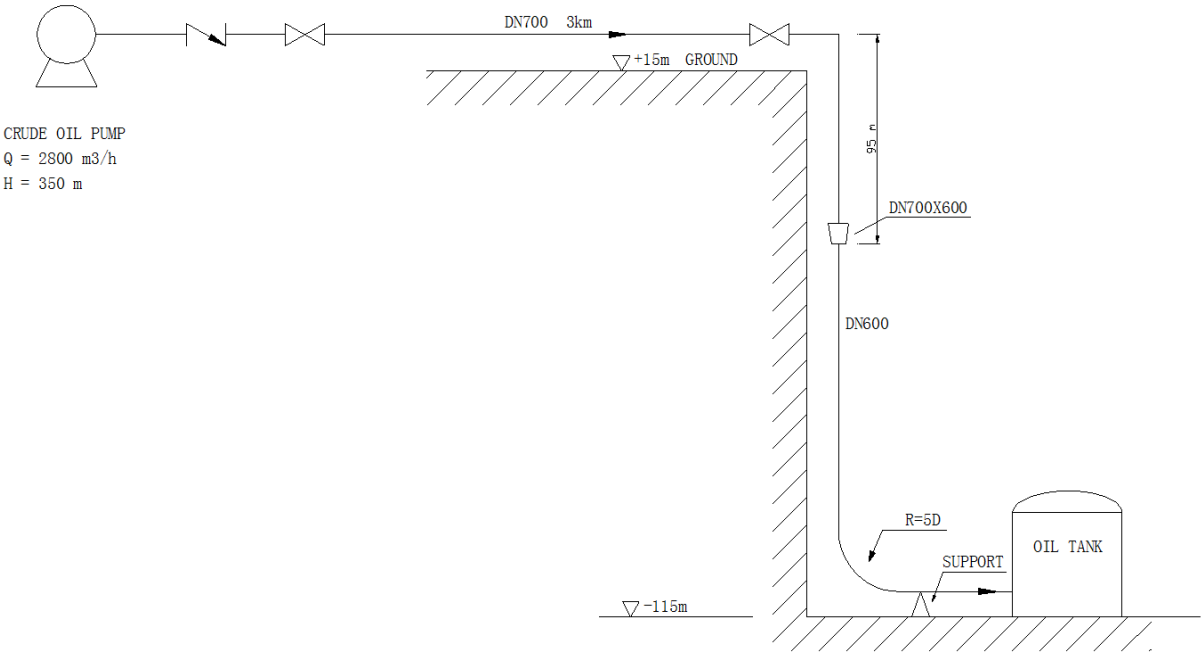
Application Bulletin – Process Industry
PIPENET® Transient Module Case Study

Cavitation Elimination in Long Vertical Pipeline

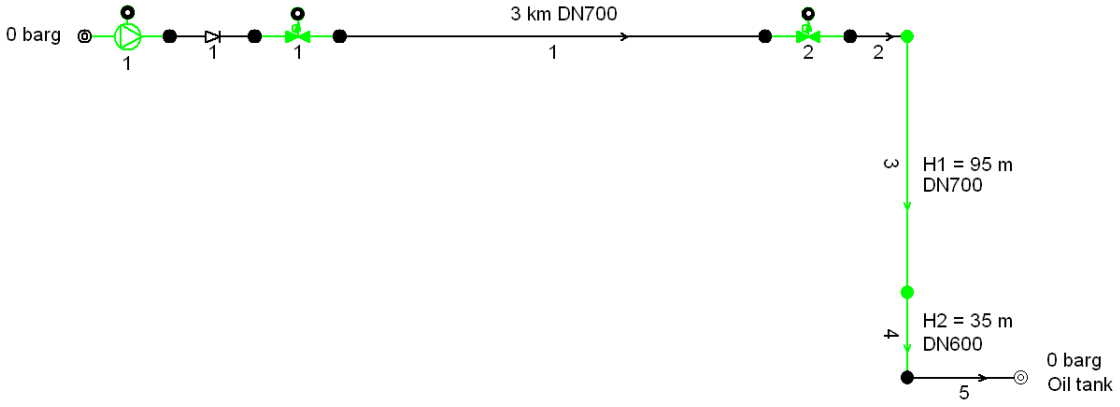
BACKGROUND

The project under investigation is a light crude oil transportation system, located in China. The pipeline (constructed from DN700/DN600) is over 3km in length, ending with a vertical drop of 130m to the tank.



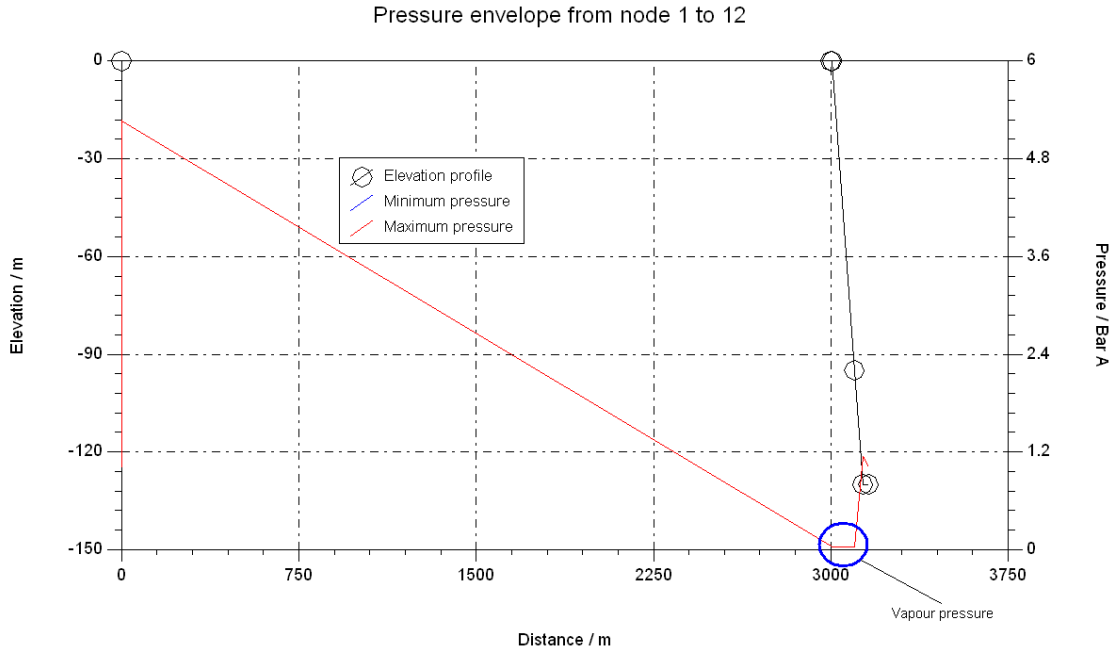
In this system a primary concern was the likelihood of cavitation in the vertical section. PIPENET was used to estimate the steady state pressure distribution, estimate the cavity volume in the vertical pipes, and assess proposed measures for eliminating any cavity thereby reducing vibration and noise.

SCENARIO 1 – ORIGINAL NETWORK

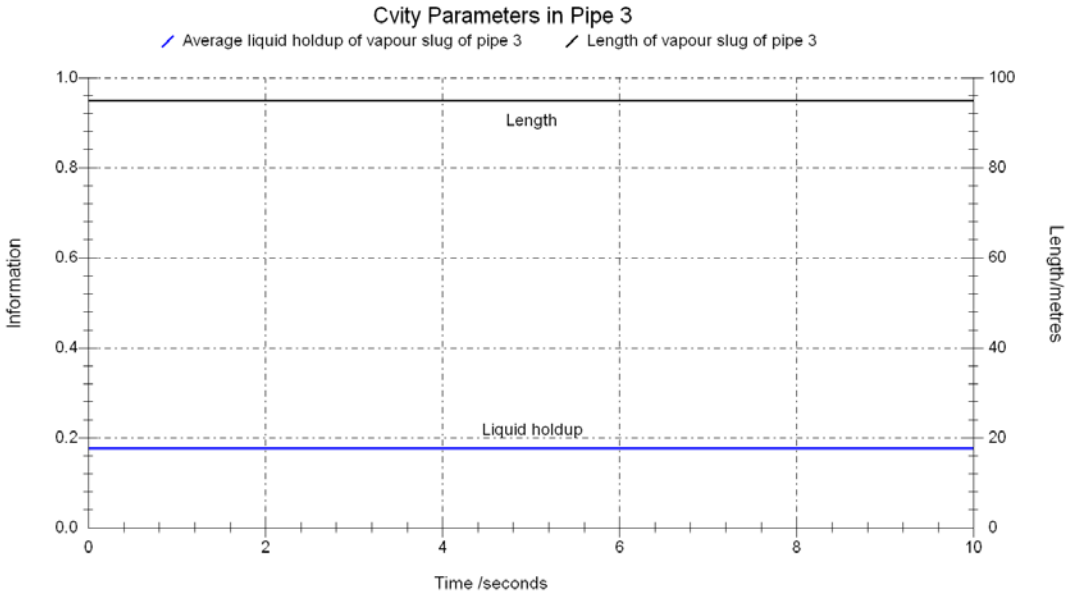


Having constructed the PIPENET model as above, our first scenario is to run the oil pump at full speed with the valves fully opened. The supply pressure at the pump inlet is 0 barg. The oil level in the oil tank is assumed to be zero because this would be the worst case, causing the largest cavity volume in the pipeline.

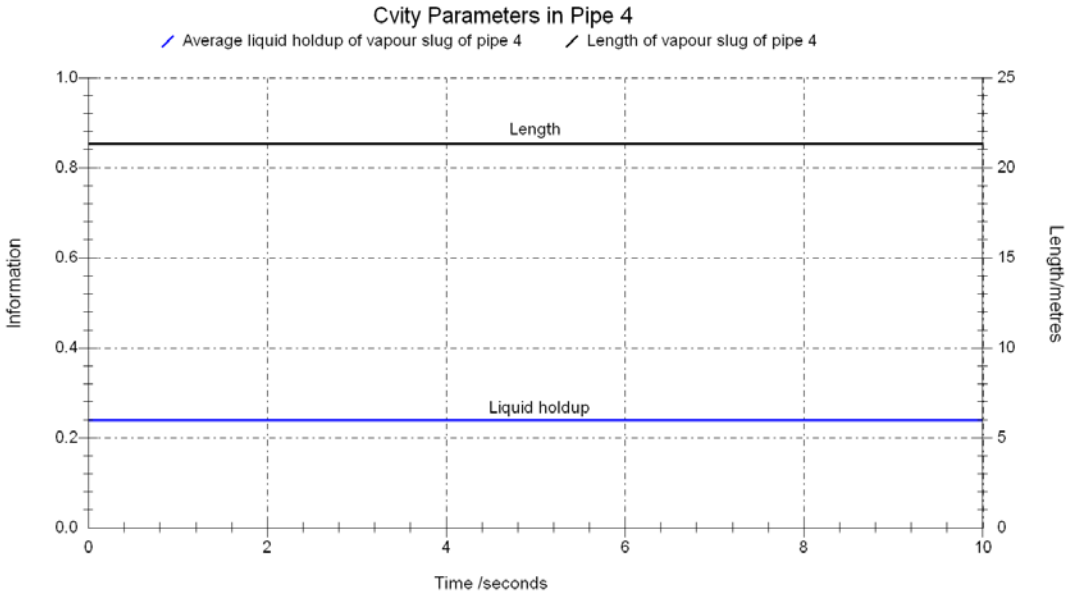
The elevation and the pressures along the pipeline are shown below, from which we can see that a cavity is formed in the vertical pipes 3 and 4 because the pressure drops to the vapour pressure 0.03625 bara.



The length of vapour slug is 95 m in 95 m Pipe 3, i.e. the cavity is the whole length of the pipe. The average liquid holdup is about 18% in the DN700 pipe.

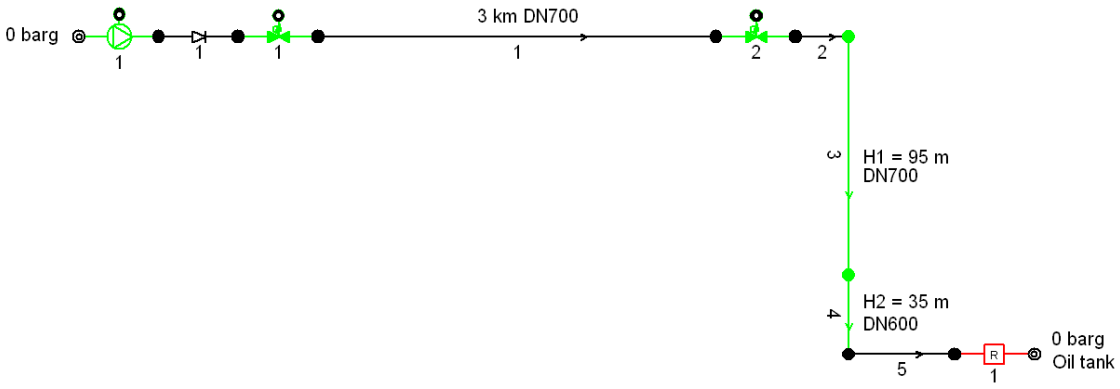


The length of vapour slug is 21.3 m in 35 m Pipe 4. The average liquid holdup is about 24% in the DN600 pipe.

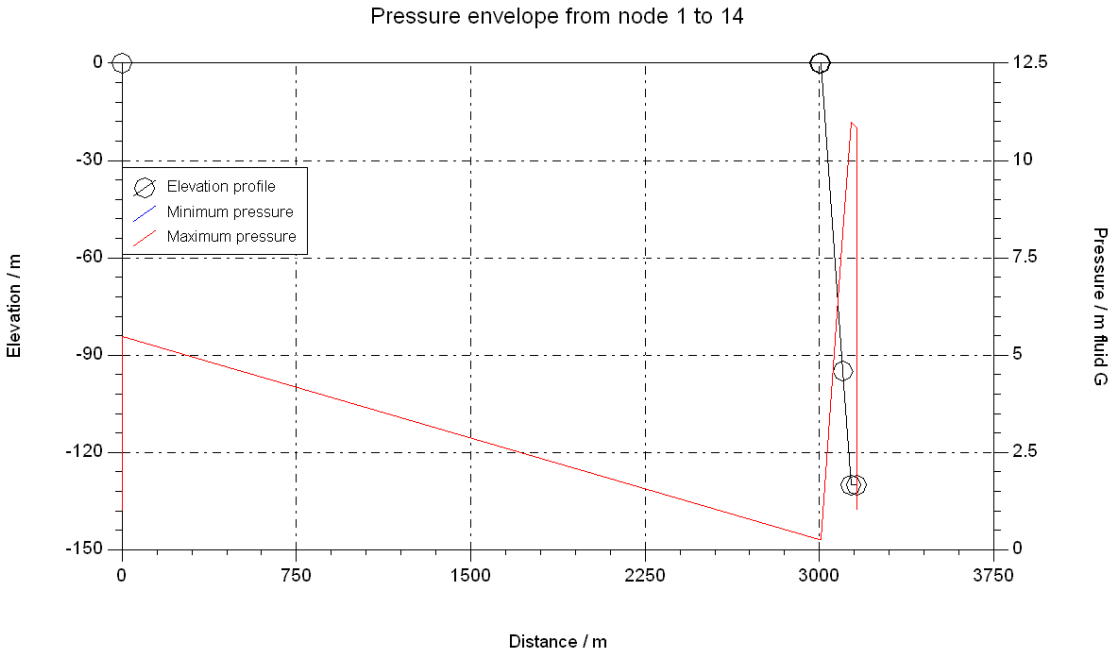


SCENARIO 2 – IMPROVED NETWORK TO ELIMINATE CAVITY

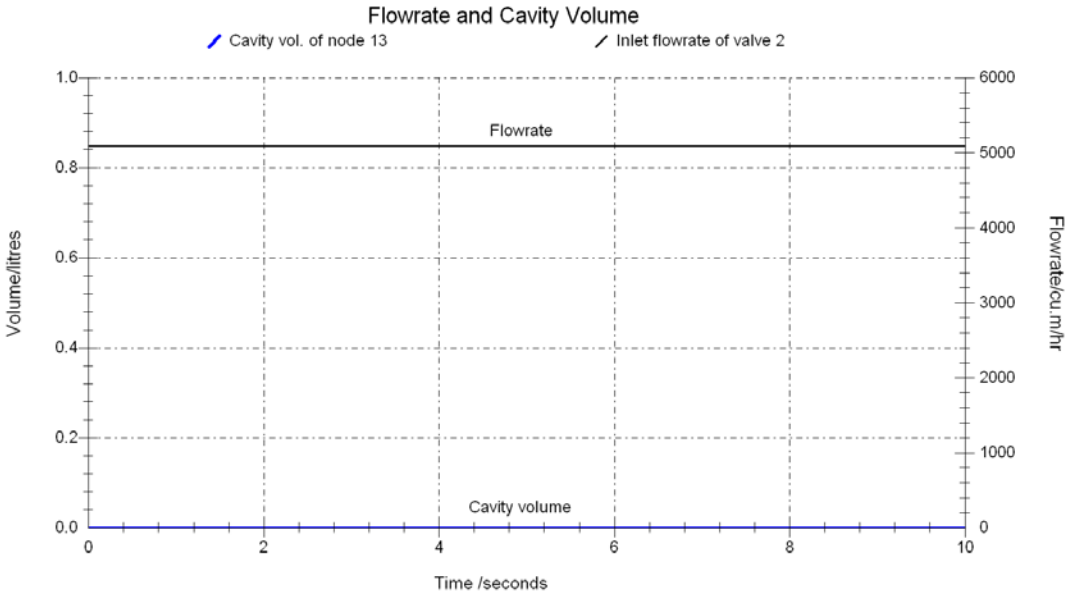
In the above original network the total cavity length is 95+21.3 = 116.3 m, and the flowrate is 5100 m3/hr. Therefore, the cavity can be eliminated if a resistance with 116.3m pressure loss at 5100 m3/hr flowrate is set downstream of the vertical pipes, as drawn in red below:



After analysing the new network, the elevation and the pressures along the pipeline are shown below. We can see that now the minimum pressure in the pipeline is above the vapour pressure 0.03625 bara, which indicates that the resistance has done its job and no cavity is formed in the network.



The flowrate of the pipeline is unchanged at 5100 m3/hr but the cavity volume decreases to zero after installing a resistance at the exit of the pipeline. The proposed solution improves the stability and reliability of the network but does not affect the transportation capacity.



CONCLUSIONS

The study confirmed the user's suspicions that cavitation would be significant in the vertical section of the pipeline. By quantifying the problem, an appropriate measure could be devised for preventing it happening.

If you have any questions about this case study, or any other of PIPENET's capabilities, please email us at Pipenet@sunrise-sys.com.

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