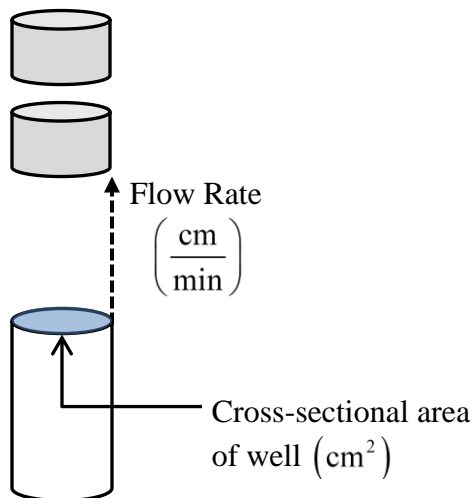
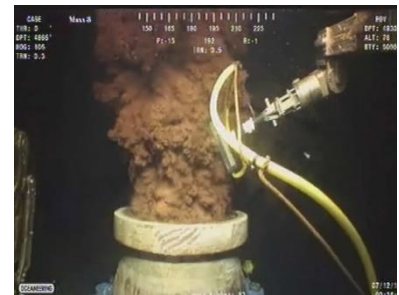


On April 20, 2010, the Deepwater Horizon oil rig, operated by British Petroleum in the Gulf of Mexico, suffered a catastrophic blowout which caused the largest marine oil spill in the history of the petroleum industry. An animation of the blowout failure can be seen at:

Flow Rate Data, provided by independent teams relied on underwater video of hydrocarbon plumes taken by ROVs as the primary data for assessing the flow of the well.

With the data of the velocity of the petroleum escaping the well head on the sea floor and the diameter of the well, engineers were able to use integrals to estimate the volume of oil that was released into the ocean.



Oil Column

$$h = (\text{Flow Rate})(\Delta \text{time})$$

$$= \left(\frac{\text{cm}}{\text{min}} \right) (\Delta \text{min})$$

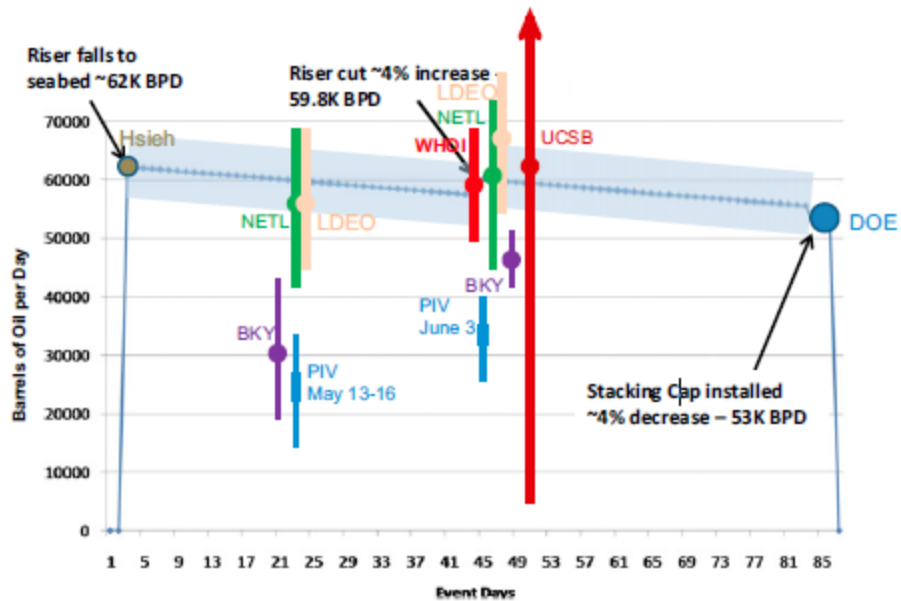
Base Area = cm^2

$$\text{Volume of Oil Column} = \text{cm}^2 \cdot \left(\frac{\text{cm}}{\text{min}} \right) \cdot \text{min}$$

$$= \text{cm}^3$$

If we let $f(t)$ represent the velocity at which oil is being released out of the well head, measured in $\frac{\text{cm}}{\text{min}}$, then we can determine the volume of oil that has flowed out of the well head by:

$$\begin{aligned} \text{Volume of oil} &= \int_{t_1}^{t_2} \pi r^2 \cdot f(t) dt \\ &= \int_{t_1}^{t_2} (\text{cross sectional area}) \cdot (\text{flow rate}) dt \end{aligned}$$



Summary of flow rate estimates from Table 1. The continuous curve represents the August model for the evolution in flow rate throughout the oil spill incident obtained by extrapolating the 53,000 BPD estimate from DOE at the time that the capping stack was closed (12) back to the beginning of the incident using the reservoir depletion model of Hsieh (13). In this extrapolation, a flow rate increase of 4% was estimated to have occurred when the riser was severed, and a decrease of 4% was estimated when the capping stack was installed. The stippled band represents a $\pm 10\%$ uncertainty in the August flow rate model. Compared with this August model are flow rate estimates from in situ ocean data plotted as a function of the day that the data for that flow rate were collected. Flow rates were typically reported at later dates. The post riser cut estimates all used data obtained on event day 45, but they are slightly offset from each other in time for ease of viewing. The upper bounds of the post rise cut UCSB estimate is shown as an arrow where it goes off the chart. The PIV estimates from the various sources are pooled together, with the thick part of the bar showing the range of the means and the thin part showing the range of the SD.

Use the graph above to estimate the number of barrels oil that was released into the ocean during the Deepwater Horizon Disaster.

Appendix:

Animation of blowout: <https://www.youtube.com/watch?v=9NQ8LehUWSE>

Flow Rate Data: <https://www.pnas.org/content/pnas/109/50/20260.full.pdf>