



Deepwater Oil Spill - Why Top Kill Starts and Stops, Watching the Flows, and a Live Comment Thread

Posted by [Heading Out](#) on May 28, 2010 - 3:26pm

Topic: [Supply/Production](#)

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Latest: NYT says the "[BP's Effort to Plug Oil Leak Suspended a Second Time](#)". 29/05/2010 1:18 am There are small indications of some success in the plume shots, can you tell what they are? Out in the Gulf BP are going through the preparations for the next stage in the attempt to top kill the deep water well that has been leaking oil and gas for more than a month. The kill attempt has now been underway for a couple of days, and so this is initially a recap on what I believe has happened to date, and what they are currently planning on doing. I will include in this explanation the two attempts that BP have made so far, and what I expect that they will do next.

To help with the explanation I am going to use some very simple models, which oversimplify the situation, but hopefully will help explain it. To start with I am going to break the overall system down into a very simple diagram.

for the full column to balance the pressure in the rock, and the leakage of mud out of the hole in the top of the BOP was higher than BP had thought, so they were losing too much mud to the Gulf.

So they moved to step two. The first part of this is to try to reduce the size of the hole in the BOP. And for this they used a variety of what everyone is calling a junk shot. It actually isn't. Given the problem that I am about to outline, they have an ally that folks normally don't have. As Secretary Chu has pointed out there is the full intellectual strength of the Federal Labs behind this attempt, so where one would normally just chop up tires and similar materials, there is a fascinating mathematical problem in designing plug pieces of the right shape that will fit the constraints, and which will accelerate the blocking of the flow path. So I suspect that some of the shapes that will appear in the flow will have been specifically designed for the problem.

Not being familiar with their answer I'm going to stick with the spheres and triangles of the more traditional, shall we say old fashioned, way of addressing the problem.

It is one of these problems where the bounding conditions can make life rather difficult. Let me redraw the problem with a different orientation. What we have to do is to block (the term that is being used is bridge) the passage through the BOP. This will stabilize the flow, and will allow the cement plug time to set up. (We'll talk about cements another time).

So here is the slit: through the BOP – it is going to be a more complex shape, but this allows some explanation of the problems.



Simplified picture of the slot to be sealed

Now to block the slot we have to have some pieces of material (although they are quite large for simplicity I am going to call them all particles) that are big enough to wedge in the slot, but small enough to get through the feed lines to that point.

Now here's the first catch, we don't want them to be hard enough that we will damage the passages, nor soft enough that they will bend distort and compress and squeeze through the hole. Rubber turns out to fit the bill, and though there are other materials that could be better, in this initial explanation that's what I am going to use.

The easy thing to do is to use some spheres, not easy to get, though golf balls are an example. Unfortunately they are a bit too big. The reason is that the feed line through the choke has a

maximum inner tube size of probably 2.75 inches. A golf ball is about 1.6 inches, which is more than half this, so that two balls together could block the feed line – a definite no-no. (And don't say it can't happen, I've seen it with smaller particle ratios than this).

The maximum size that you can get through the line should be about a third of the minimum diameter – say 0.9 inches, stretch a point and make it a maximum ball size of an inch. So we fill the mud with miniature golf balls, pump enough of them down that they end up going through the BOP and wait for the effect. Let me show you, using pearl spheres, how the problem evolves:



Spheres in slot

See all the open space around the spheres, and how much of the slot remains open. We really haven't made much of a blockage in the slot area of contact, and we have made it hard to push other materials into the slot area itself. However the smallest open area now may be at the maximum diameter of the spheres, which is further back, where the feed pipe is larger. Putting more spheres of the same size down won't improve the situation much, because they still leave room, around the spheres, for fluid to flow.

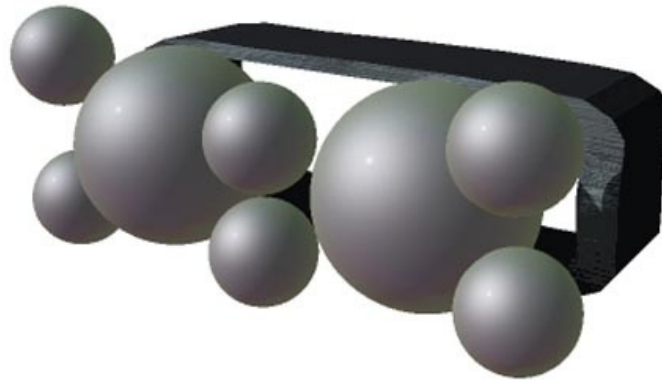
There are two ways to go, once the initial building blocks for the bridge have been established. The first might be to use triangular pieces of rubber (as we saw protruding from the crack in the riser). These can fit closer together and fill more of the slot and flow passage.



Ideal case of three rubber strips blocking flow

Here the strips have aligned in the right way and have been driven into the slot, reducing the flow path. But note, as with the spheres that the gaps that are left are now too small for more strips of that size to feed into the slot and do more blocking.

So in either case what has to happen is that there should be a second pass, where smaller particles are used. These couldn't be used before, because they would push through the slot, but now the slot size is smaller, and so these can start to fill in the gaps. Let me illustrate with the spheres:



Filling the gaps with a smaller second set of spheres.

So now the gaps that remain are even smaller, and so in a third shot, with even smaller gaps the feed particles have to be even smaller.

It can take a number of different slugs of material going through the choke line (and being pushed into the BOP instead of falling down the well, before the slot is sufficiently "bridged" that there isn't much flow out of the BOP.

So expect that there will be a number of these shots, after each of which mud will be pumped in to see how much progress in filling the holes they have made. Bear again in mind that there is this restriction on how big a piece they can feed in, and just hope that all the gaps in the BOP are small enough that big enough particles can be fed into the lines to block it.

Now, as I said, they are probably using more sophisticated shapes from the National Labs, that will allow the number of shots to be reduced, but the relative sequence still has to be followed, as they build the bridge. Let's see how it goes, and be patient, each shot takes time to set up.

And at the same time, given that they have to balance the weight of the column of mud against the rock pressure, they are using the interval to change the mud weight increasing it each time, to seek that balance. (They don't want it higher than it has to be or it could hydraulically fracture the rock and lose the mud into the crack).

(Oh and if some of you remember the class in school where the teacher filled a jar with big pebbles and asked you if it was full, you said yes, then he/she poured in smaller pebbles, now is it full? Then came sand - now is it full? And then the jar was filled with water - its the same basic idea).



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