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Kinetic modelling of methane hydrate formation and agglomeration with and without anti-agglomerants from emulsion in pipelines

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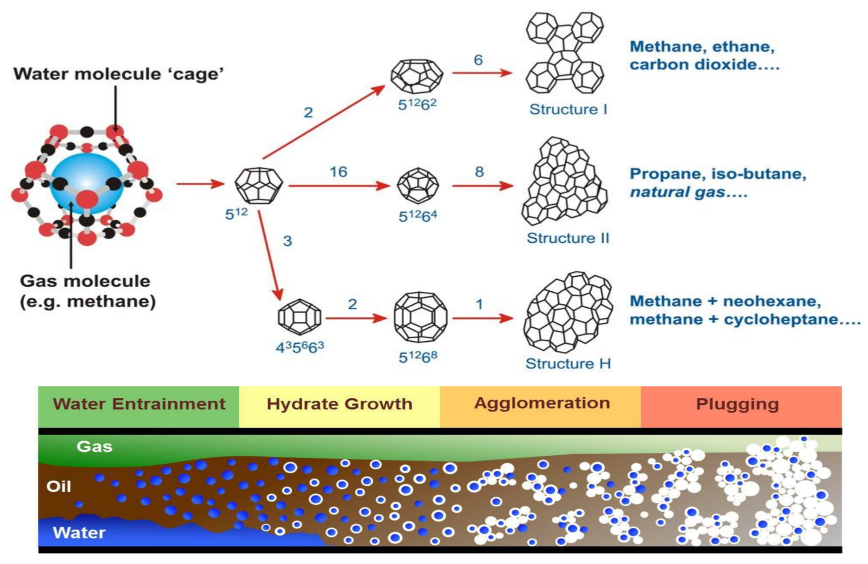
Introduction

- Offshore systems mainly containing crude oil, natural gas and water operate at low temperature and high pressure which favour 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 pipeline.

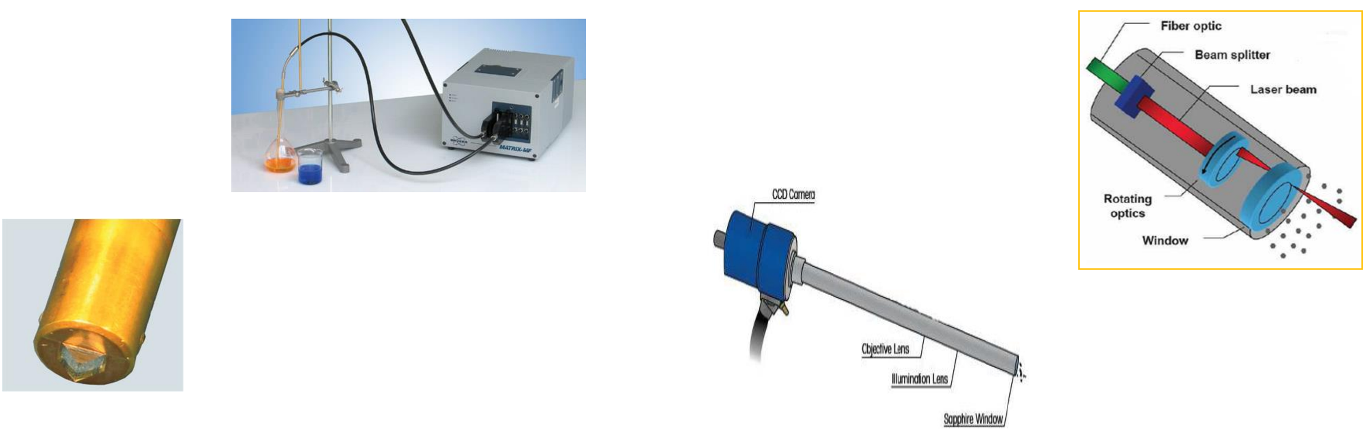


Objective

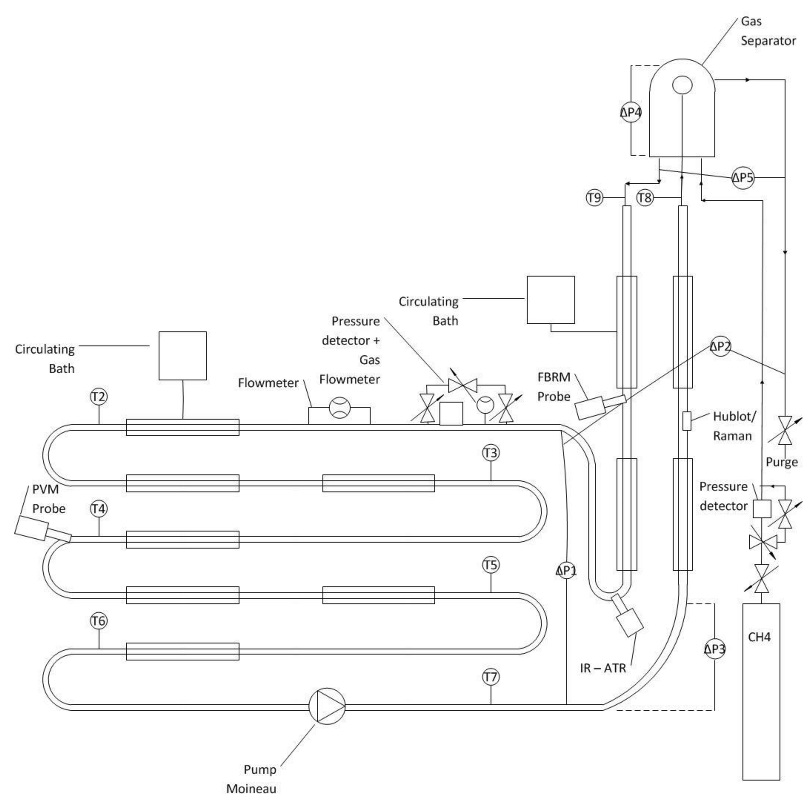
- Intend to develop a kinetic model to predict gas hydrate formation, agglomeration and plugging in flowlines based on the experimental data obtained from Archimede Flowloop from the work of Mendes-Melchuna (2015).
- A preliminary study of the emulsion formation and behaviour will contribute to a better understanding of the hydrates formation and agglomeration.

Experimental Method

- Emulsions formed by water and oil (Kerdane®) are charged into flow loop with and without anti- agglomerants (AAs-LDHI) to study rheology.
- The system is cooled down 4-5°C and pressed up to 80 bar by the injection of methane for gas hydrate formation and agglomeration study.
- Probes used: Particle Video Microscope (PVM), Focus Beam Reflectance Measurement (FBRM) and Attenuated Total Reflection – Infrared (ATR-FTIR)



Experimental Apparatus (Archimede Flowloop)



Mean Droplet Size Model

Schema for Developing Mean Droplet Size Model

Develop mean droplet size model (d_p) from model of Turner (2009) and Boxall (2011)

↓

Experimental data: velocity (v), dispersed phase cut (dpc), viscosity of continuous phase (μ), interfacial tension between oil and water (σ)

↓

$$d_P = A_*(v)^B{}_*(dpc)^C{}_*(\mu)^D{}_*(\sigma)^E$$

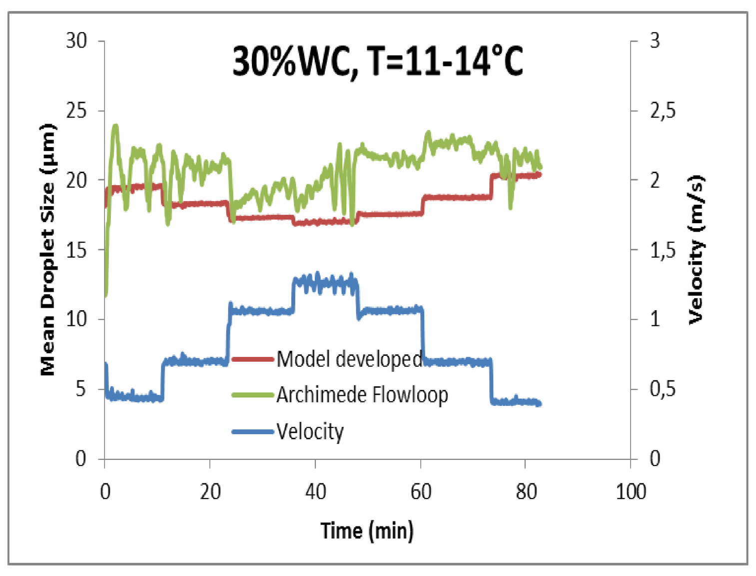
↓

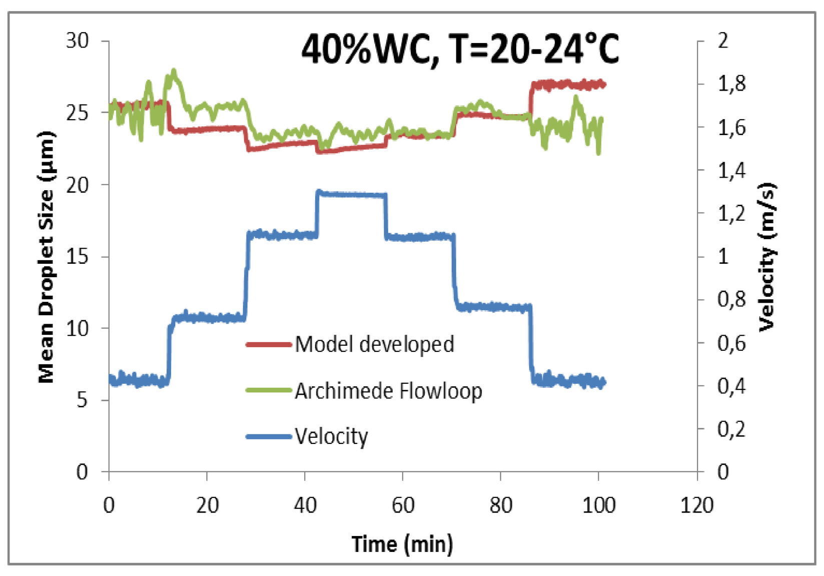
Regressed d_P (A, B, C, D, E) from Archimede Flowloop experimental data

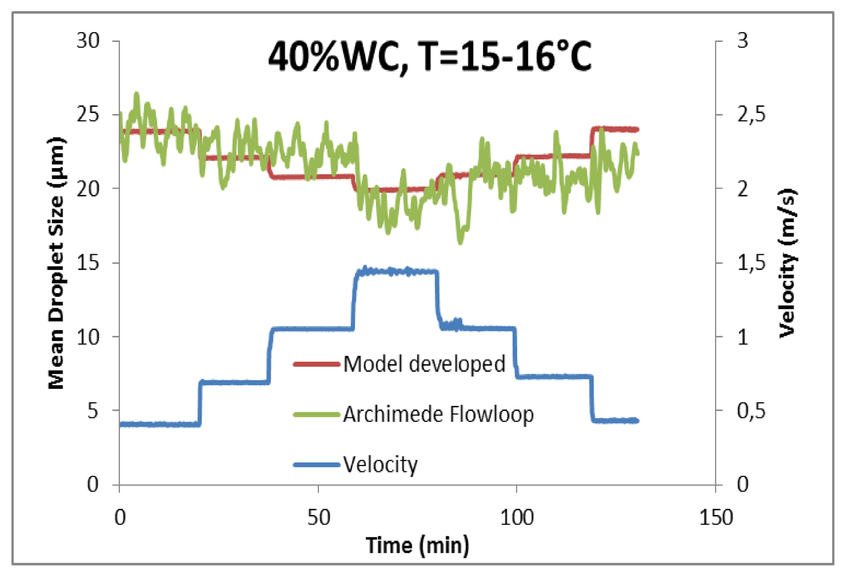
↓

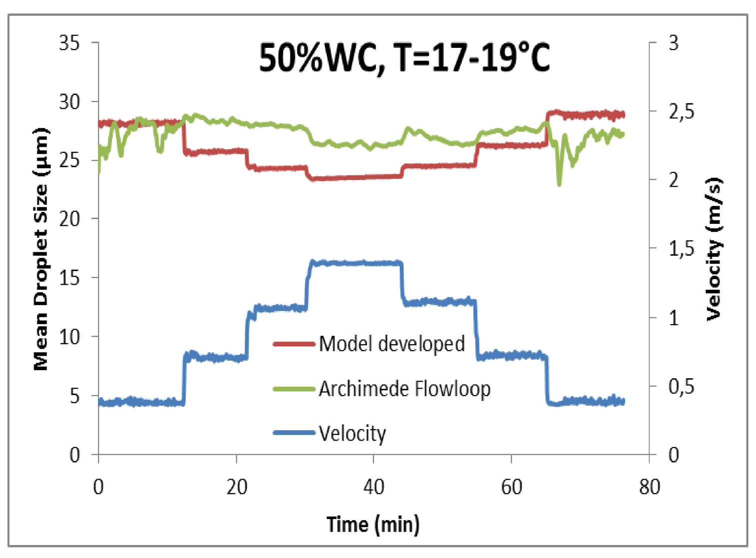
$$d_P = (100/6)_*(v)^{-0.15}{}_*(dpc)^{0.526}{}_*(\mu)^{-0.5}{}_*(\sigma)^{3/5}$$

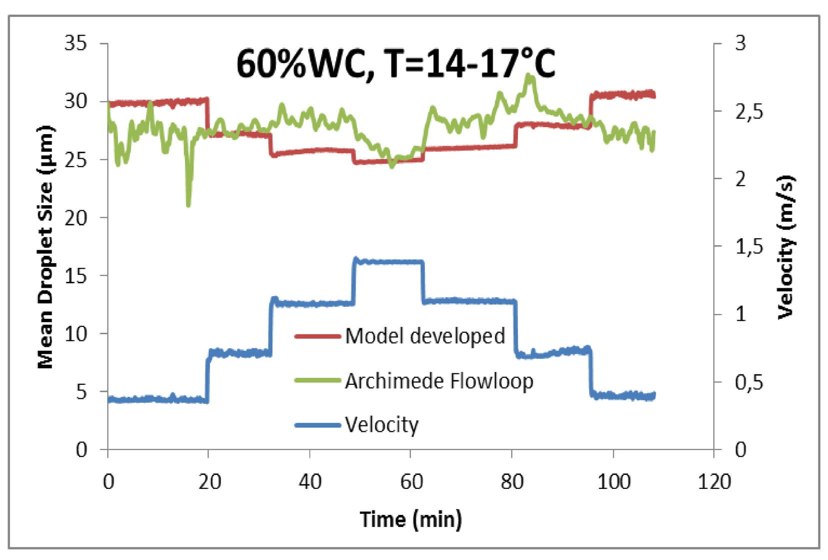
Initial results for mean droplet size model developed from Archimede Flowloop data

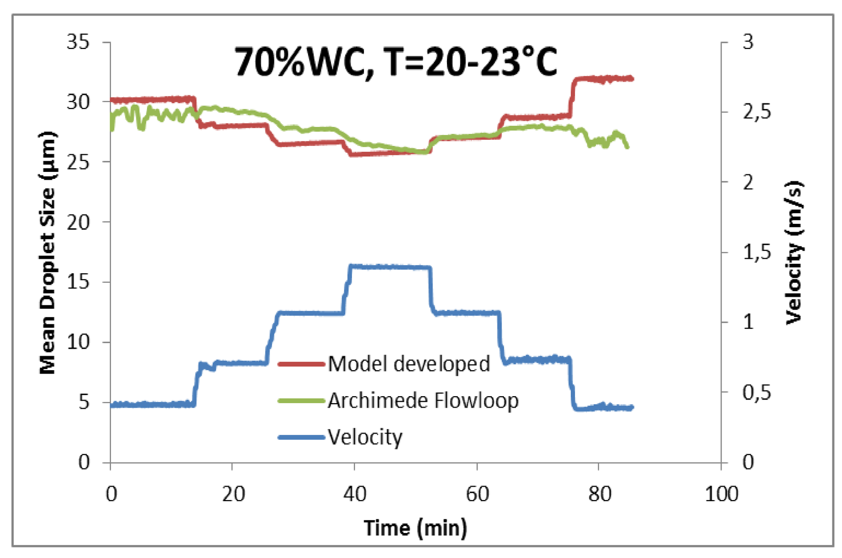


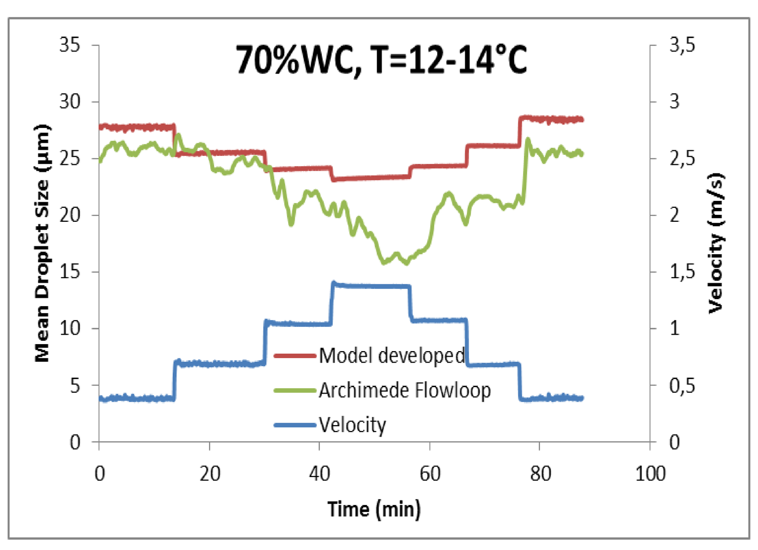


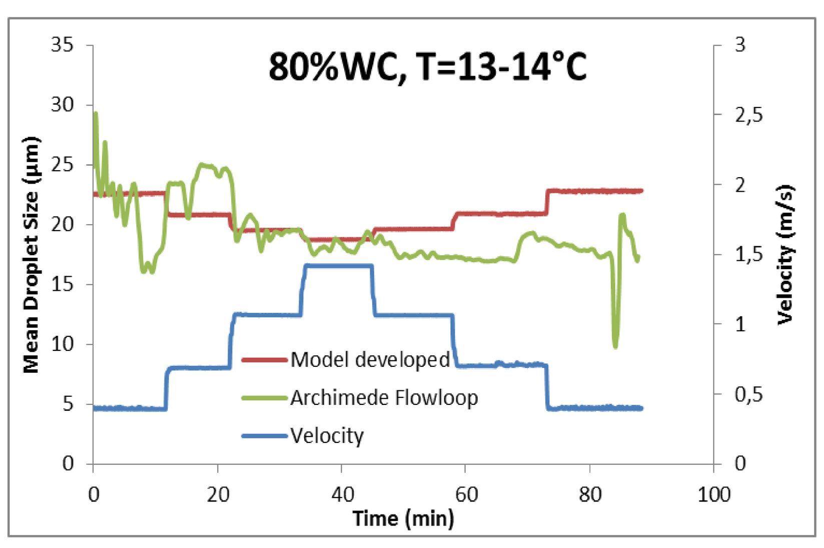


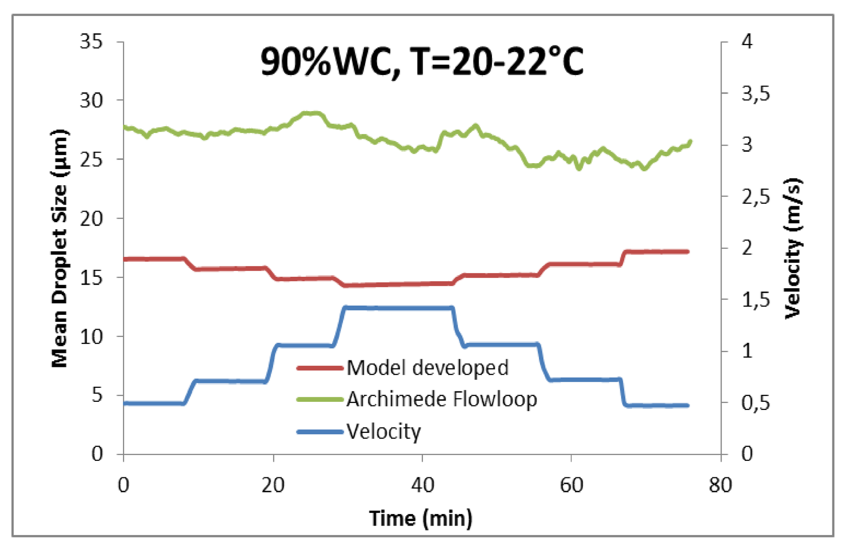












Conclusions & Perspectives

- Mean droplet size of emulsion is a key factor for kinetics of gas hydrate formation and agglomeration in oil and gas pipelines.
- This mean droplet diameter model will be further studied to better match with higher water cut and in the presence of AAs-LDHI using dimensionless parameters (Reynolds and Weber numbers).
- Future work will focus on developing model of gas hydrate formation and agglomeration in flowlines.

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