From: Austin, Julian
Sent: Sun Apr 25 11:58:29 2010
To: Birrell, Gordon Y; Tooms, Paul J
Subject: RE: Erosion
Importance: Normal
Attachments: Estimate of erosion rates for kinked riser.pdf

Gordon, Paul,

Here is a draft document that presents my estimate of the risk of erosion. John and Richard currently have it for review. I anticipate having a less conservative estimate of the aperture size by the end of the day from the Frazer-Nash modelling efforts.

Kind regards,
Julian

From: Birrell, Gordon Y
Sent: 25 April 2010 03:40
To: Austin, Julian; Tooms, Paul J
Subject: RE: Erosion

Julian,

Thanks – given these are initial calcs, with lots of uncertainty (I assume) I have taken a judgement that we safely have a week before erosion becomes an issue. I am happy to broaden that tomorrow after we talk and get more insight about uncertainty.

The MMS challenged whether we had assumed sand and I said we had not assumed large quantities of sand, they seemed to agree with that assumption.

The MMS are asking the drillers for their calcs around the possibility of broaching, therefore it would be good if I could have a copy of any calcs associated with erosion.

Rgds

Gordon

From: Austin, Julian
Sent: Saturday, April 24, 2010 1:41 PM
To: Birrell, Gordon Y; Tooms, Paul J
Subject: Erosion

Gordon, Paul,

I have just received initial calculations from Richard Woollam which I have now also discussed briefly with John Martin. These support my view that we will not erode the riser on the timescale of days or even weeks.

Kind regards,
Julian

Julian Austin [illegible]
[illegible]
Weblink: Static Mechanical Community of Practice
[illegible]

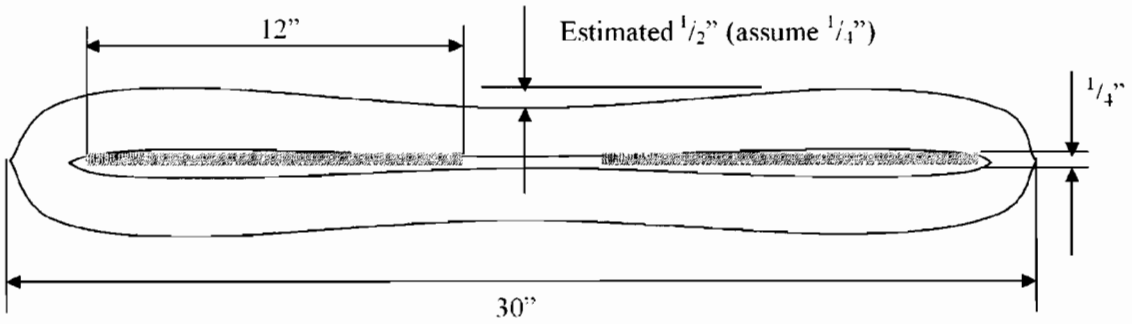
Estimate of erosion rates for kinked riser.

1. Estimate of maximum flow velocity

The leak rate has been estimated by US Coastguard at 1000 bbls per day - assume 2000 bbls per day as a gas/oil mixture to include for 50% by volume gas breakout.

Assume that the kink is almost making contact in the middle. The height of the dogbone shape estimated from photos as $^1/_2$" minimum on each side - assume $^1/_4$". The flattened width of the pipe is approximately half the original circumference $\pi D/2 = 34$", assume 30".

Assume two apertures in the minimum cross section of the dogbone that circumscribe rectangular apertures of 12" x $^1/_4$" (green). These rectangular apertures are considered to be the likely minimum apertures that exist within the kink.



The maximum velocity through the total aperture of 24" x $^1/_4$" for a leak estimated as 1000 bbls of oil per day is calculated as follows:

Leak rate	2000	bbls per day (assume 50% gas breakout)
Leak rate	11229	cubic ft per day
Leak rate	0.130	cubic ft per second
Height of two apertures	0.250	Inches
Total width of two apertures	24.0	Inches
Total area of apertures	0.042	square feet
Velocity through apertures	**3.12**	feet per second

2. Estimation of erosion rates using the BP Erosion Model

The following erosion rates were calculated for a range of assumed flow rates through a 2" circular orifice (approximately 50% of the total minimum aperture estimated above), assuming single phase liquid flow (see attached Annex):

Velocity	Erosion rate
50 feet per second	1-2mm per year
100 feet per second	15mm per year

3. Conclusion

Given the low predicted erosion damage at 100 feet per second (0.6mm in two weeks) and the relatively low velocity of 3 feet per second predicted from an estimate of the likely total minimum aperture in the kink and the US Coastguard's estimate of the leak rate, it is concluded that the risk of significant erosion on a timescale of several weeks is negligible.

Julian Austin, SETA for Static Mechanical Equipment

Annex. Emails detailing erosion calculations

Richard,

Given the paucity of information I think you have done the best you can. As we get better (multi phase) information we should probably switch to SPPS (with a churn flow assumption I should think) as well as CFD.

Regards
John W Martin. Advisor Materials& Corrosion, IRF Technology Team
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Sent using BlackBerry

From: Woollam, Richard C
To: Martin, John JW
Cc: Austin, Julian; Webster, Simon
Sent: Sat Apr 24 18:44:01 2010
Subject: RE: Assistance required

John,

Julian et al are looking for guidance on the potential erosion rate through the damaged riser from the stricken Transocean drill rig in GOM. The riser has collapsed/buckled with flow proceeding through the reduced cross-sectional area at the buckle. My suggestion, as a first pass, would be to estimate the erosion potential using the BP Erosion Model which, as you are aware estimates erosion rates for 1½ – 5 D bends using Salama's methodology.

Clearly, the fluid physical properties/rates and sand rate are the critical variables, it seems unlikely that we will have sand rate information, so as a first pass we can use the default values (BP Erosion Guidelines) 10 lbs/1000 bbl and 100 - 150 μm – the GOM DW guidance range is 100 - 120 μm I extended the upper end range.

To try and get a "feel" for the likely values I have run a couple of quick calculations guessing/assuming 2" diameter, 50 ft/s, liquid density 50 lb/ft^3 – I assumed liquid packed/no gas which is probably unrealistic, 150 F, 7500 psi, and 100, 150 micron particle size at 10 lb/1000 bbl. Obviously, these values could be completely wrong but, at the conditions assumed you get an erosion rate between 1 and 2 mm/yr. Increasing the velocity to 100 ft/s (outside the model validity range) increased the erosion rate to 15 mm/yr showing the importance/criticality of the velocity estimate.

I have not taken any account for corrosion and it is not known if there is any sand control in the well.

As we get more/better estimates we can update the guidance.

At a later date we can run a CFD simulation once the damage configuration is known and the fluid properties/rates estimated.

Any other thoughts/comments would be appreciated.

Richard.

Inputs, process conditions

Internal Diameter	inches	2.000
Superficial GAS velocity	m/s	0.00
Superficial LIQUID velocity	ft/s	50.00
GAS density @ process conditions	kg/m3	0.00
LIQUID density	lb/ft3	50.00
Temperature	F	150.0
Pressure	psia	7500.0
Sand size	microns	150
Sand content in gas	lb/mmscf	0.00
Sand content in liquids	lb/mbbl	10.00

Sand size criteria:	Calculation is OK
Liquid velocity criteria	Calculation is OK
Gas velocity criteria	Calculation is OK
Mixture velocity criteria	Calculation is OK

Outputs

GLR	scf/bbl	0.00
Mixture density	kg/m3	800.92
Mixture velocity	m/s	15.24
Sand content	lb/day	167.60

Predicted Erosion Rate mm/yr 1.77

Erosion rate in service likely to be unacceptable. Either recalculate for other (less severe) conditions or contact EPTG to discuss further

Inputs, process conditions

Internal Diameter	inches	2.000
Superficial GAS velocity	m/s	0.00
Superficial LIQUID velocity	ft/s	50.00
GAS density @ process conditions	kg/m3	0.00
LIQUID density	lb/ft3	50.00
Temperature	F	150.0
Pressure	psia	7500.0
Sand size	microns	100
Sand content in gas	lb/mmscf	0.00
Sand content in liquids	lb/mbbl	10.00

Sand size criteria:	Calculation is OK
Liquid velocity criteria	Calculation is OK
Gas velocity criteria:	Calculation is OK
Mixture velocity criteria	Calculation is OK

Outputs

GLR	scf/bbl	0.00
Mixture density	kg/m3	800.92
Mixture velocity	m/s	5.24
Sand content	lb/day	167.60

Predicted Erosion Rate mm/yr 1.18

Erosion rate in service likely to be unacceptable. Either recalculate for other (less severe) conditions or contact EPTG to discuss further

Inputs, process conditions

Internal Diameter	inches	2.000
Superficial GAS velocity	m/s	0.00
Superficial LIQUID velocity	ft/s	100.00
GAS density @ process conditions	kg/m3	0.00
LIQUID density	lb/ft3	50.00
Temperature	F	150.0
Pressure	psia	7500.0
Sand size	microns	150
Sand content in gas	lb/mmscf	0.00
Sand content in liquids	lb/mbbl	10.00

Sand size criteria:	Calculation is OK
Liquid velocity criteria	Liquid velocity must not exceed 20 m/s (66 ft/s)
Gas velocity criteria:	Calculation is OK
Mixture velocity criteria	Calculation is OK

Outputs

GLR	scf/bbl	0.00
Mixture density	kg/m3	800.92
Mixture velocity	m/s	30.48
Sand content	lb/day	335.20

Predicted Erosion Rate mm/yr 14.19

Erosion rate in service likely to be unacceptable. Either recalculate for other (less severe) conditions or contact EPTG to discuss further