

EXPERIMENTAL STUDY ON METHANE HYDRATE FORMATION AND TRANSPORT FROM EMULSIONS IN A "GAS LIFT" RISER IN A FLOWLOOP



Trung-Kien PHAM^{a,c}, Ana CAMEIRAO^{a,*}, Jean-Michel HERRI^a, Philippe GLENAT^b
^aGas Hydrate Dynamics Centre, Ecole Nationale Supérieure des Mines de Saint-Etienne, 158 Cours Fauriel, Saint-Etienne 42023, France
^bTOTAL S.A., CSTJF, Avenue Larribau, Pau Cédex 64018, France
^cHanoi University of Mining and Geology, Duc Thang, Bac Tu Liem, Ha Noi, Vietnam
 (*) cameirao@emse.fr



1. Introduction

- Offshore systems operate at low temperature and high pressure which favor conditions for gas hydrate formation and agglomeration.
- Gas hydrate is a serious issue in flow assurance; it may cause many troubles, especially, plugging in oil and gas pipelines.

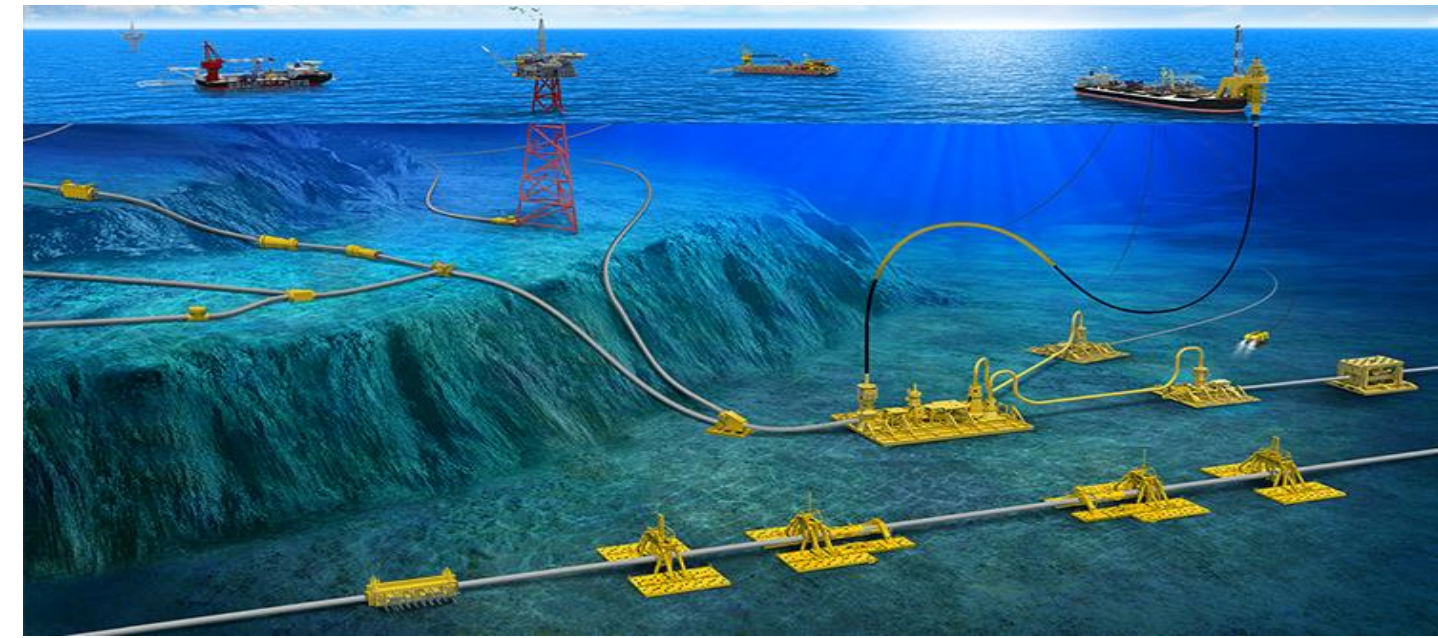


Figure 1 – Subsea pipelines [4].

- The previous work (Melchuna 2016, [1]) allowed to construct a preliminary model of understanding of the crystallization under flow.

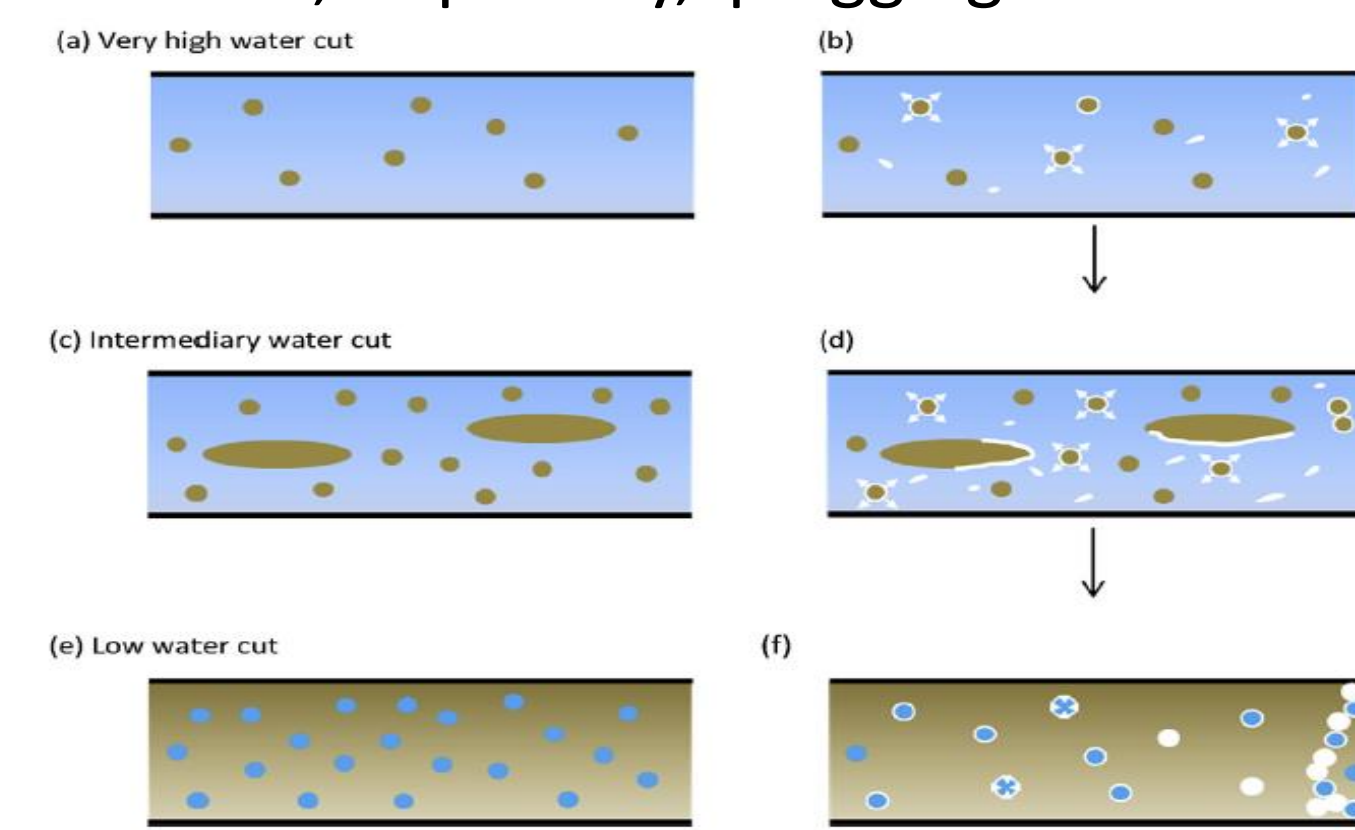


Figure 2 – Topological model of crystallization under flow [1].

2. Objective

- **Science:** understand the mechanisms of methane hydrate crystallization, agglomeration together with slurry transport and deposition in oil and gas pipelines at low and high water cut with a gas-lift.
- **Industry:** understand the properties and role of commercial additives (anti-agglomerants- AA-LDHIs) in dispersing hydrate particles to prevent plugging in offshore pipelines.

3. Materials and Methods

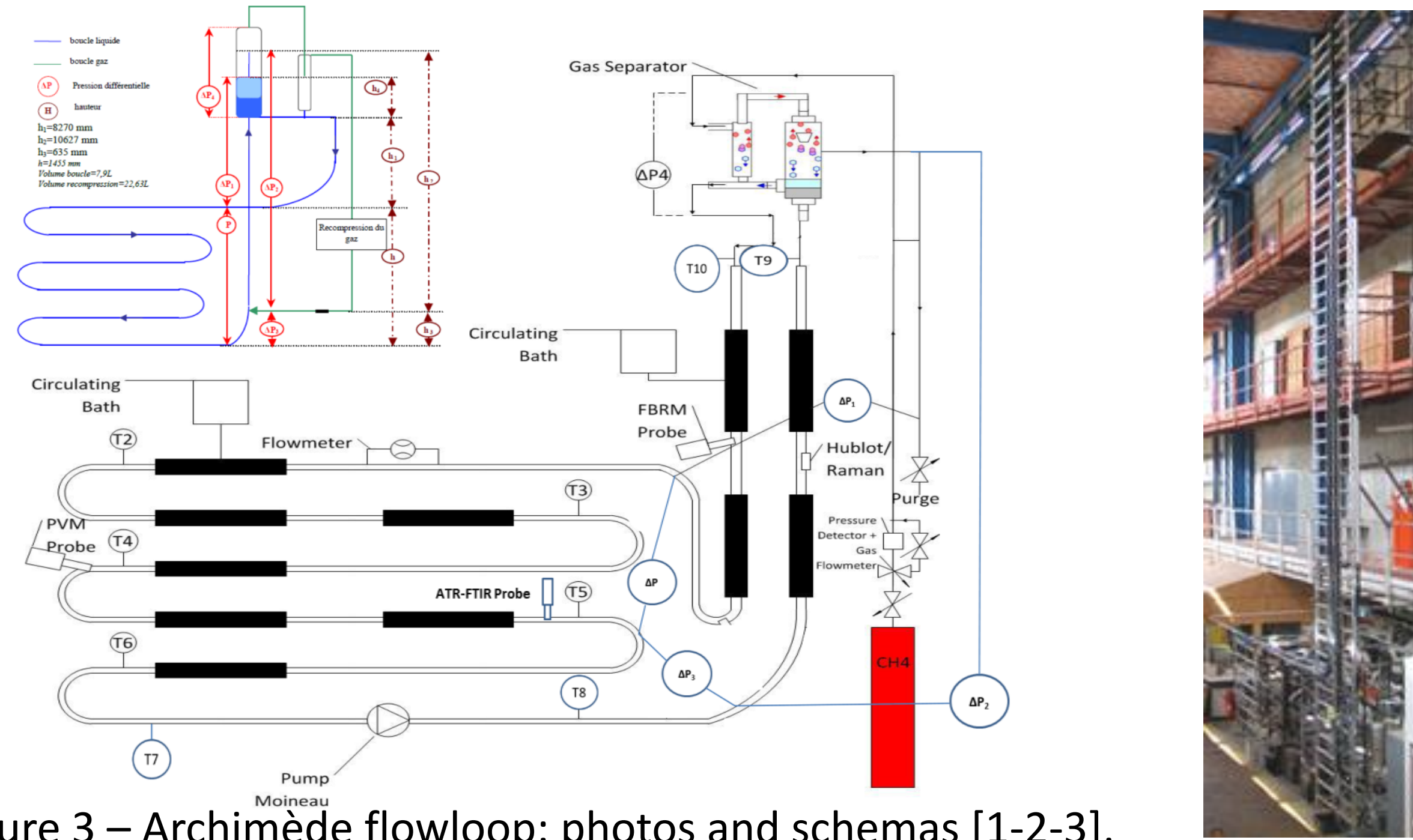


Figure 3 – Archimède flowloop: photos and schemas [1-2-3].

Experimental procedure and apparatus

- Emulsions formed by water (with and without salt) and oil (Kerdane[®]) are charged into the flow loop with and without anti-agglomerants (AA-LDHIs).
- The system is cooled down until 4-5°C and pressurized up to 75 bar by the injection of methane for gas hydrate formation, agglomeration and deposition study.
- Flowrate: 30-150L/h; water volume fraction (30-80-90-100%); dosage of AA-LDHI: 0; 0.01; 0.05; 0.1 and 0.5 %; salt: 0 and 30g per liter of water.
- Probes used: Particle Video Microscope (PVM), Focus Beam Reflectance Measurement (FBRM), pressure drop, flowrate and density measurement.

4. Experimental Results

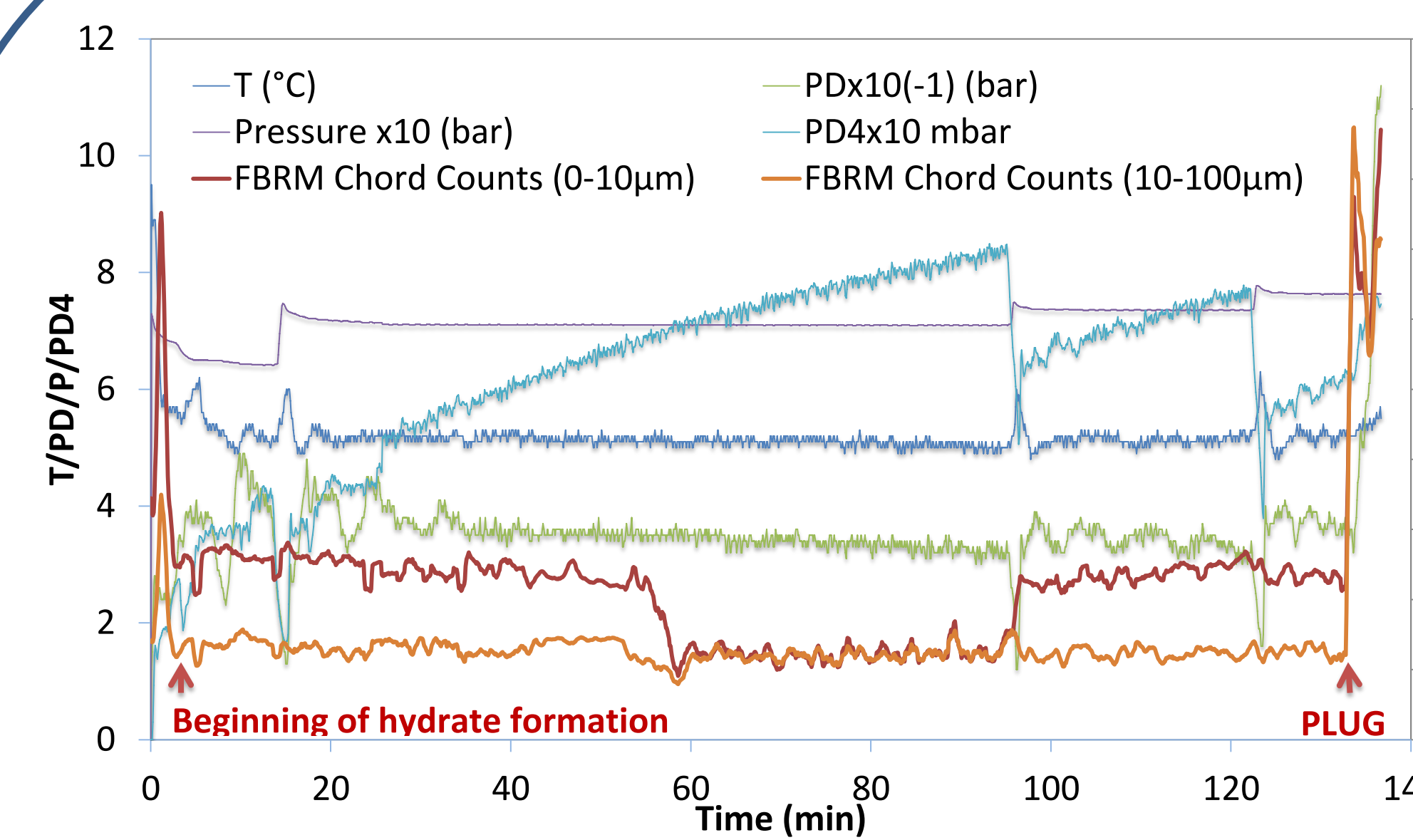


Figure 4 – Typical experiment at low water cut (30%WC+NaCl without AA-LDHI). In order to enhance hydrate formation, three gas injections were made at 14, 95 and 121 min. During the gas injection, the flow was stopped and restarted once the injection was finished.

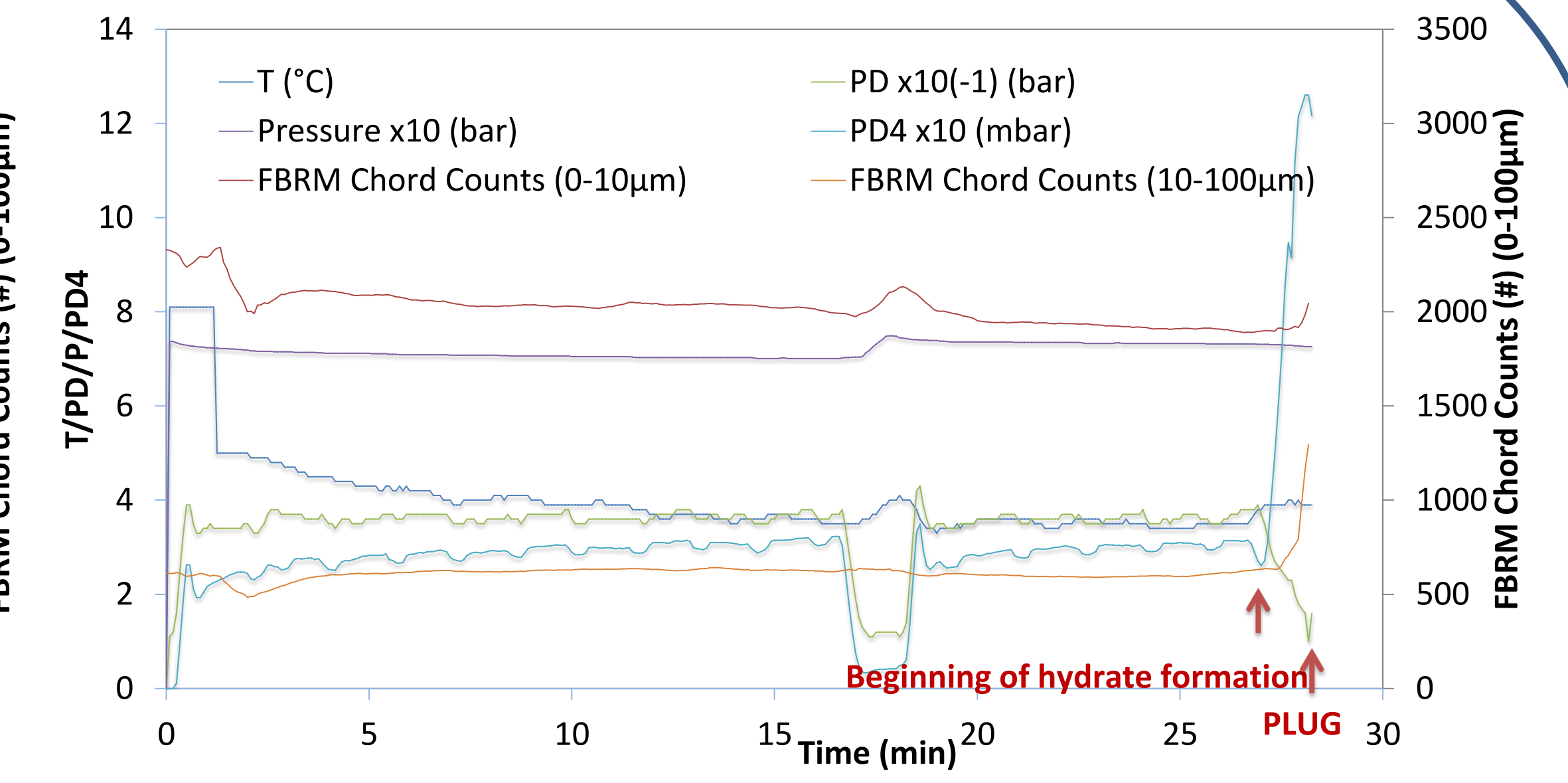


Figure 5 – Typical experiment at high water cut (90%WC+NaCl without AA-LDHI). In order to promote hydrate formation, the gas injections were made between 16.5 and 18.5 min. During the gas injection the flow was stopped and restarted once the injection was finished.

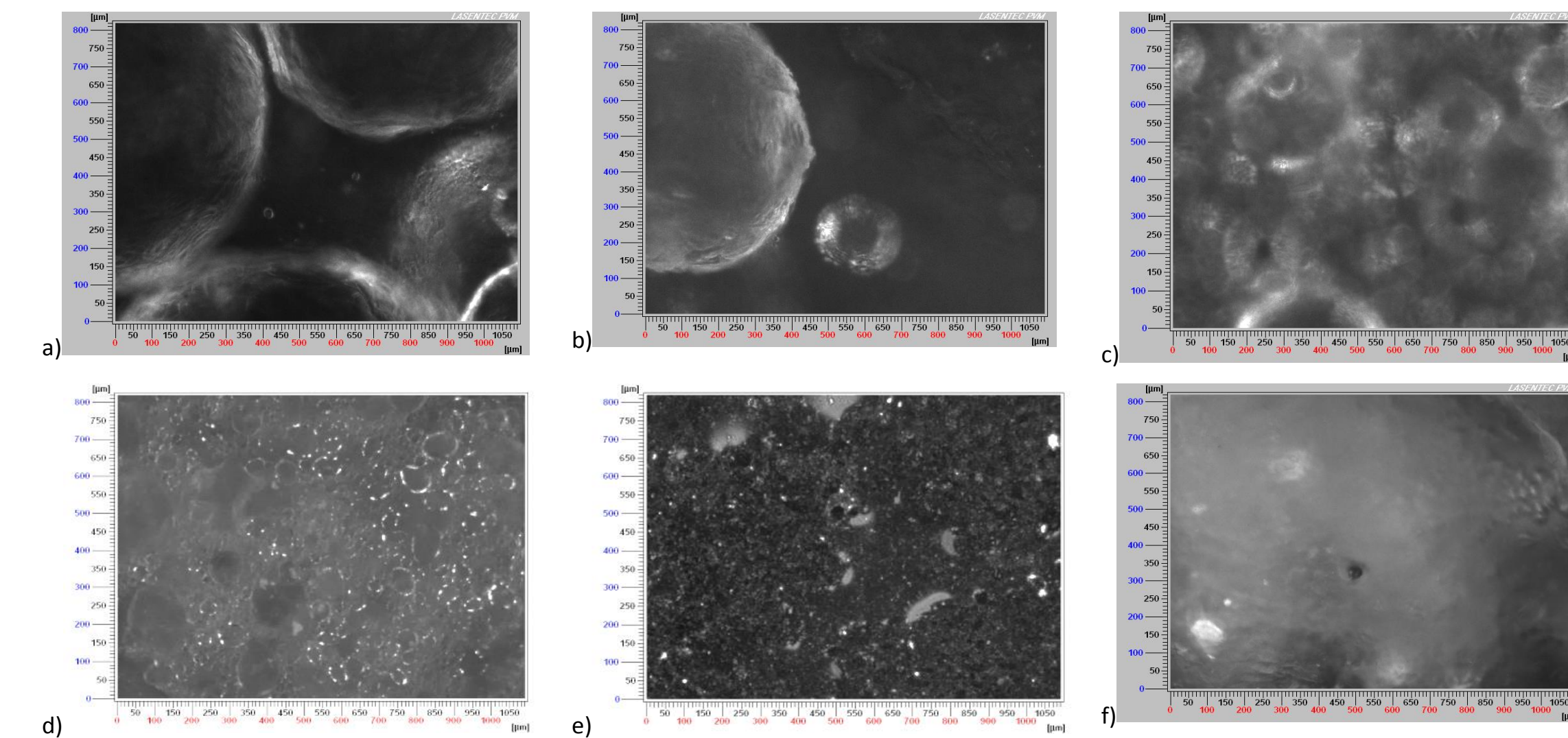


Figure 6 – PVM images of gas hydrate formation for different mixtures: (a) 90%WC without AA-LDHI; (b) 90%WC+NaCl without AA-LDHI; (c) 90%WC with 0.01% AA-LDHI; (d) 80%WC without AA-LDHI; (e) 30%WC without AA-LDHI; (f) 30%WC+NaCl with 0.01% AA-LDHI.

5. Crystallization Mechanism

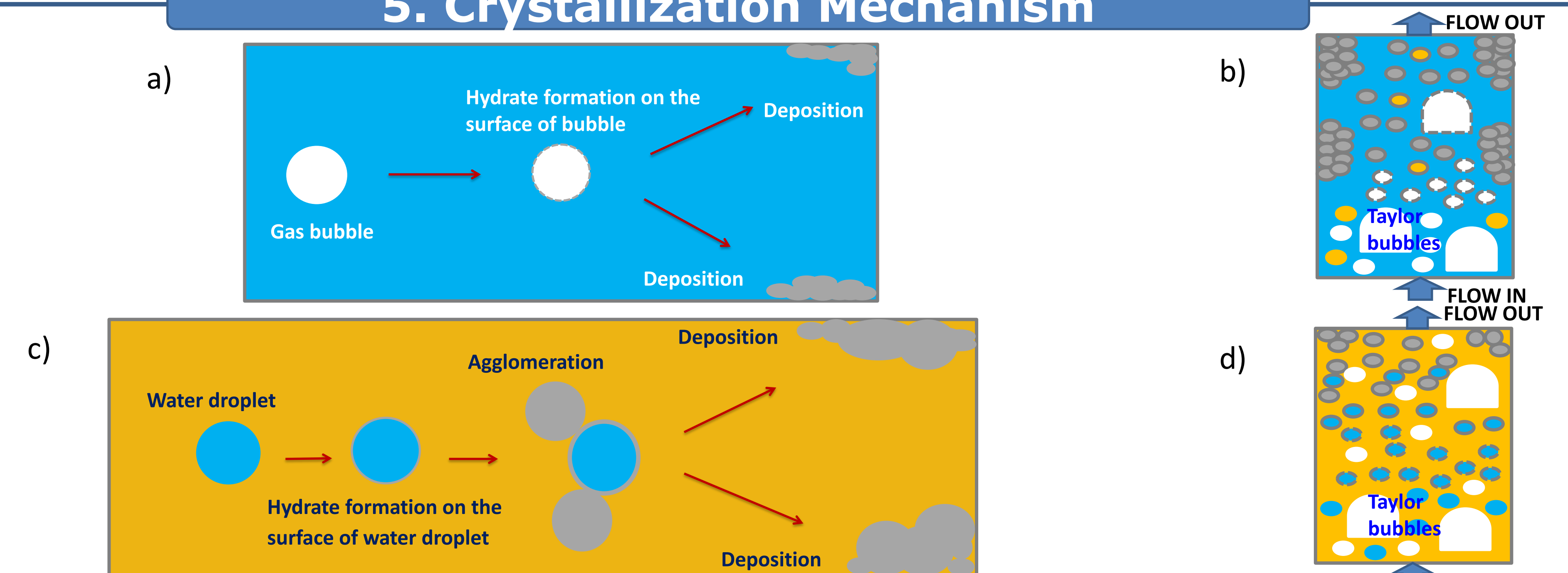


Figure 7 – Conceptual mechanism for hydrate formation, agglomeration, deposition and plugging in the gas-lift riser and separator without AA-LDHI: (a, b) at high water cut; (c, d) at low water cut.

6. Conclusions & Perspectives

In high water cut systems, the risk of hydrate blockage is high because of high rate of hydrate formation, proportional to the high gas/water interface generated by bubbles. The high rate of gas transfer results in a high risk of quick plug formation. AA-LDHI at low dosage (0.01%) is not sufficient to prevent their deposition, and plugging occurs rapidly. Also, specific risk in the separator was identified because hydrates can accumulate.

In low water cut systems, gas hydrates form sooner but the plugging can be prevented by using the AA-LDHI. With pure water, without salt, the plugging is prevented even at low AA-LDHI dosage (0,01%). In salty systems, the plugging is prevented by using a higher quantity of AA-LDHI, up to 0.5%.

Future work will be modelling of gas hydrate formation, agglomeration, deposition and plugging combined with flow pattern.

7. References

- [1]. A.Melchuna, A.Cameirao, JM.Herri, P.Glenat, "Topological modeling of methane hydrate crystallization from low to high water cut emulsion systems", *Fluid Phase Equilibria*, Volume 413, 15 April 2016, P.158-169
- [2]. Fidel-Dufour, Annie, Frédéric Gruy, and Jean Michel Herri. 2006. "Rheology of Methane Hydrate Slurries during Their Crystallization in a Water in Dodecane Emulsion under Flowing." *Chemical Engineering Science* 61(2): 505–15.
- [3]. Leba, Hung et al. 2010. "Chord Length Distributions Measurements during Crystallization and Agglomeration of Gas Hydrate in a Water-in-Oil Emulsion: Simulation and Experimentation." *Chemical Engineering Science* 65(3): 1185–1200.
- [4]. <http://oilstates.com/offshore/subsea-pipeline-products/> (13/06/2017)

