Crystallization of methane hydrates from an emulsion in a flowloop: Experiments in a gas-liquid-liquid system in the gas-lift

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CRYSTALLIZATION OF METHANE HYDRATES FROM AN EMULSION IN A FLOWLOOP: EXPERIMENTS IN A GAS-LIQUID-LIQUID SYSTEM WITH A GAS-LIFT

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

Figure 1 – Subsea pipelines [6].

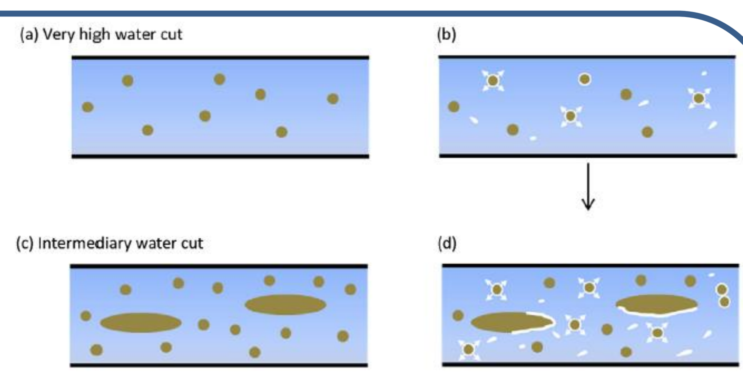


Figure 2 – Topological model of crystallization under flow [1].

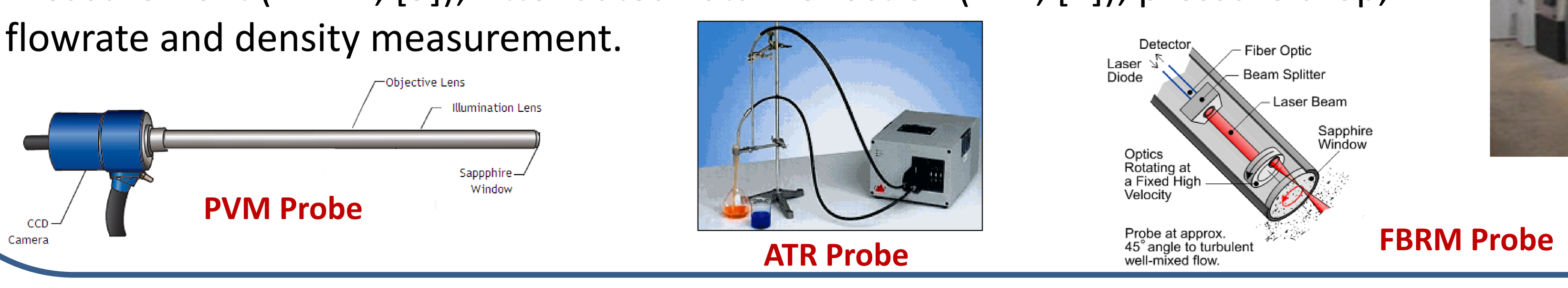
2. Objective

- **Science:** understand the mechanisms of methane hydrate crystallization, agglomeration together with slurry transport and deposition in oil and gas pipelines at 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

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 4-5ºC and pressurized up to 75 bar by the injection of methane for gas hydrate formation, agglomeration and deposition study.
- Flowrate: 150-400 L/h; water volume fraction (80-100%); dosage of AA-LDHI: 0; 0.01; 0.05; 0.5; 1.0 and 2.0%; salt: 0 and 30g per liter of water.
- Probes used: Particle Video Microscope (PVM, [4]); Focus Beam Reflectance Measurement (FBRM, [5]); Attenuated Total Reflection (ATR, [7]); pressure drop, flowrate and density measurement.



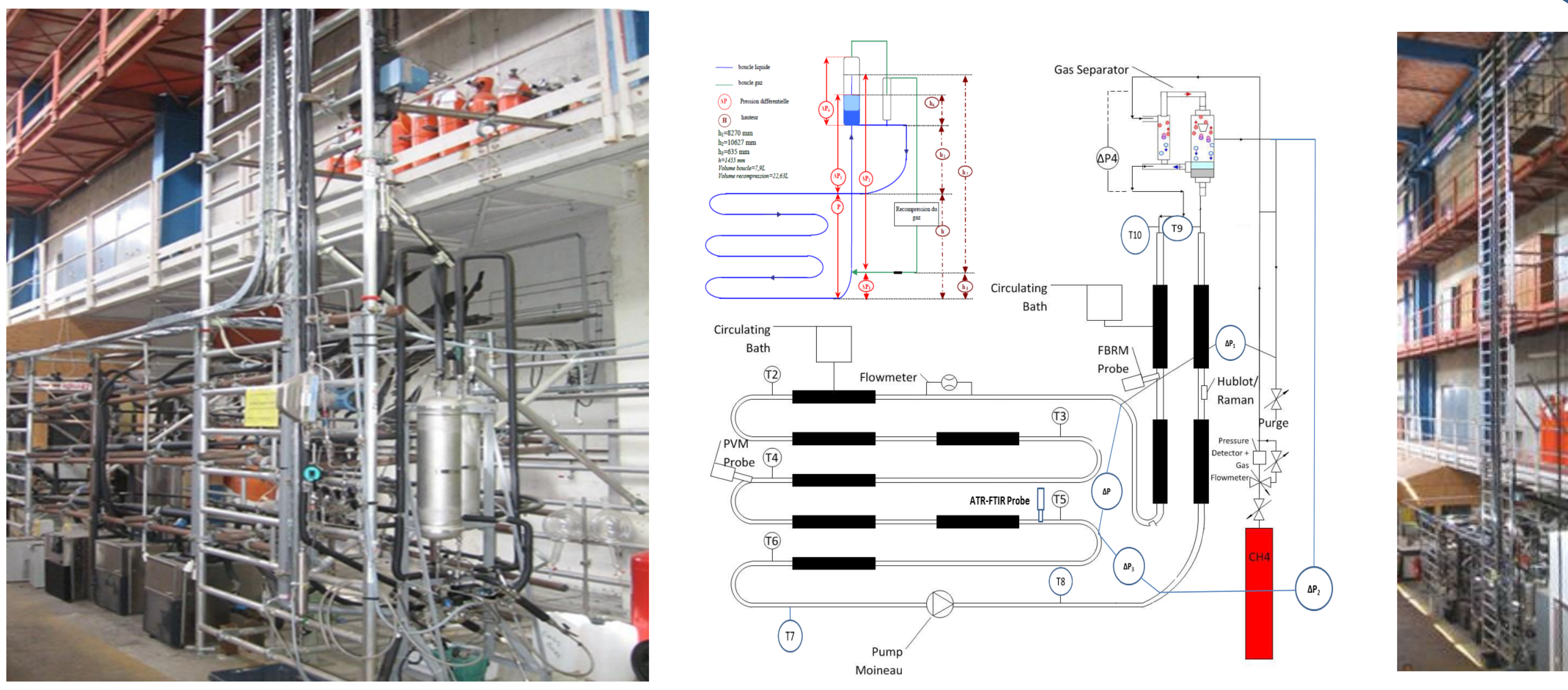


Figure 3 – Archimède flowloop photos and schemas [1-2-3].

4. Experimental Results

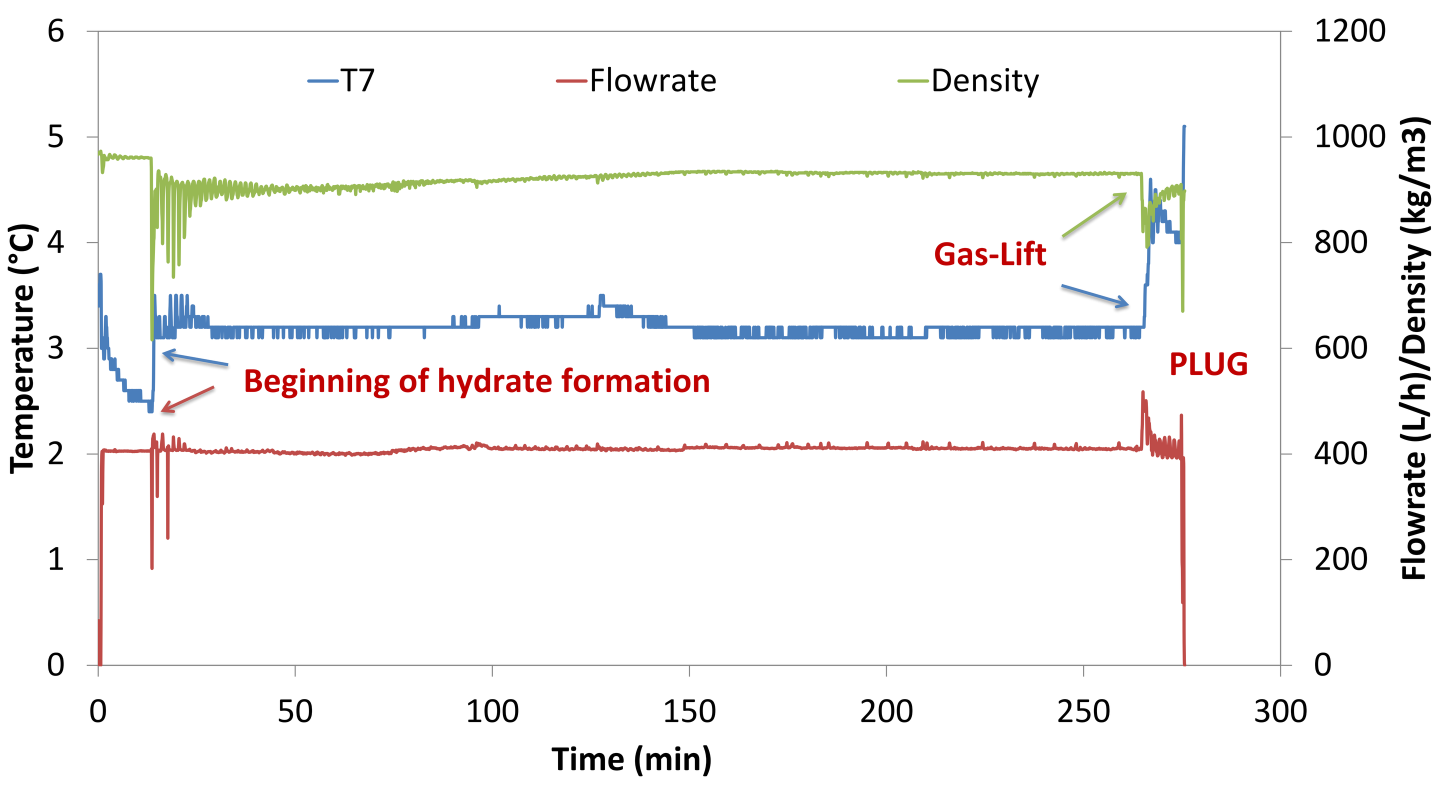


Figure 4 – Typical temperature (T7), flowrate and density profile during a crystallization experiment for mixture of 80%WC at 400L/h and 85%LV.

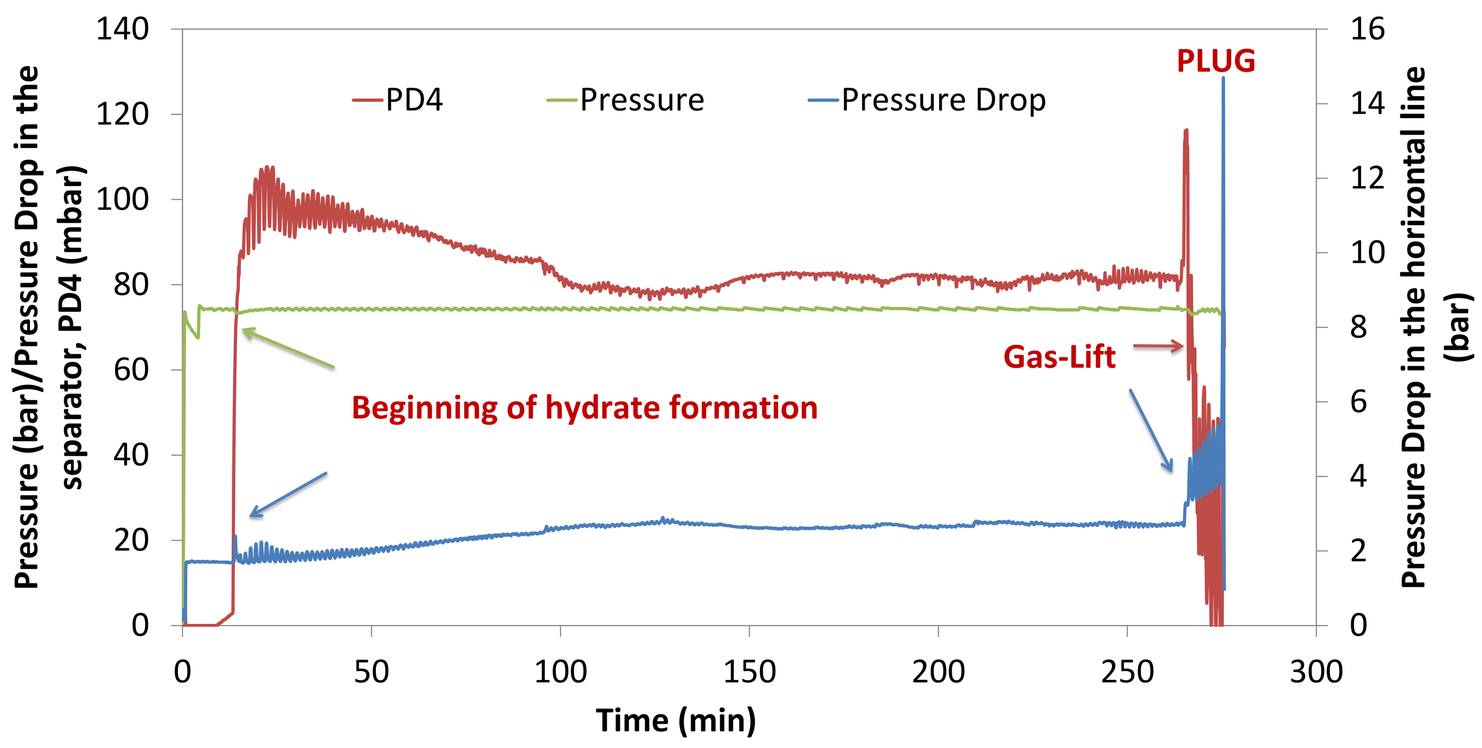


Figure 5 – Typical pressure drop (in horizontal line), pressure drop in the separator (PD4) and pressure profile during a crystallization experiment for mixture of 80%WC at 400L/h and 85%LV.

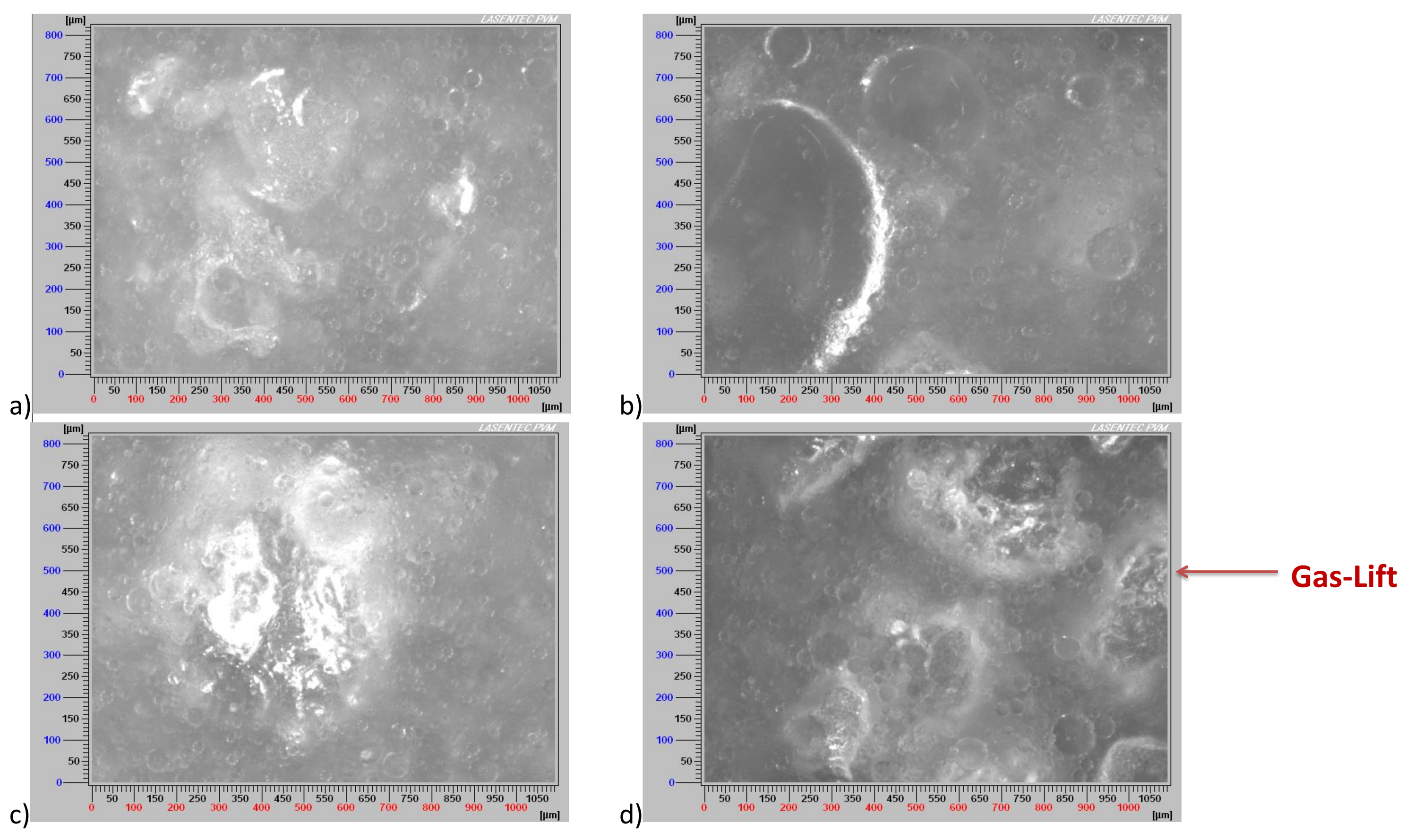


Figure 6 – PVM images of gas hydrate formation for mixture of 80%WC at 400L/h and 85%LV [a) 102.8 min; b) 131.8 min; c) 145.9 min; d) 270.8 min].

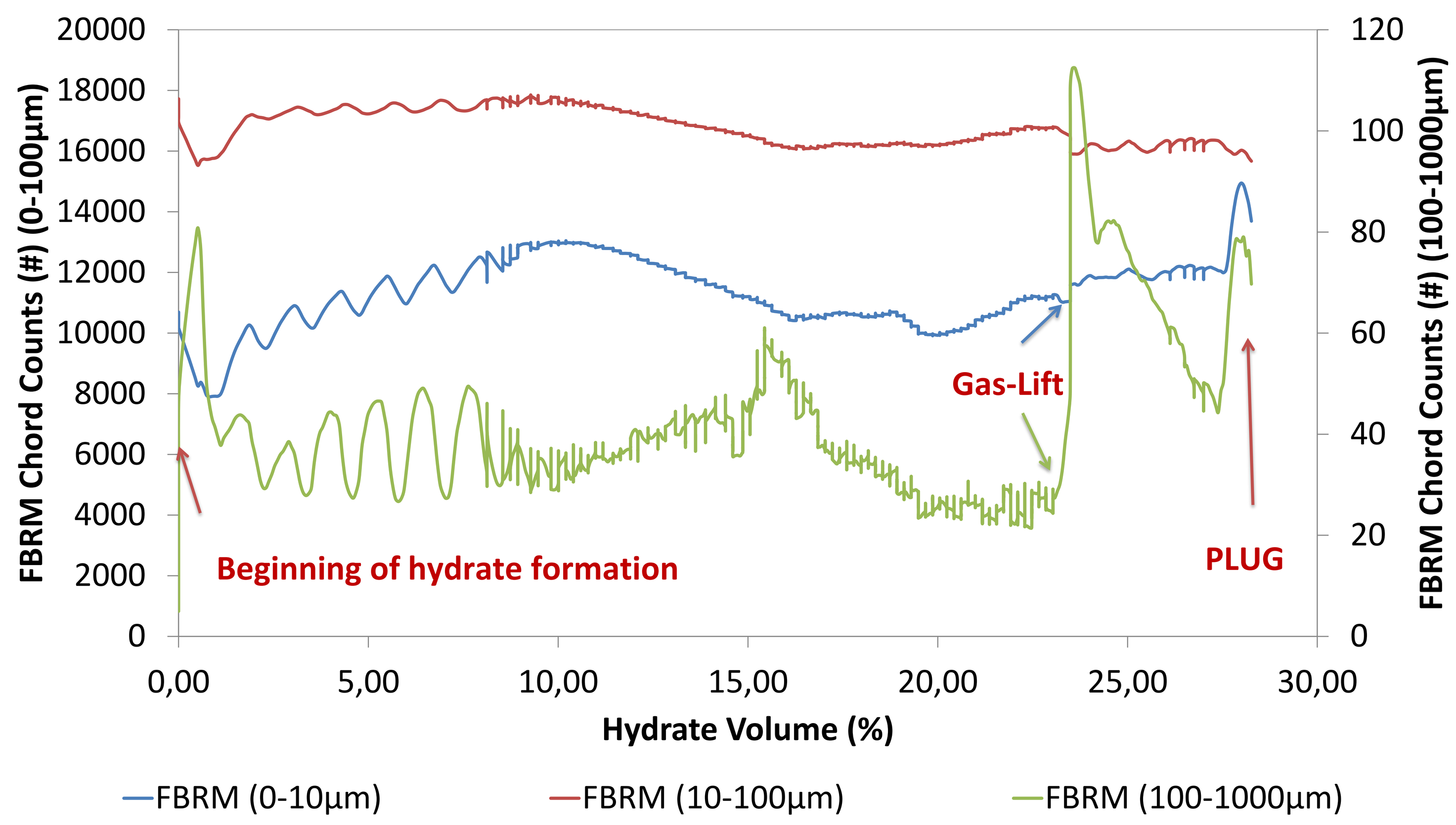


Figure 7 – FBRM chord counts as function of hydrate volume for experiment of 80%WC at 400L/h and 85%LV.

5. Conclusions & Perspectives

The FBRM probe enables to monitor the crystallization by following the size of droplets, particles and agglomerates with chord length distribution measurements during time.

Different morphologies of hydrate particles during crystallization were observed with PVM.

Hydrate deposition on the pipe wall was observed with the FBRM, the PVM and the density measurements.

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

6. References

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[7]. https://www.thejournalofindustryandtechnology.biz/page66.html (14/06/2017)