

## **Experimental investigation of gas hydrate plugging mechanisms in pipelines and the influence of the flow pattern**

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### **Abstract**

The formation of gas hydrates in oil and gas pipelines has developed into a hazardous problem, since it may cause the plugging of the pipeline. Recent studies have shown that coupling multiphase flow and gas hydrate formation is necessary in order to predict plugging tendencies (Ding et al., 2017; Joshi et al., 2013; Melchuna et al., 2016; Pham, 2018). The flow pattern before hydrate formation affects the hydrate formation rate, since the hydrate formation requires the contact between water and gas. The droplets sizes present on the flow will directly interfere on the initial size of the particles. The flow pattern after hydrate formation plays a decisive role on whether the plugging will be observed or not. Three important phenomena in solid-liquid flow are agglomeration, deposition and sedimentation of particles. Agglomeration occurs when two particles collide and adhere each other due to the attractive forces and growth near the contact between them. It directly affects the size of the dispersed particles. The larger are the particles flowing in the pipeline, the higher is the risk of plugging. Deposition occurs due to the collision of the particles to the wall and other phenomena. Sedimentation of particles at the bottom or at the top of the pipeline takes place when the flow velocity is not enough to carry the particles. When deposition or sedimentation occur, the cross sectional area is reduced, affecting the flow rate and the pressure drop, which increases the risk of plugging. The biggest challenge is to understand how these three phenomena will occur over time and space. The objective of this work is to analyze the mechanisms observed in agglomeration, deposition and sedimentation of particles, investigate how they behave according to the flow initial conditions, and see if it is possible to stablish a relationship between the observed flow patterns and the plugging risk. An experimental work will be conducted to simulate hydrate formation using a flow loop (Melchuna et al., 2016), applying high pressure and low temperature similar to the ones found in deep sea. A range of water cut with different flow rates will be tested. A commercial anti-agglomerant and salt will be tested as well to evaluate if they reduce the risk of plugging.

### **References**

- Ding, L., Shi, B., Lv, X., Liu, Y., Wu, H., Wang, W., Gong, J. Hydrate Formation and Plugging Mechanisms in Different Gas-Liquid Flow Patterns. *Ind. Eng. Chem. Res.*, Vol. 56, pp. 4173 – 4184 (2017)
- Joshi, S. V., Grasso, G.A., Lafond, P.G., Rao, I., Webb, E., Zepa, L.E., Sloan, E.D., Koh, C.A., Sum, A.K. Experimental flow loop investigations of gas hydrate formation in high water cut systems. *Chem. Eng. Sci.*, Vol. 97, pp. 198 – 209 (2013)
- Melchuna, A., Cameirao, A., Herri, J.M., Glenat, P. Topological modeling of methane hydrate crystallization from low to high water cut emulsion systems. *Fluid Phase Equilib.*, Vol. 413, pp. 158 – 169 (2016)
- Pham, T.K. Experimental study and modelling on methane hydrates crystallization under flow from a water-oil dispersion at high water cut. PhD Thesis, 334 p., Mines Saint Etienne, France (2018)

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