CFD Simulation for Gas-Liquid Vortex Reactor Design

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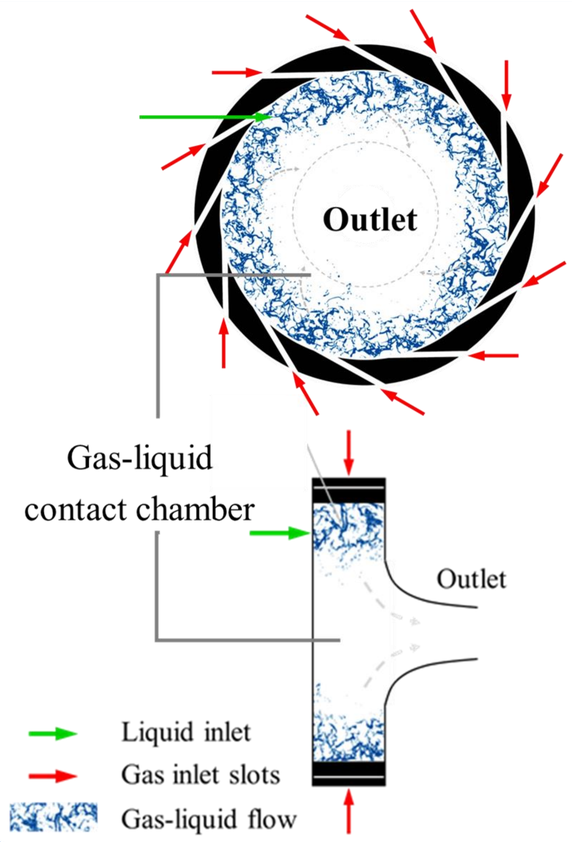
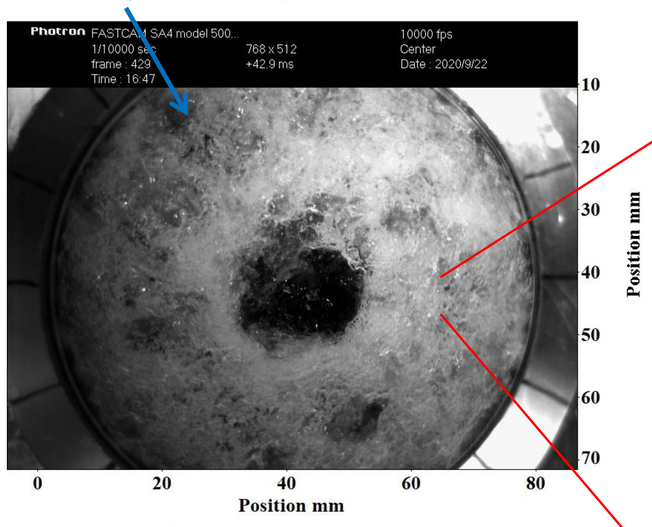
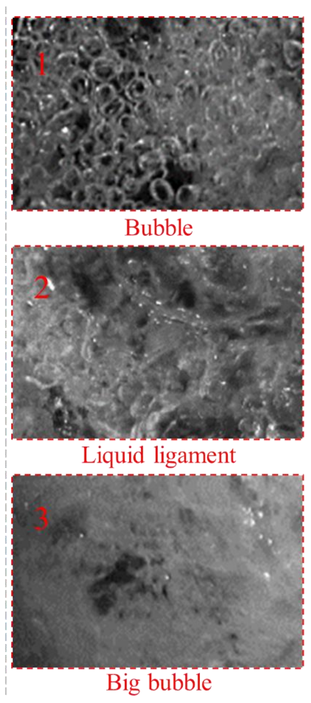
INTRODUCTION: Gas-Liquid Vortex Reactor



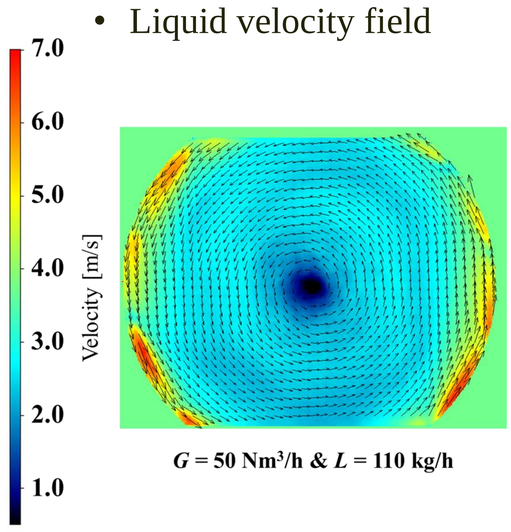


- Tangential gas injection
- Momentum transfer from gas to liquid
- Centrifugal force field (rotating liquid)
- Vortex technology
- High turbulent energy dissipation
- Large interfacial area

- Flow patterns



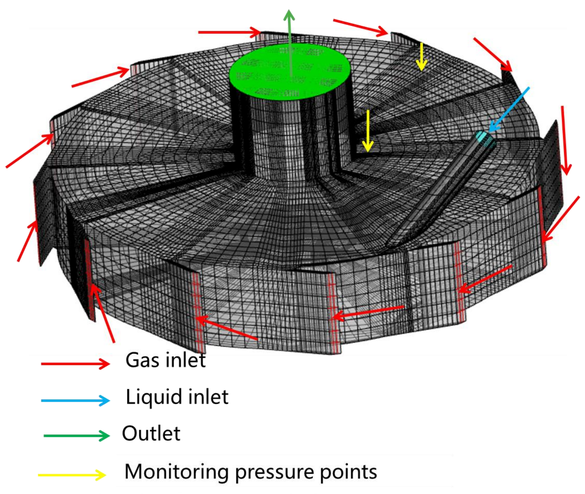
- Liquid velocity field



- Pressure drop
- Liquid turbulent properties
- Gas-liquid layer thickness

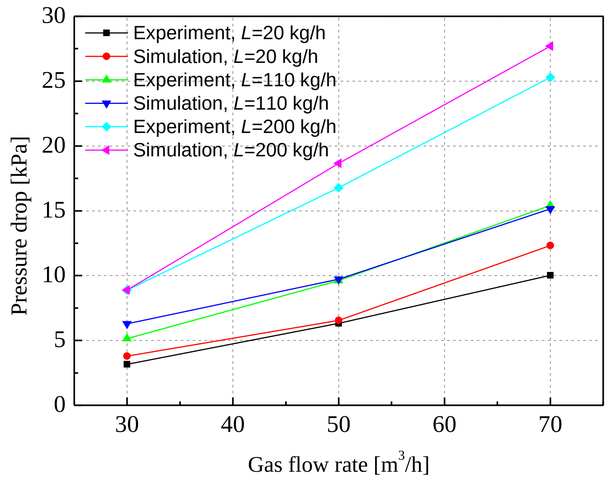
RESEARCH METHODOLOGY: Modeling and Validation

Computational model

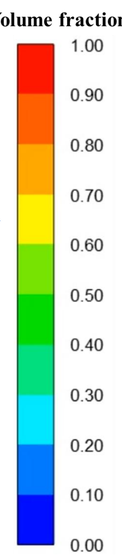


- ANSYS Fluent v19.0
- Euler-Euler model with Tomiyama drag model
- SST-*k* omega turbulence model

Validation study

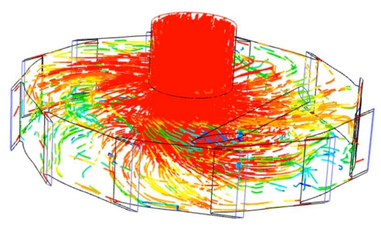


- Simulation results agree well with experimental results

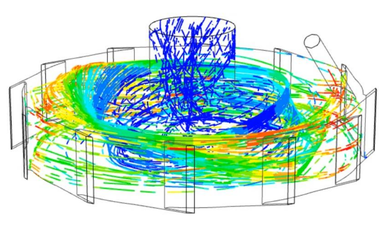


Gas-liquid flow behaviors

- Gas streamlines



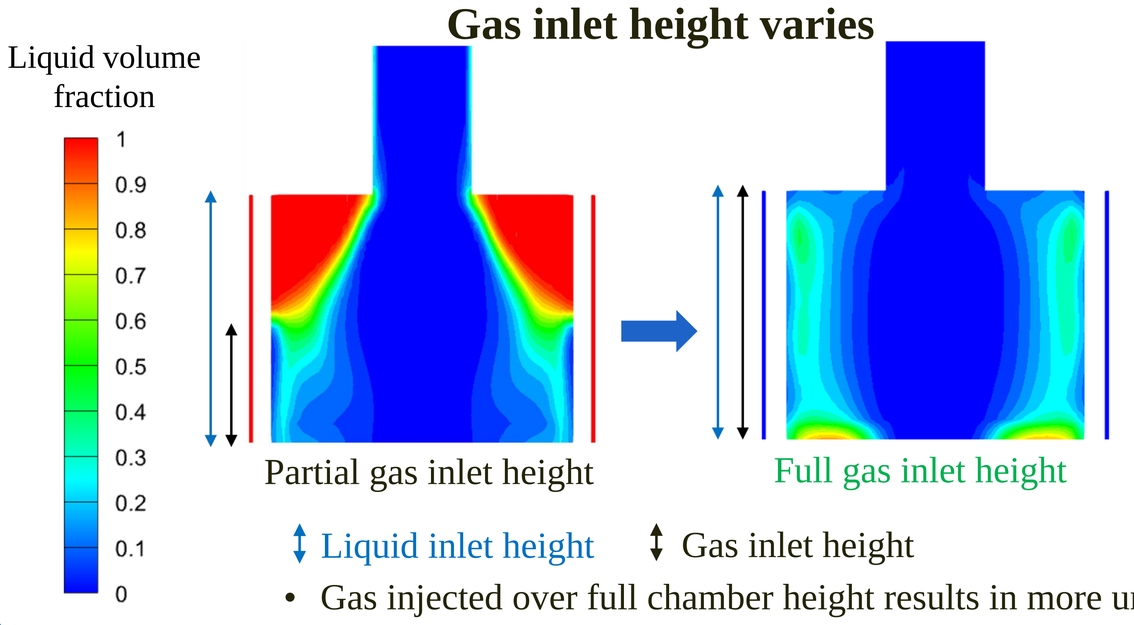
- Liquid streamlines



- Gas vortex flow is broken due to liquid injection
- Liquid is rotating in chamber

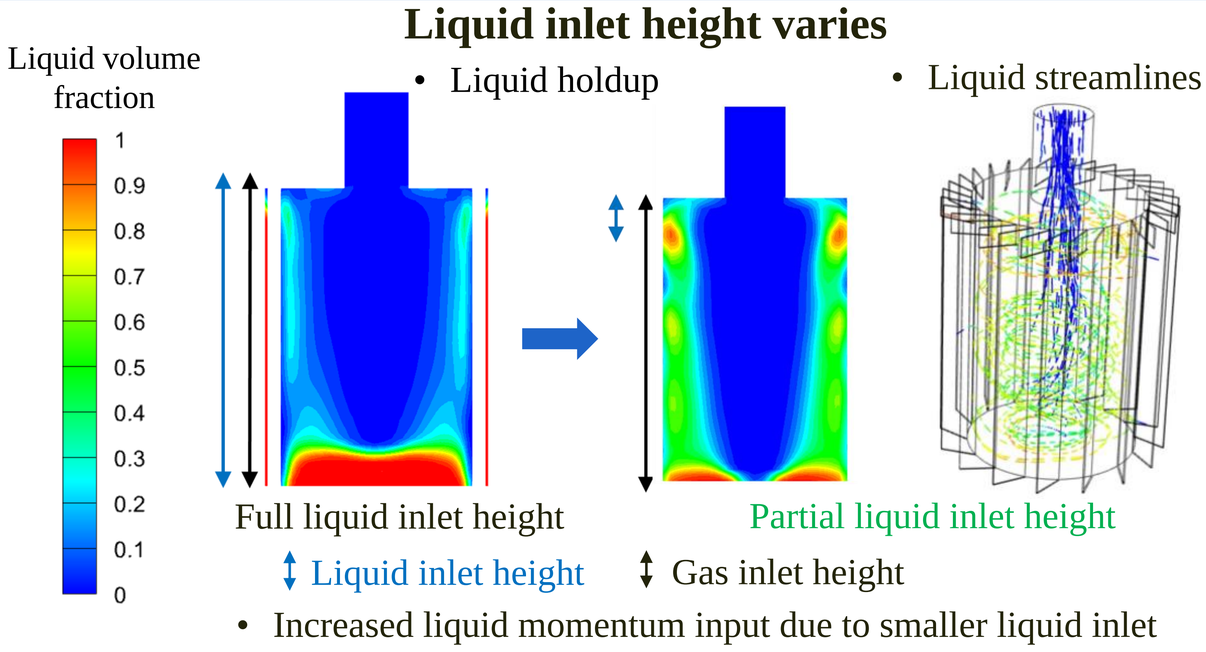
GEOMETRY OPTIMIZATION: Improve gas-liquid contact

Gas inlet height varies



- Gas injected over full chamber height results in more uniform gas-liquid dispersion

Liquid inlet height varies



- Liquid holdup
- Liquid streamlines
- Increased liquid momentum input due to smaller liquid inlet

CONCLUSIONS

- 3D CFD model on GLVR is validated and shows good agreement
- Liquid rotates in vortex chamber and breaks gas vortex flow
- Full gas inlet height (i.e. equal to reactor height) is needed for improved gas-liquid dispersion
- Smaller liquid inlets increase momentum injected with liquid flow, resulting in improved gas-liquid dispersion

REFERENCES

1. Y. Ouyang, et al., AIChE Journal, 67, 2021, e17264.
2. Y. Ouyang, et al., Chemical Engineering Science, 246, 2021, 116970.

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