MODEGAT V
03.- 05. Sept. 2017
Bad Herrenalb

CFD simulation of liquid back suction and gas bubble formation in connected tubes of different cross-section

Xuan Cai[1], **Martin Wörner**[2], **Holger Marschall**[3], **Olaf Deutschmann**[1,2]

[1] Karlsruhe Institute of Technology — Institute for Chemical Technology and Polymer Chemistry
[2] Karlsruhe Institute of Technology — Institute of Catalysis Research and Technology
[3] Technische Universität Darmstadt — Mathematical Modeling and Analysis, Dep. of Mathematics

Motivation and goal

- In urea-water-solution (UWS) dosing system of SCR, UWS is drained from delivery line and sucked back to UWS tank, when vehicle is out of operation
- During the above process, there is a risk of air being sucked into delivery unit. Such gas bubble formation adversely affects working pressure for atomization and thus should be prevented
- This study is devoted to numerical investigation of the UWS back suction in expanding pipes and exploration of effective means to prevent gas bubble formation

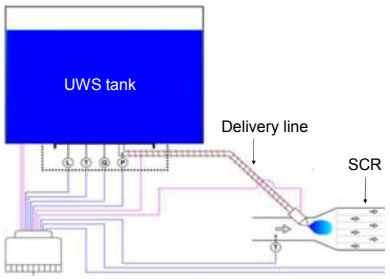
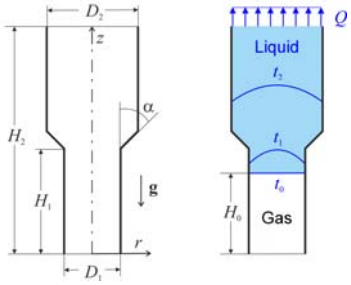


Image source: Stola et al. *SAE Int. J. Engines*, 2015



Numerical method and setup

Phase-field method

- Interface-capturing method where interface is treated as being of certain thickness
- Especially suited for moving contact line

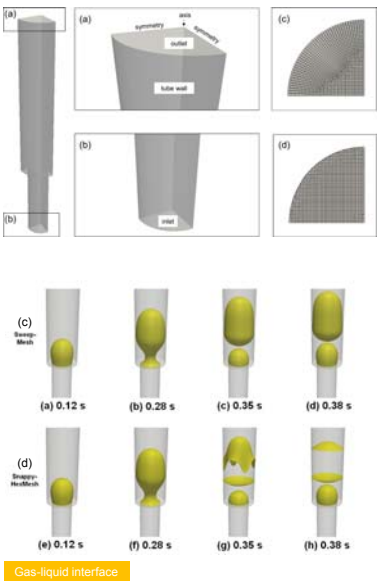
phaseFieldFoam

- A novel OpenFOAM solver for a Cahn-Hilliard coupled with Navier-Stokes equations
- Developed by the authors (Marschall and Cai)

Physical parameter

- Liquid: UWS (32.5% urea) under room temp.
- Contact angle $\theta_0 = 52°$
- Fixed outlet mass flow rate $Q = 700\ \mathrm{mm^3/s}$

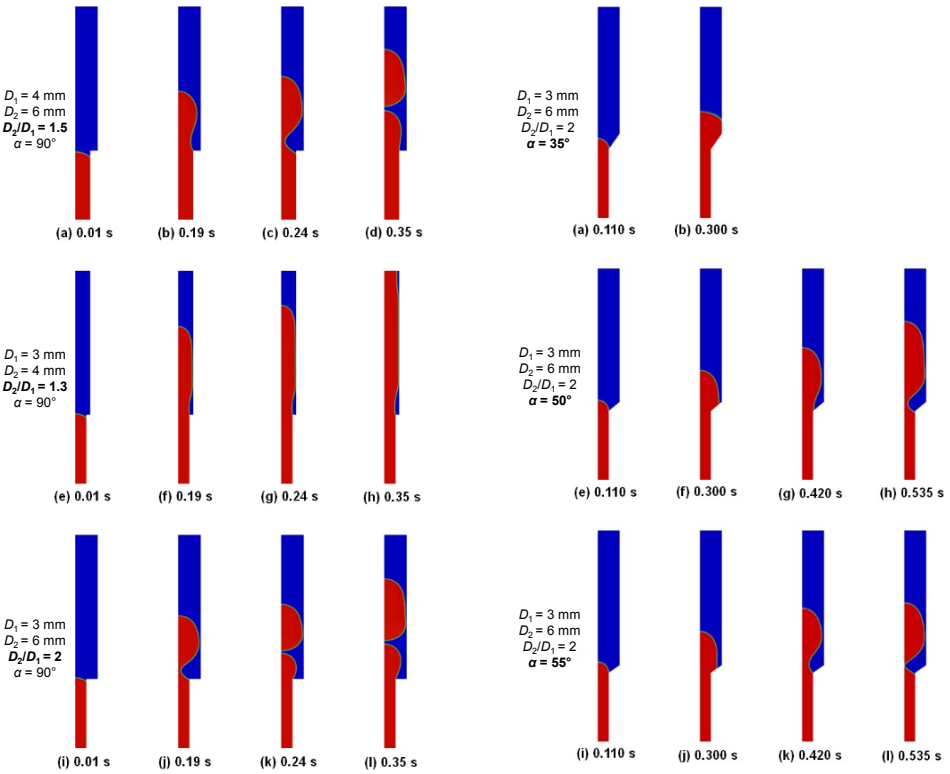
Influence of mesh



Conclusions

- Mesh alignment near wall is vital
- Reducing diameter ratio D_2/D_1 can delay bubble formation
- Decreasing inclination angle α can suppress bubble formation

Effect of geometry on bubble formation



Effect of diameter ratio D_2/D_1

Effect of cone inclination angle α

UWS liquid | Gas

All the simulations here are 2D-axisymmetric; mesh cell size = 30 µm

We acknowledge the financial support by Deutsche Forschungsgemeinschaft (DFG) through SFB/Transregio 150 project B05

SFB/Transregio 150
Turbulente, chemisch reagierende Mehrphasenströmungen in Wandnähe

References

Cai, Wörner, Marschall and Deutschmann, *Emission Control Science and Technology*, in press, 2017, DOI: https://doi.org/10.1007/s40825-017-0073-3

Contact: Xuan Cai (xuan.cai@kit.edu)
Engesserstr. 20, 76131 Karlsruhe, Germany