From: Hill, Trevor
Sent: Thu Apr 29 10:36:13 2010
To: Cook, Howard H; Beynet, Pierre A
Cc: Pattillo, Phillip D; Saidi, Farah; Lockett, Tim; Tognarelli, Michael A
Subject: RE: Current Density/Pressure assumptions
Importance: Normal

It looks as if the one bouyant (inverted) U tube is of a much bigger length and elevation scale to the others, so will likely dominate what happens, driving fluids through the other U tubes. Basic principle will be the same though, that gas likely to stay trapped at high points.

Regards
Trevo

From: Cook, Howard H
Sent: 29 April 2010 10:57
To: Beynet, Pierre A; Hill, Trevor
Cc: Pattillo, Phillip D; Saidi, Farah; Lockett, Tim; Tognarelli, Michael A
Subject: RE: Current Density/Pressure assumptions

"Several U tubes **may be** present upstream of the loop."

I agree with Pierre on this point - i.e. per the possible configuration on Mike's sketch from a couple of days ago.
There is some doubt as to whether the "missing" joints are in the trench, or never run and the riser numbering tally observed from survey is misleading.
But I do I think it is quite plausible that all the "missing" slick joints were driven into the trench by the axial driving force from above as the riser slumped.

regards
Howard

<< File: Survey_Importance.ppt >>

From: Beynet, Pierre A
Sent: 29 April 2010 10:46
To: Hill, Trevor; Tognarelli, Michael A
Cc: Pattillo, Phillip D; Saidi, Farah; Cook, Howard H; Lockett, Tim
Subject: RE: Current Density/Pressure assumptions

Trevor,

Food for thought.

I can think of a scenario where the density of the fluid decrease on both side so we have to be careful.

At the present the inside pressure at the top of the loop is equal to sea floor pressure - hydrostatic of 0.2 density assuming no restriction and no U tubes (up and down exciding 1 D) downstream of the top. Thus the pressure at the bottom of the upstream loop is sea floor + height (500 -200) G . The density of the down stream fluid being .5 per your attached diagram.

When we open the upstream to sea water the loop bottom pressure will equalize to sea floor pressure. The 500 fluid in the upstream leg will flow back toward the sea,
The pressure at the top of the loop will decrease, the pressure in the upstream leg decrease, more gas come out of solution, the 200 gas expand its pressure decrease sea water is coming into the end of the riser. If the riser has a small downward near the downstream leg touch down point the down stream weight will not change as the flow back up , thus reducing the weight increase on the upstream leg.

I can think of scenarios, where the opposite take place, for example restrictions(hydrates?) downstream of the loop .

Several U tubes may be present upstream of the loop.

Regards

Pierre

From: Hill, Trevor
Sent: Thursday, April 29, 2010 1:26 AM
To: Tognarelli, Michael A
Cc: Pattillo, Phillip D; Saidi, Farah; Cook, Howard H; Lockett, Tim; Beynet, Pierre A
Subject: RE: Current Density/Pressure assumptions

Mike

A quick view to start with, then further comment when I get to the office.

Once cut is made and pressure equalises (this probably has already happened if kink is holed - can we confirm no oil now leaving original riser end location?), the fluids in the bouyant loop will adjust so the gas volume in the loop is evenly distributed between upstream and downstream legs, leaving both legs roughly half full of gas, with oil filling the lower halves of the legs. Oil will drop out of upstream leg, and be sucked back into downstream leg until equilibrium.

As system was already discharging to sea water pressure then it should be (have been) a relatively gentle equalisation .

What happens at the open ends of the system depends on inclination. If the pipe ends slope uphill to the open end then oil will come out and be replaced by water down to the first low point. If pipe ends slope downhill to the open end then oil remains inside. Depends on inclination profile of pipe. If there are low points close to the ends there will be little exchange. But if a long uphilll sloping section then replacement of gassy oil with water could be significant eg downstream of BOP stack.

Hydrate formation rate will be low if there is no water and no mixing.

More later...

Regards
Trevor

From: Tognarelli, Michael A

Sent: 29 April 2010 01:28
To: Hill, Trevor
Cc: Pattillo, Phillip D; Saidi, Farah; Cook, Howard H; Lockett, Tim; Beynet, Pierre A
Subject: RE: Current Density/Pressure assumptions

Trevor,

What can your team tell us about what is going to happen to the fluid in the buoyant loop after it is cut off from the flow stream and open on both ends to the sea? We are trying to analyze the riser + contents during the removal operation.

Thanks.

Mike

From: Hill, Trevor
Sent: Wednesday, April 28, 2010 11:13 AM
To: Tognarelli, Michael A
Cc: Pattillo, Phillip D; Saidi, Farah; Cook, Howard H; Lockett, Tim
Subject: RE: Current Density/Pressure assumptions

Mike

In terms of current understanding of the contents of the riser at the bouyant section...

If the hydrocarbons are flowing through the riser annulus, and the flow rate is ~10mbd (as I understand it this is still the working assumption), then we have following:

We are currently assuming that the main flow restriction is at or upstream of the BOP stack, so the contents of the riser will be at close to seawater pressure, 2250 psi. At these conditions the predicted flowing mixture density of the oil and associated gas is about 500 kg/m3, or 4.2 lb/US gal on the upstream side of the highpoint of the bouyant section, and almost gas filled (200 kg/m3, 1.7 lb/US gal) on the downstream side (as liquid collects going uphill, and drains away going downhill)... Please see attached plot showing elevation/distance, density, and liquid holdup.

<< File: Riser holdup.ZIP >>
Farah will shortly have the OLGA model that generated this information and can re-run for different conditions as needed.

Please note that if the riser crimp is made downstream of the buoyant section, then the overall system pressure will rise up to the wellhead shut-in pressure of 8500 psi, at which pressure all of the gas should be dissolved back in the oil at equilibrium. This would take some considerable time to achieve, as there would be no mixing to help the gas redissolve, but could eventually leave you with a completely liquid filled riser (both sides of the buoyant section).

Happy to discuss as required...

Regards
Trevor

From: Tognarelli, Michael A
Sent: 27 April 2010 18:57
To: Hill, Trevor
Cc: Pattillo, Phillip D
Subject: RE: Current Density/Pressure assumptions

Trevor,

We had assumed the annulus was full of a homogenous fluid having one of three densities and one of three wellhead pressures. It would be worth your team pursuing Kurt Mix / Phil Pattillo if understanding has evolved since then. The scenarios we were given were:

Mostly Oil: 7ppg, 7ksi wellhead pressure
Mixture: 6ppg, 7.8ksi wellhead pressure
Mostly Gas: 2.2 ppg, 10.5 ksi wellhead pressure

Mike

From: Hill, Trevor
Sent: Tuesday, April 27, 2010 12:31 PM
To: Tognarelli, Michael A
Cc: Saidi, Farah
Subject: RE: Current Density/Pressure assumptions

Mike

Thanks...

What is your understanding of the contents of the riser annulus at the various key locations in the system? What was in the riser annulus under normal operating conditions?

It does not yet seem clear where the break in the drill pipe is, and whether the production fluids are filling the riser from BOP onwards, or only after the drill pipe break, and that the location of that break is unknown (again, do you have a view?). I may be missing the early discussions about the likely sequence of events...

The PipeSim model can be run to simulate production fluids in the whole riser cross-section (which is what we have done to date) and also to simulate production fluids only in the drill pipe up until a specified breakpoint. For production fluids flow through the whole riser cross-section the flowing velocity is relatively slow (~0.5 m/s mixture velocity) and likely to be a bubbly liquid dominated sort of flow. For production fluids flowing through the drill pipe I will ask Farah to advise the velocity, flow regime and density in the riser when it lifts off the seabed.

The wellhead pressure is estimated as around 8500 psi.

Farah, please would you also pass on the calculated average fluid density in the riser for the production fluids in whole riser cross-section case.

Happy to talk later, as required.

Regards - Trevor

From: Tognarelli, Michael A
Sent: 27 April 2010 15:11
To: Hill, Trevor
Subject: Current Density/Pressure assumptions

Trevor,

For our simulations, we are assuming:

Density Range: 2.2ppg (mostly gas) - 7.0 ppg (mostly oil); constant properties throughout riser
Wellhead Pressure Range: 7ksi (mostly oil) - 10ksi (mostly gas)

Numbers from Kurt Mix. If there are updates, please advise.

Regards,

Mike

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