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Module 10

EROSION EXERCISE

CONTENT

- *Information and data*
- *Formulae*
- *Results*
- *Interpretations*

INFORMATION AND DATA

Pipes of three(3) different diameters have been identified as having a risk of erosion for the rate and volumes of sand being produced from the field(See table below). Fluid mixture velocity has also been estimated.

- You are requested to investigate the rate of erosion for these conditions using the four(4) criteria provided in the following page.
- Using the API formulae determine the V_{crit} for a crude API 30 degrees, carbon steel and super duplex pipes
- Compare results between the four(4) criteria provided

Sand Rate (grs/sec)	Mixture Velocity (m/sec)	Pipe Diameter (mm)
100	1	50
200	1	50
300	1	50
400	1	50
400	1.5	50
400	2	50
500	2	50
500	2	75
500	2	100

FORMULAE

CRITERIA	MODEL	CONDITIONS & USE
API	$E = 22.4\ M \times V^2 / d^2$	Single phase fluids, used for preliminary assessment
Salama & Venkatesh	$E = 604\ M \times V^2 / d^2$	Mainly used for downhole completions and > 5D bends
University of Tulsa	$E = 4280\ M \times V^{1.73} / d^2$	Single phase fluid flow, allows for variable sand particles sized. Not commercially available
RCS	$E = 4.1\ M \times V^{2.5} / d^2$	Used for preliminary assessment, works well for 1.5D bends, reductions and tees, not commercially available

Where:

E	Erosion rate (mm/yr)
M	Sand flow rate (grs/sec)
V	Mixture velocity (m/sec)
d	I.D. of the pipe (mm)

FORMULAE (Continued)

The critical velocity for oil wells (API) $V_{crit} = C / \rho^{0.5}$

Where (Oil)

C Material constant

ρ Fluid density

MATERIAL	MATERIAL COEFFICIENT " C "	REMARKS
Carbon steel	80 to 150	J-55, L-80, N-80……..
Duplex steel	280	13% Chrome
Super Duplex	350	25% Chrome
Monel	400	-

RESULTS

CRITERIA	EROSION RATE [mm/year]	EROSION RATE [mm/year]	EROSION RATE [mm/year]	OBSERVATIONS
API	0.896	1.792	2.68	Results for sand rates of 100, 200 and 300 grs/sec in 50 mm pipe diameter
Salama & Venkatesh	24.16	48.32	72.48	
University of Tulsa	171.2	342.4	513.16	
RCS	0.16	0.328	0.48	

Note: Result presented in the table are only for the first 3 sand rates and at constant pipe diameter

RESULTS (Continued)

Density for a crude API 30° degrees	55.35 Lb/ft^3
Value of material constant C for carbon steel	150
Value of material constant C for super duplex steel	350

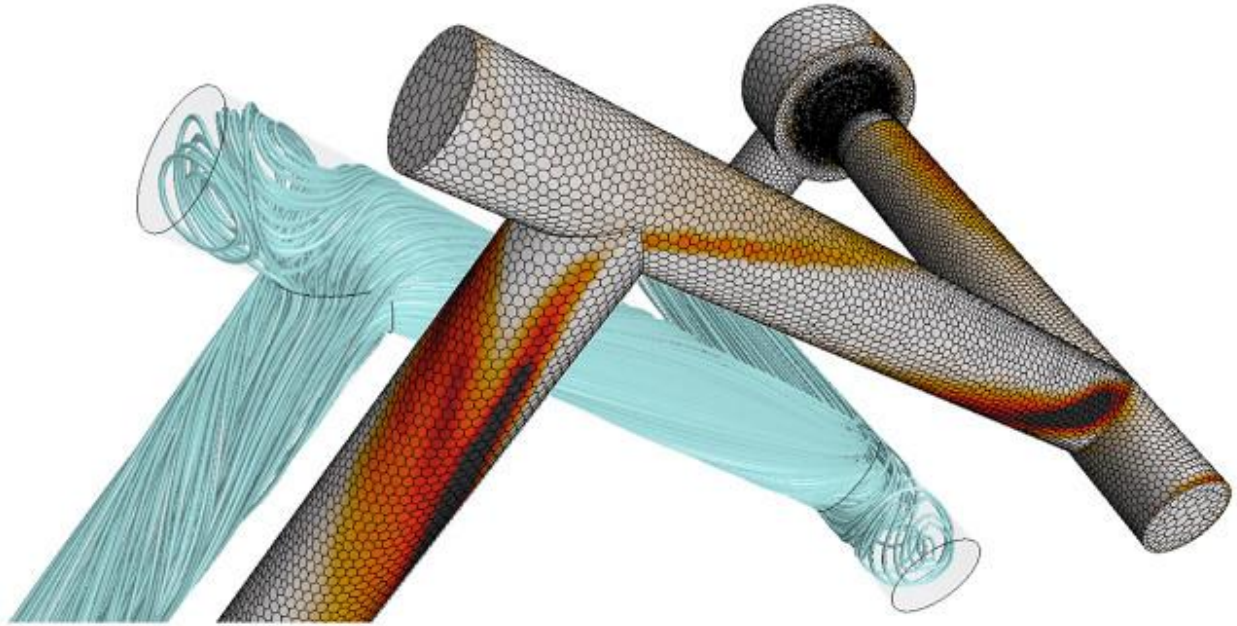
Following the API criteria then we have:

V_{crit} for Carbon Steel	20.16 ft/sec
V_{crit} for Super Duplex	47.04 ft/sec

INTERPRETATION

- The four (4) correlations used for the estimation of the erosion rate give very different results. The API correlation and the RCS results differ by one order of magnitude
- This is common with empirical correlations as they have been obtained for specific sets of conditions
- The only solution is to take actual measurements either in the lab or in the field in order to calibrate the correlation
- The critical velocities to avoid erosion estimated using the API formulae give both reasonable values despite its limitations.
- These results also indicate that resistance to erosion can be mitigated by changing the metallurgy of the pipe as in this case.

FLOW & EROSION SIMULATION RESULTS USING CFD



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