This pressure is acting over a partially obstructed pipe of approximately $A=0.3$ sq ft pipe cross section and of length $L=13,000$ ft. The upward pressure is huge yielding typically an upward force of about half a million pounds. Referring to a standard Moody diagram for turbulent flow in a riveted steel pipe of diameter $D= 7.5$ inches corresponding to a cross-section of $A=0.3\text{ft}^2$ one has a friction factor of $f=0.03$. For steady flow this predicts a flow velocity v given by the formula-

$$2 D (dp/L)=f(\rho)v^2$$

For the Deep Horizon well one has a pipe diameter of about $D=19.05$ cm, a length of $L=13,000 \times 30.5=3.965 \times 10^5$ cm, a pressure difference of $dp=650 \times 10^6$ dynes/cm², and a fluid density of $\rho=0.8$ gm/cm³. This yields an exit speed of $v=1.61 \times 10^3$ cm/sec= 16.1 meters/sec= 52.8 ft/sec. Thus the outflow is $Q=A \times v=279$ cm² x 1610 cm/sec= 4.492×10^5 cm³/sec. Using the conversion that [1 barrel oil=42US gallons=158.99liters=1.5899 x 10⁵ cm³](#), we conclude that the oil leak from the Deep Water Horizon well should be –

$Q=2.825$ barrels per second= $2.825 \times 3600 \times 24=244$ thousand barrels per day

This figure is in the right ball park but larger than the official number by a factor of four. The discrepancy may be (1) that we are still not getting the correct numbers for the oil leakage, (2) that the casing may be damaged leading to a partial leakage into the surrounding rocks, and(3) that the well is actually much deeper(say $L > 20,000\text{ft}$).

What is clear is that the deeper one drills the larger will be the leakage in the event of a blowout. However a benefit gained from the BP disaster is that it is becoming obvious that there may be very large, if not unlimited, supplies of abiogenic oil and methane existing around the world provided we develop the technology to safely drill to ultradepths of 40,000ft or so. **The concept of Peak Oil may turn out to have been a myth although the greenhouse effect due to the burning of hydrocarbons remains real.**