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The Gulf Deepwater Oil Spill, barriers, flow rates, and top kill

Posted by Heading Out on May 24, 2010 - 9:21am
Topic: Environment/Sustainability
Tags: deepwater horizon, oil spill, top kill [list all tags]

The Gulf oil spill continues to generate headlines, and ABC News has been running the story at the top, or close to the top of its evening World News with Diane Sawyer. This photo was at the top of the page on Sunday morning. Their coverage, as with the most recent comments from the Administration, are increasingly unfavorable to BP.

Burning parts of the oil spill (ABC News 11 am 23-5-2010)

However, while BP has overall responsibility, sometimes (as in the accident itself) some of the problems may arise from those subcontractors tasked with some of the work, of which more anon.

Part of the ABC story deals with a drop in the production volumes that are being picked up by the riser insertion tube (RIT) that is taking oil from the leak to storage tanks on the surface.

> BP spokesman John Curry told The Associated Press on Sunday that a mile-long tube inserted into the leaking well siphoned some 57,120 gallons of oil (1,360 barrels a day) within the past 24 hours, a sharp drop from the 92,400 gallons of oil a day (2,200 bd) (and 15 million cf of natural gas) that the device was sucking up on Friday. However, the company has said the amount of oil siphoned will vary widely from day to day.

Both of those numbers are significantly short of the 5,000 bd that the system was anticipated to remove from the riser, thereby significantly lowering the amount that is piped to the surface. At the same time there is an Op-Ed piece that has just run in the NYT which suggests, based in part on the measurements at Purdue from the oil venting video, that the real flow rate is around 40 – 100,000 barrels a day. BP have not released some of the information that would allow ball-park calculations of the actual flow, despite their claim to be open and transparent (I included the

Unified Command in that decision initially but they don't have that ability and I recognize the error). But there are some some factors that should perhaps be considered in evaluating the possible accuracy of these estimates (recognizing that there may never be a way of making an accurate assessment, though there now is a group, including the folk from Purdue, that will provide a final analysis that will be peer-reviewed and released to the public).

In an earlier post, BP had noted that the pressures that they were recording at the top of the well, and across the BOP were lower than they had anticipated, and that they were falling. They need to have this information before they inject the mud into the bottom end of the riser to do the top kill later this week. The Op-Ed piece suggested that this will only limit the leak, but if the kill works it will actually stop the leak and allow a cement plug to be placed at the top of the well, sealing it from leaking. However the mud must be injected at a pressure greater than that within the well itself, and in sufficient volume that it will flow down the well, rather than through the BOP and out the broken riser. This is achieved by raising the flow level to such a value (in this case 1,680 gal/min of mud) that there is too much resistance for this to flow through the gap in the BOP and the flow therefore pushes back down the well, filling it with mud with sufficient density that it will overcome the pressure at the bottom of the well.

Now the pressure along the passage that oil and gas makes as it goes from the reservoir, up through the initial well, through the BOP, down the riser, and then either into the RIT or out into the ocean, undergoes several pressure drops. With each drop the gas content will preferentially expand more and take up a greater volume of the total flow space.

Outflow at the riser (AP feed at 11 am 23-5-2010)

However the gas is still intermixed with the oil, and not knowing the relative points of pressure change (recognizing that the presence of the RIT, flaps and the drill pipe all constrain the flow area out of the riser) the velocity component from gas expansion cannot be properly estimated. Thus taking spot velocity measurements don't really help much in estimating the average velocity of the flow, and have no bearing on the actual oil:gas ratio at that point).

After I wrote this and, as Monkeyfister noted in comments yesterday, there appears to have been a significant increase in the flow, relative to that shown in the frame above - but this may depend on where the camera is, and that view may have changed by the time that you look at the

live feed. The dispersant flow seems to be a smaller part of the overall flow volume, implying that this has increased. It could mean that there has been further erosion of the orifice through the BOP or that there is some problem with the RIT, and that less of the oil and gas is going up that channel.

To assess the possible size of the total flow one might consider the flows from existing wells in the Gulf, and as Euan Mearns has pointed out, if you look at the Thunder Horse platform after it had four wells in production (with their construction designed to ease fluid flow out of the formation to the well and production lines) it was averaging 50,000 barrels per day of oil equivalent per well. This well is not in such a productive zone. Also, the well is producing through a badly damaged cement liner, and a complex path to the well head, and from a shallower depth, so that the differential pressure will likely be less. The constraint from the damaged BOP will probably add additional resistance to the flow, and thus it is hard to see how the flow could get near 50,000 barrels per day.

On the other hand it is not clear what diverting a considerable resource, currently being directed at stopping the flow, to measuring the flow volume would achieve. The booms, siphoning ships and control burns are operating to scoop up the oil as fast as they can. The system fielded is using about as much resource as is available, and as the Admiral has noted, is not constrained by estimates of the well flow volume.

Which brings me back to my opening thought. The ABC stories at the end of the week were focused on the arrival of the oil and emulsion on the shores of Louisiana. The question that I had in an earlier post was as to why the oil was getting there, when there had been so much effort put into erecting barriers to prevent that happening. There are over 300 miles of boom that have been fielded.

Admiral Landry addressed that in her comments at the press conference on Friday, noting that oil had come ashore at Terrebonne Parish, in Louisiana. She was disappointed to note that the boom had been pre-staged in Terrebonne Parish, and that skimmers were there, but folks had hesitated to deploy them. Thus while other areas along the shore had been more aggressive and successful in controlling the oil, that there had not been the same kind of action in Terrebonne Parish, resulting in a lack of success there – however she noted that this will change. (Something missing from the ABC reports, which focus more on the inability of BP to stop the oil from coming ashore.)

Weather conditions are just about optimal for cleanup, so that while skimmers would normally only get 10 – 15% of the oil, they have been achieving 50-60% recovery, the burns have been very successful and sustained, while the use of the dispersant at depth means that there is not that much oil coming to the surface to be dealt with. (It is too calm to use surface dispersants since they need some turbulence to mix with the oil.) However the problem will only start to diminish after the well stops emitting oil.

The most likely step to stop this is the top kill, scheduled for this week, though the process must be thoroughly reviewed by the MMS before it is implemented. BP will use the Q4000 as the vehicle to carry out the kill. This has two Schlumerger MD 1000 pumps which will likely be fitted to deliver the highest flow rate (which gives a maximum pressure of 6,800 psi or around 4,300 psi differential to the water pressure at the well. The pressure can be increased to 20,000 psi but at much lower flow rates). The mud pumped will have a density that is about twice that of water. They are still also looking at crimping the well, and doing a hot tap, should the top kill not work. The attempt is currently anticipated to take place on Tuesday.