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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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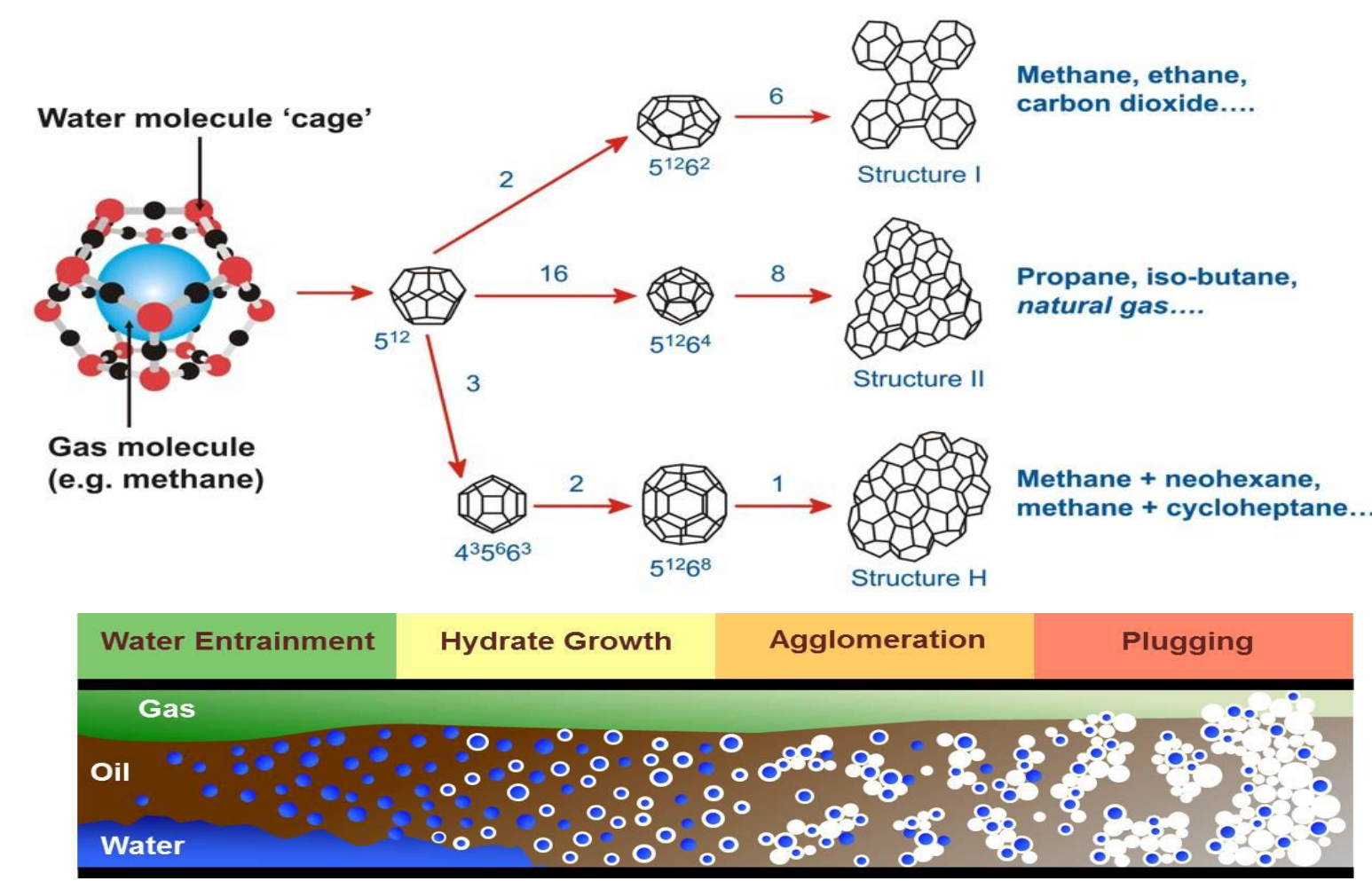
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Introduction

- 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.



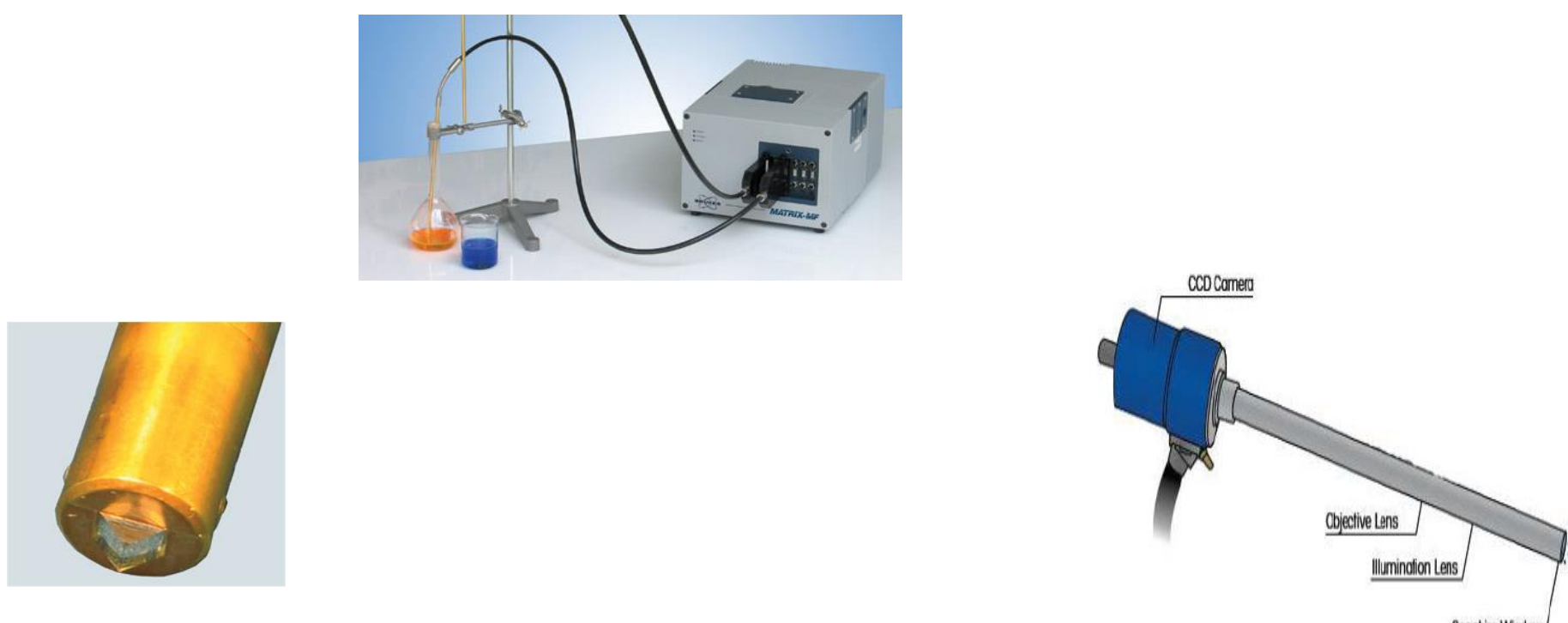
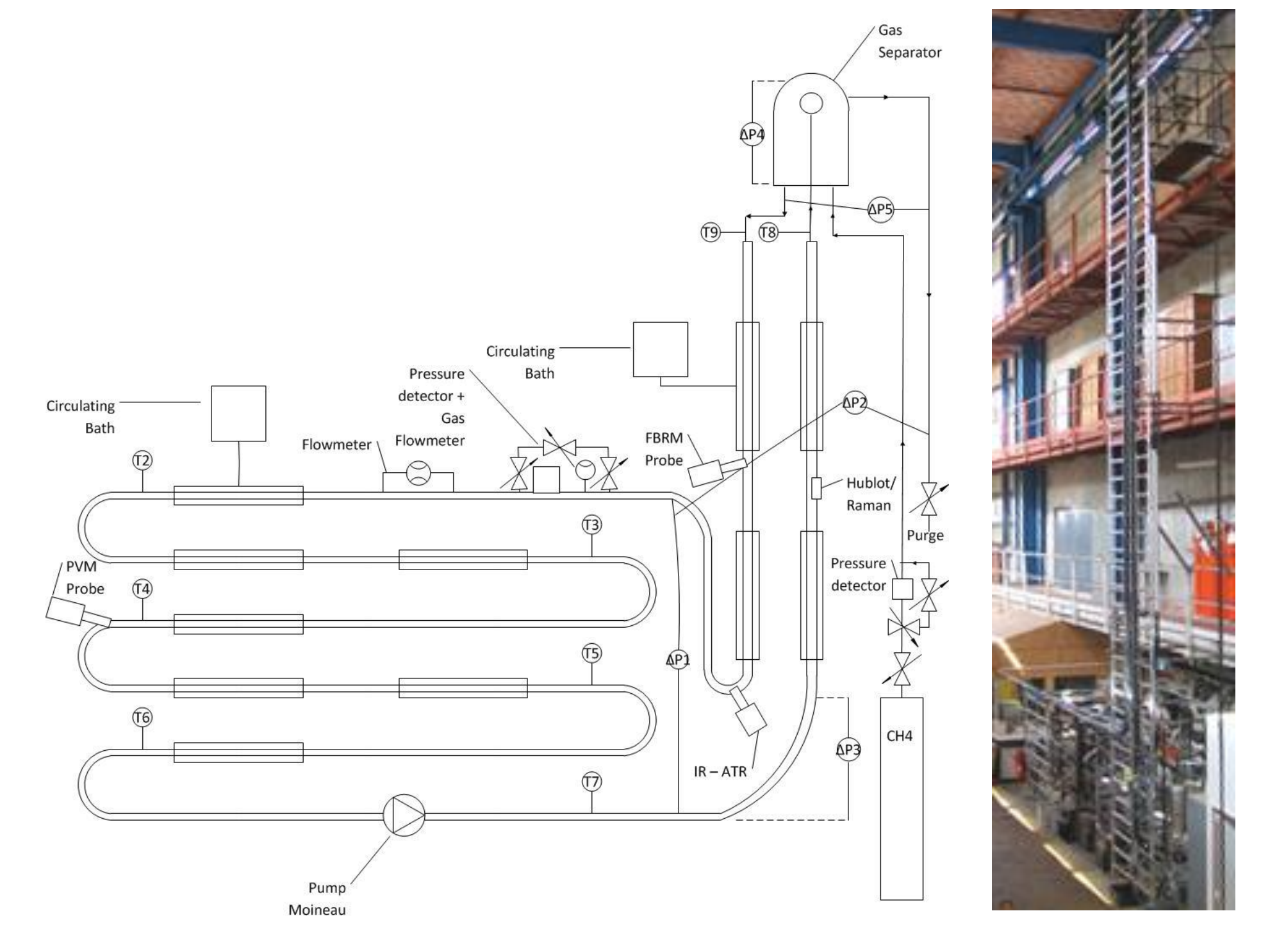
Objective

- 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

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

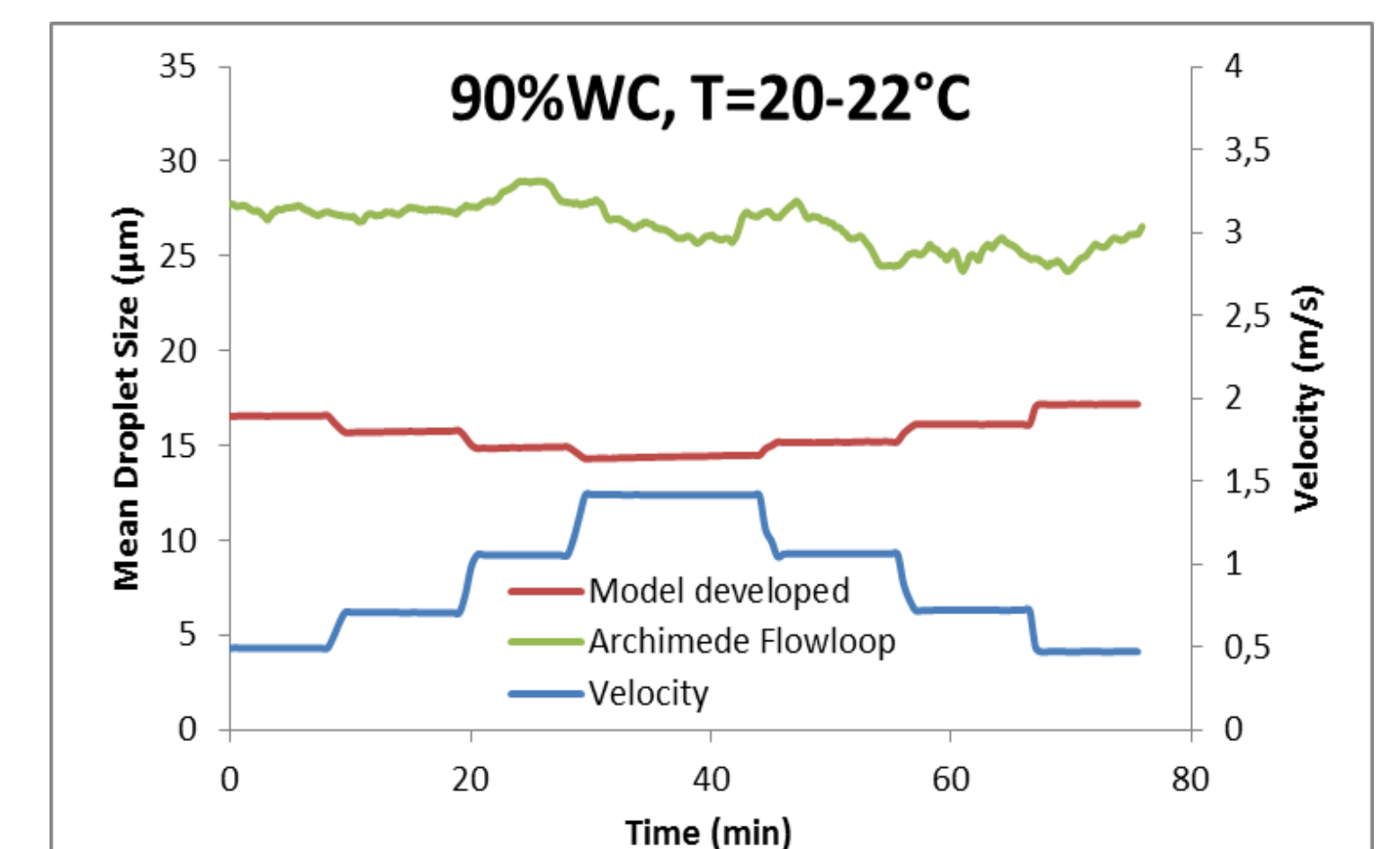
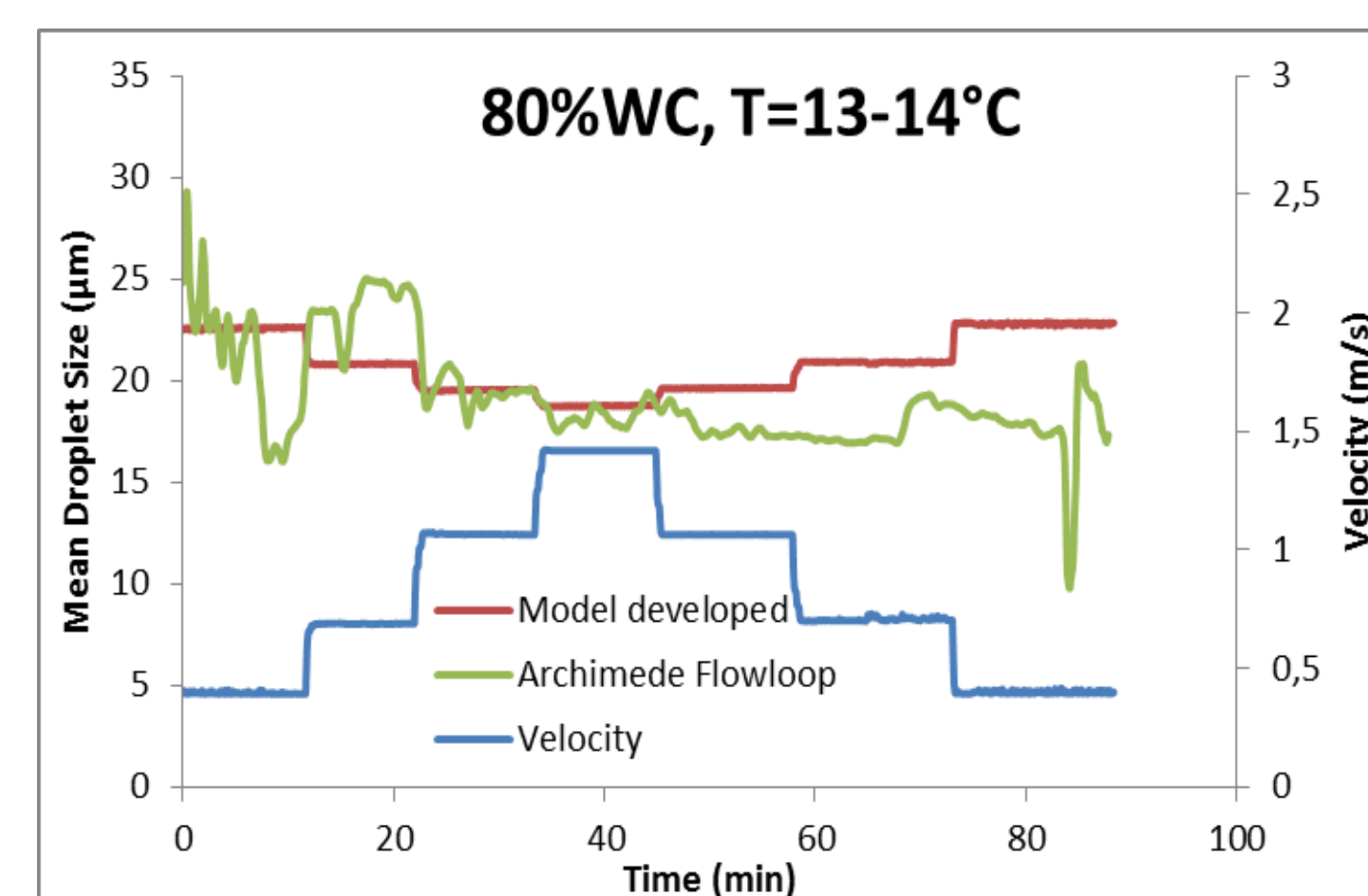
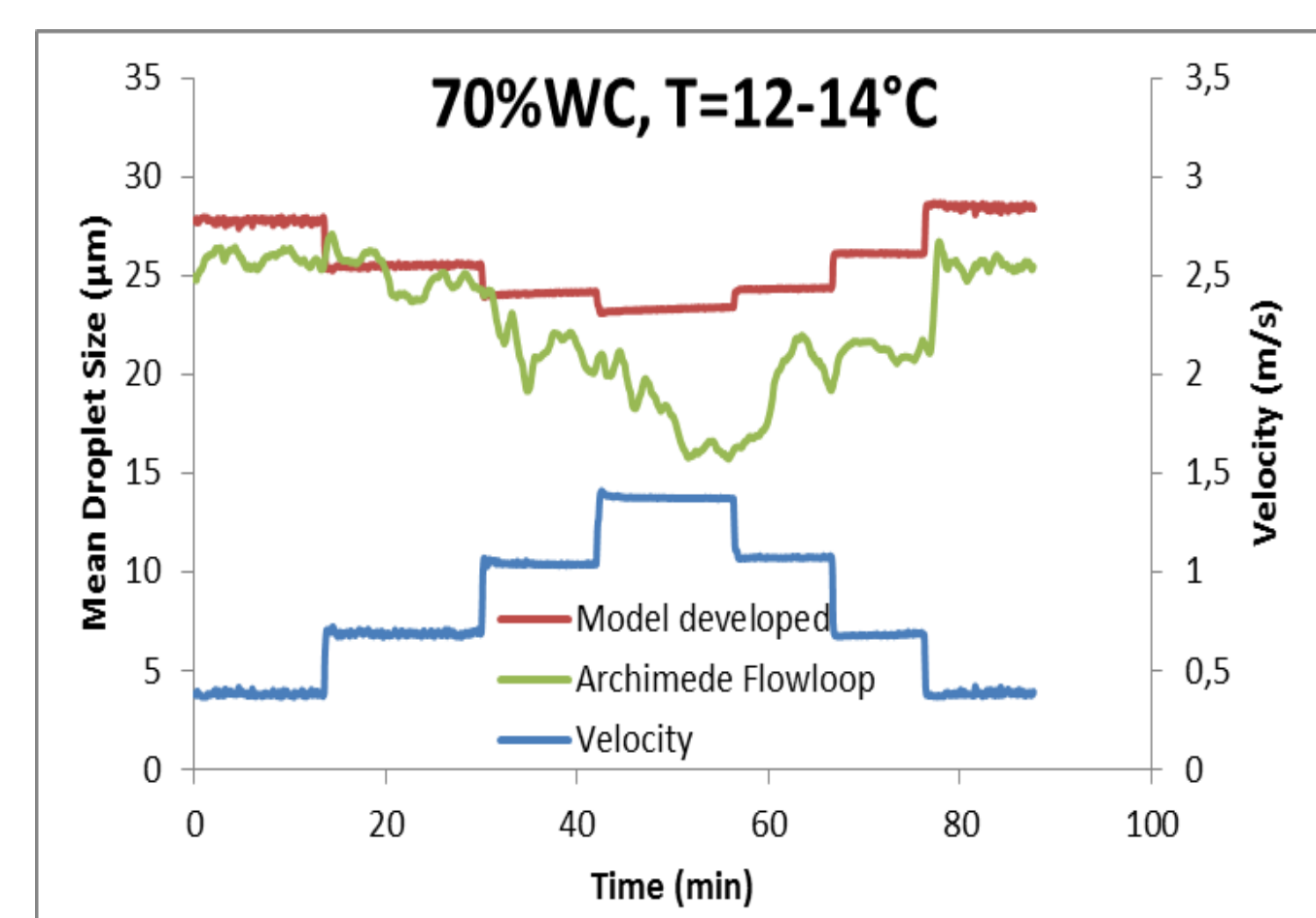
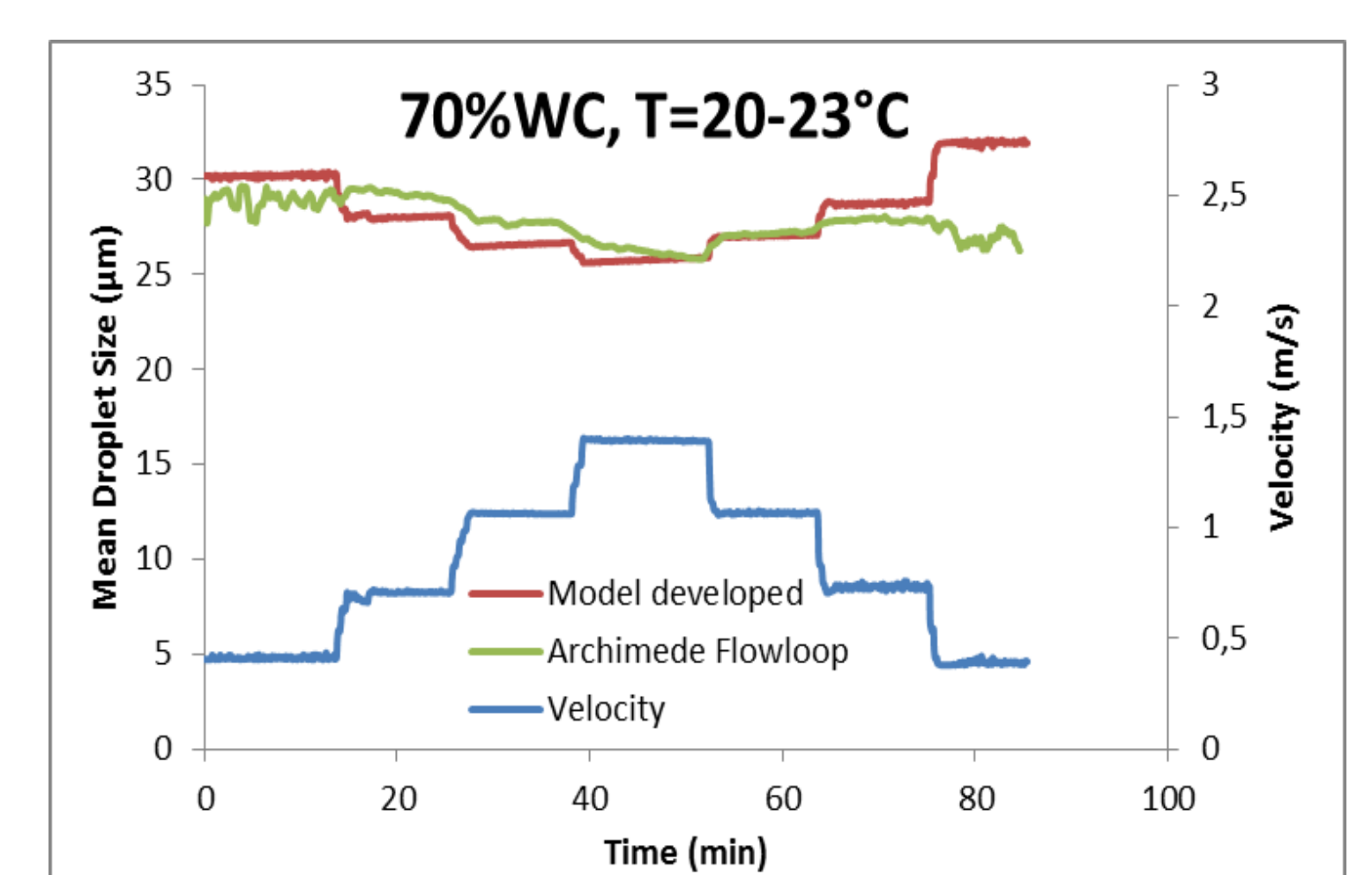
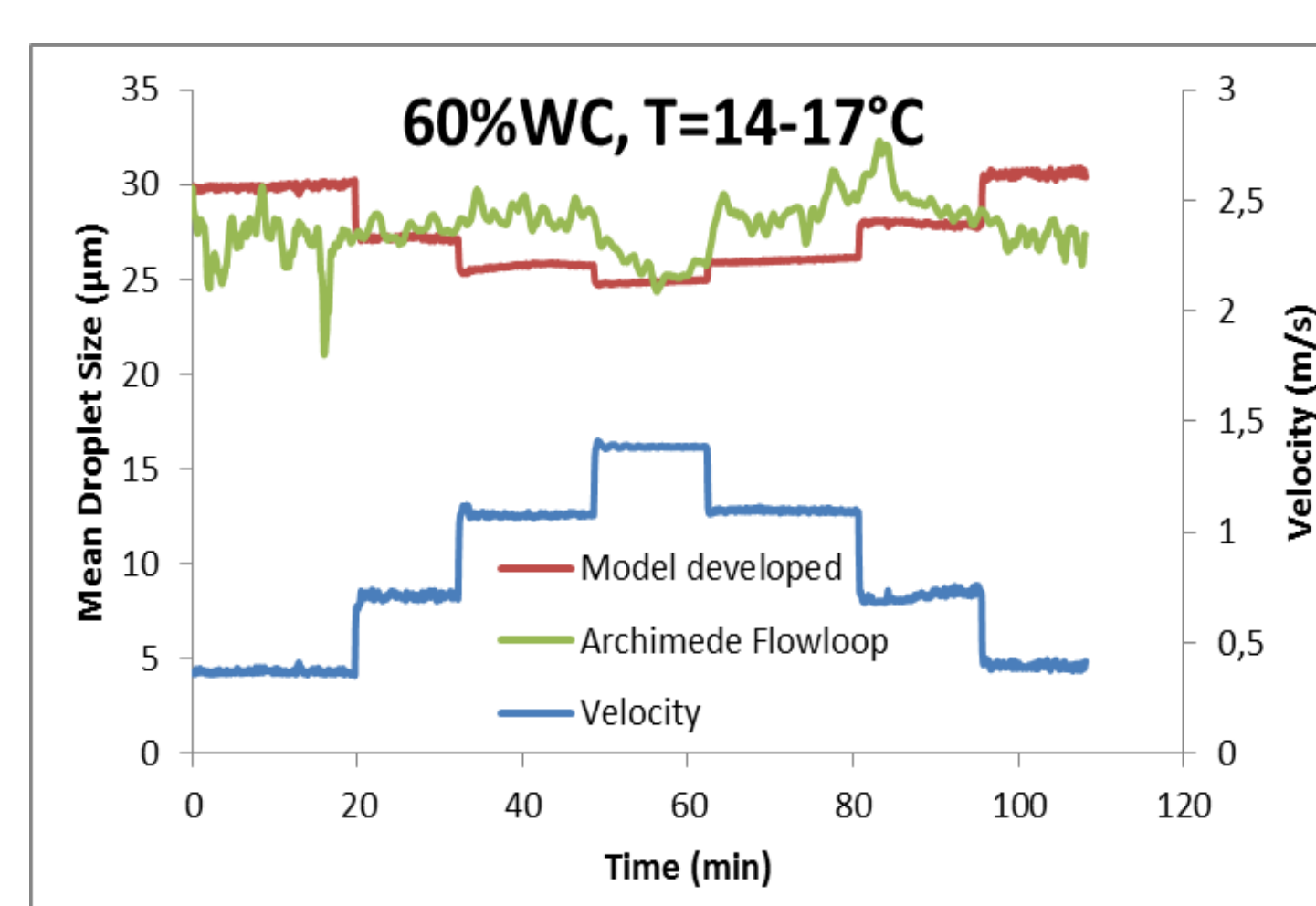
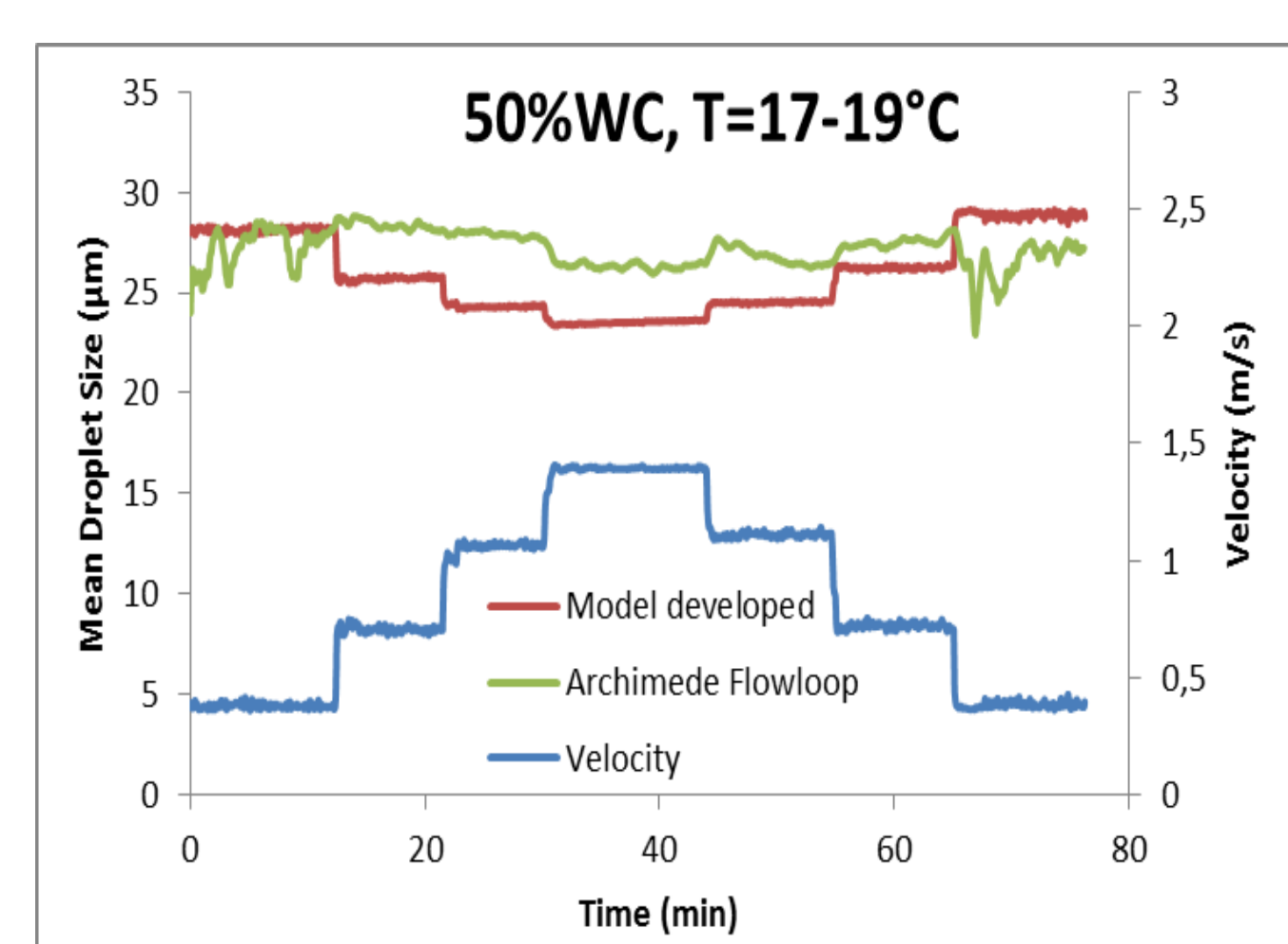
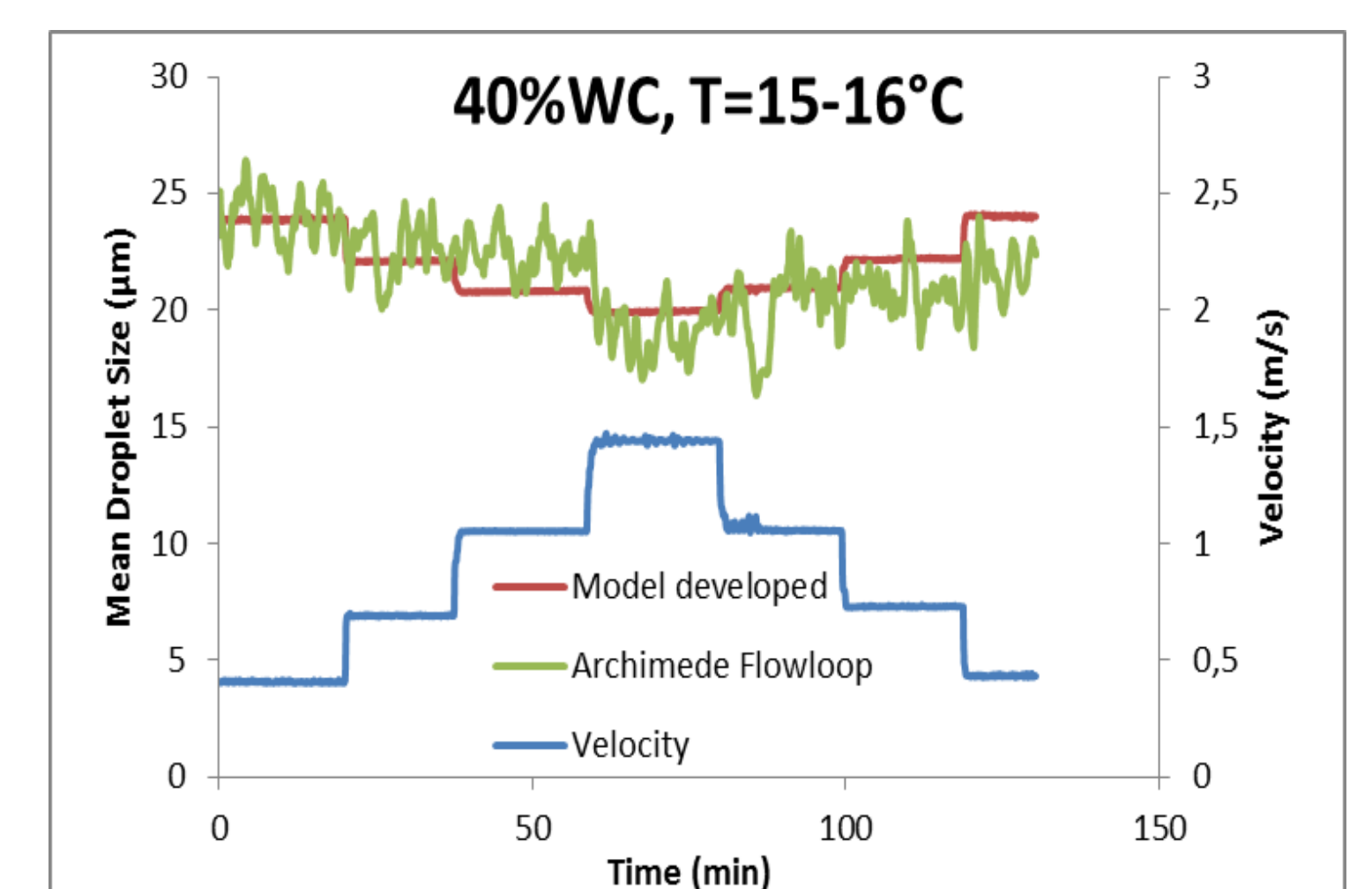
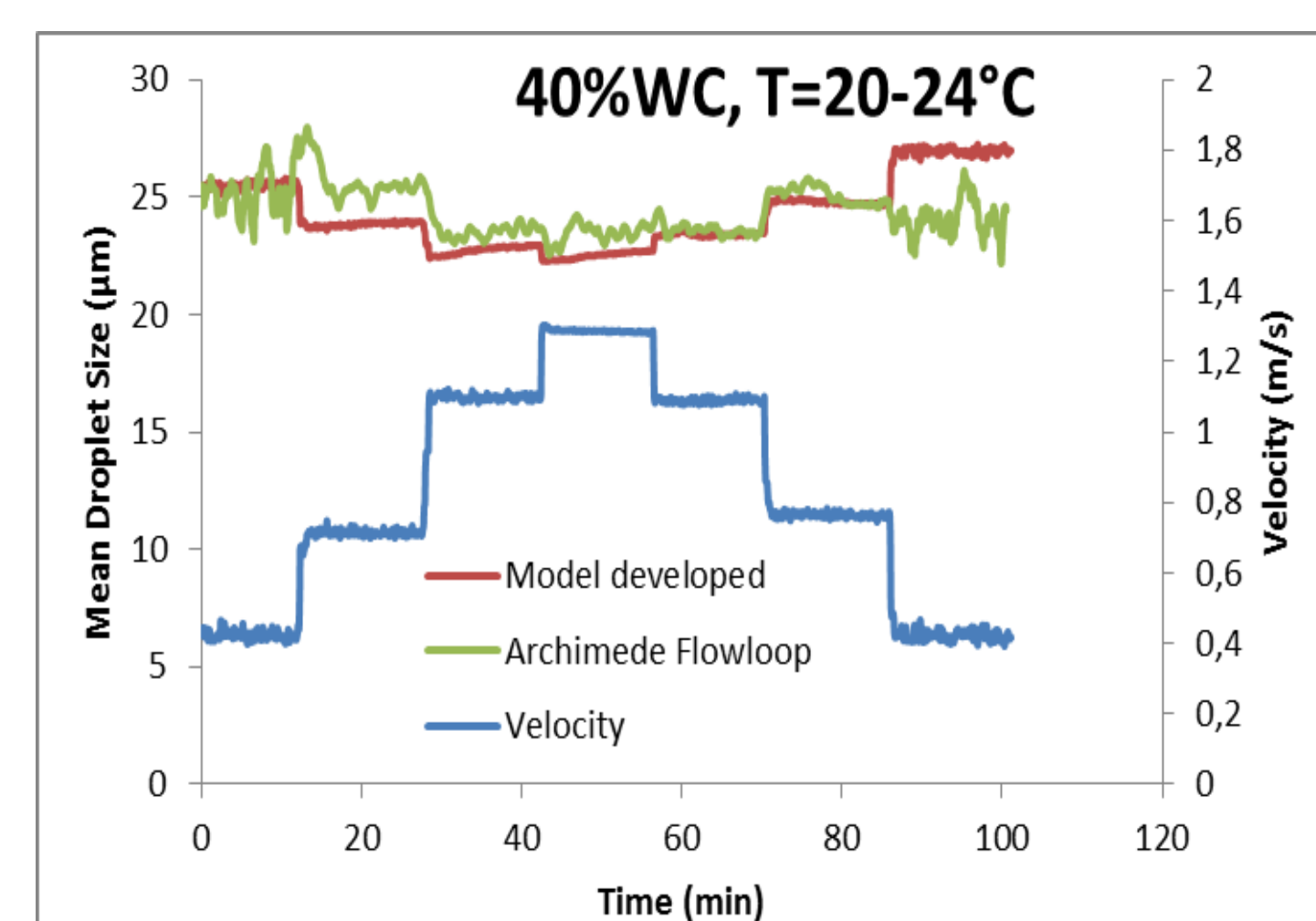
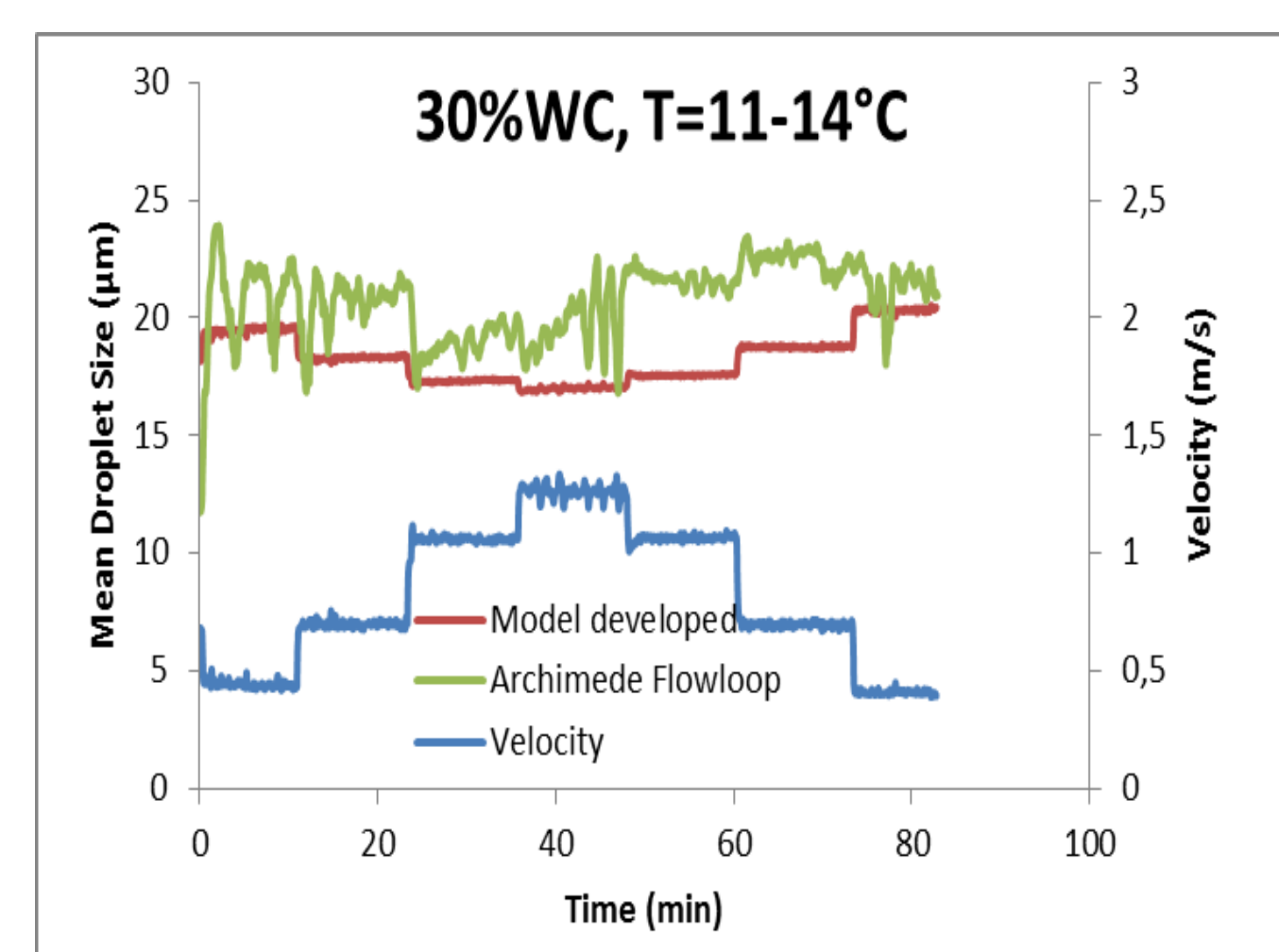
Develop mean droplet size model (d_p) from model of Turner (2009) and Boxall (2011)

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

$$d_p = A \cdot (v)^B \cdot (dpc)^C \cdot (\mu)^D \cdot (\sigma)^E$$

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

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



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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