Modeling a Multiphase Subsea Separation System

TKP 4550 Specialization Project

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Outline

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Project Scope

- Based on the work from two Master thesis'.
  - Preben F. Tyvold(2015)
  - Fahad Matovu(2015)
- Model for Gas-Liquid separation
  - Model from Tyvold
  - Parameters from Matovu

Outline

Motivation

- Increased research focus
- Large focus in industry
- Improves economics

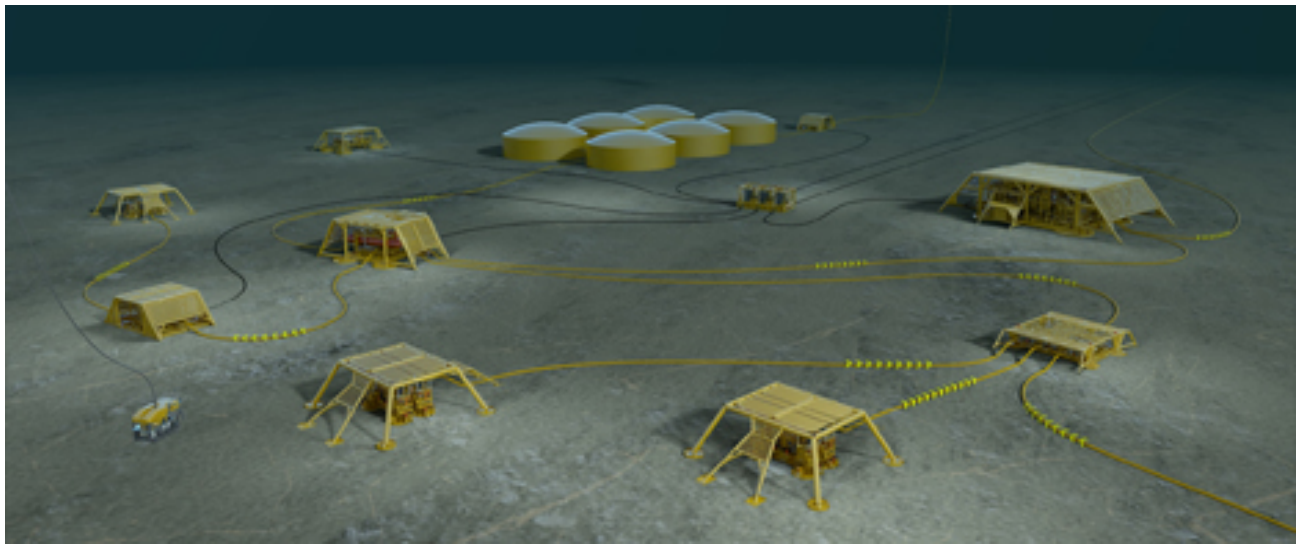

Figure: Picture from Statoil [2].

Outline

Deliquidizer

Model Description

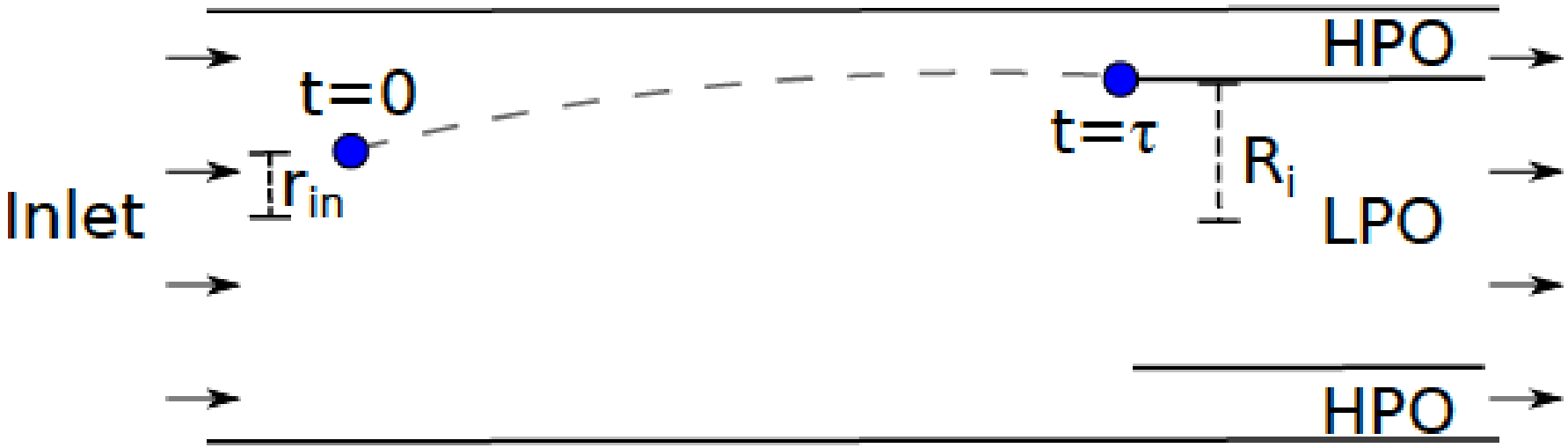

Figure: From Tyvold [1]

Radial velocity

$$v_r(r,z) = \frac{2r_d^2(\rho_d - \rho_c)}{9\mu} \frac{v_\theta^2(r,z)}{r}$$

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Soave-Redlich-Kwong Equation of State

$$p = \frac{RT}{V_m - b} - \frac{a\,\alpha}{V_m(V_m + b)}$$

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Droplet size

$$r_d = m\, q_{in} + c$$

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Droplet size

$$r_d = m\,q_{in} + c$$

Tangential velocity

$$v_\theta(r,z) = v_\theta^0(r)\ \exp\left(\frac{-C_{decay}\ z}{2R}\right)$$

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Comparison to Experimental Data

Results

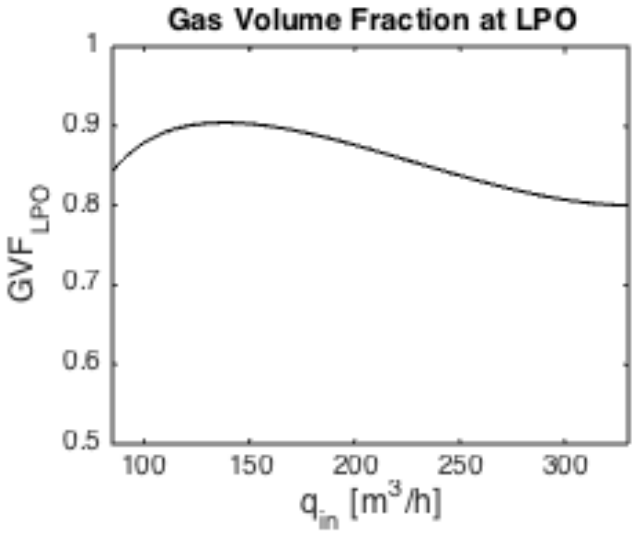
Table: Comparison between experimental data and model results. Flow split(FS) = 0.97 and inlet gas fraction $\alpha_{in} = 0.83$.

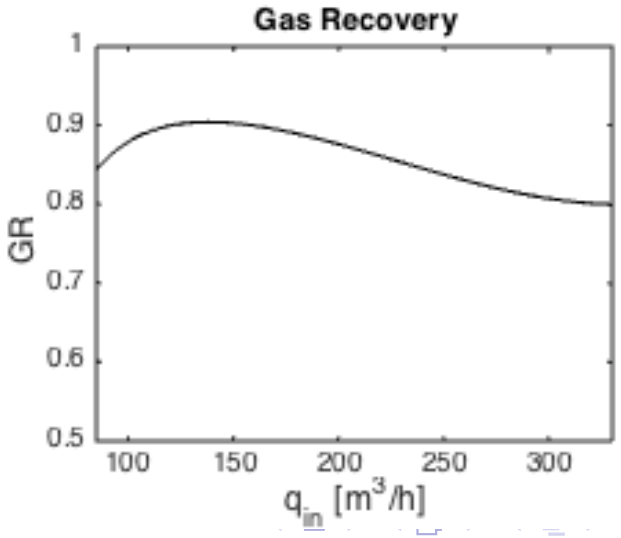
Inlet flow q_{in} $[m^3/h]$	GVF_{LPO} [-] Exp.data	GVF_{LPO} [-] Model Results	LVF_{HPO} [-] Exp.data	LVF_{HPO} [-] Model Results
204.9	0.85	0.86	0.71	1
208.1	0.85	0.86	0.83	1
217.8	0.85	0.86	0.77	1

Flow rate effect

Results

- Flow split $= 0.8$
- $\alpha_{in} = 0.8$

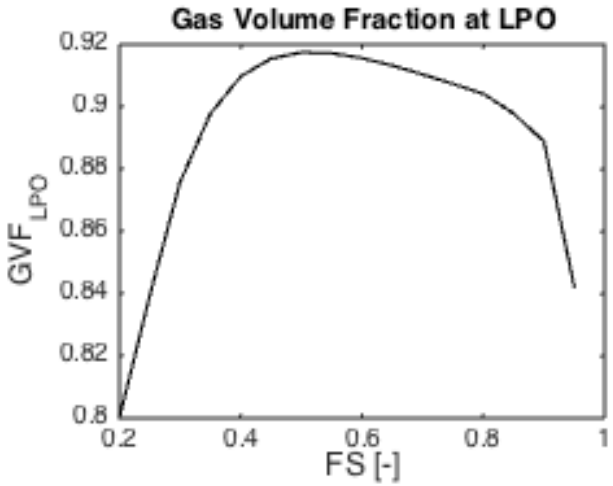


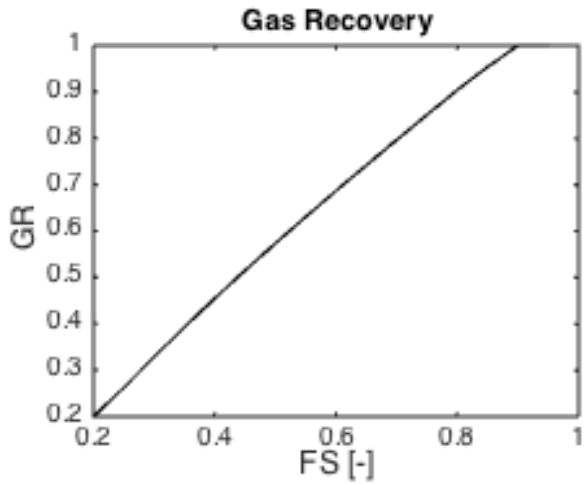


Flow split effect

Results

- $q_{in} = 140\ m^3/h$
- $\alpha_{in} = 0.8$





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Conclusion

- Satisfying accuracy in GVF_{LPO}
- Expected performance towards flow rate
- Performance towards flow split:
  - As expected at FS > 0.5
  - Not as expected at FS < 0.5
- Looking forward
  - More accurate model parameters
  - Better droplet size correlations
  - Optimization of separator.

Acknowledgements

- Johannes Jäschke
- Tamal Das

References I

Tyvold, P.
Modeling and Optimization of a Subsea Oil-Water Separation System.
Master thesis, Norwegian University of Science and Technology, Trondheim, 2015.

Statoil
The Subsea Factory
http://www.statoil.com/en/technologyinnovation/fielddevelopment/aboutsubsea/Pages/Lengre