Karlsruher Institut für Technologie

Green SWaP

WP #3.2

Plasma-Assisted Hydrogen Peroxide Production in Microgravity: Reactor Design

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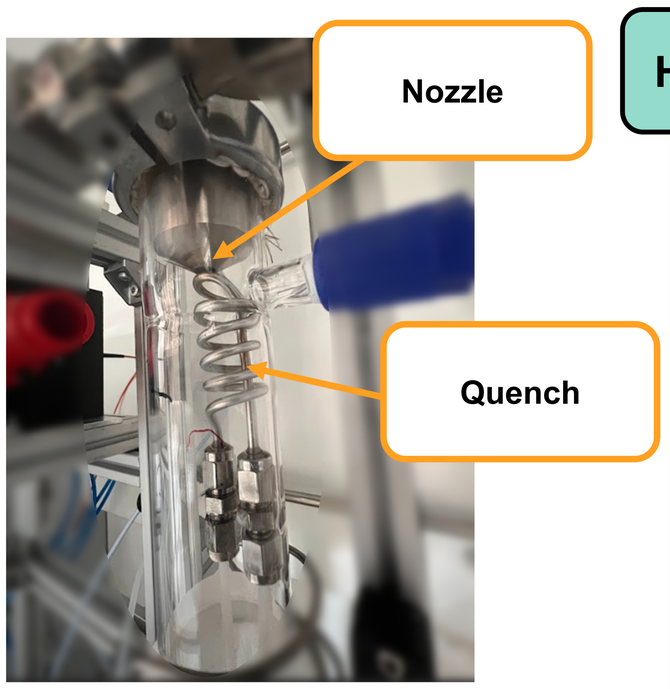
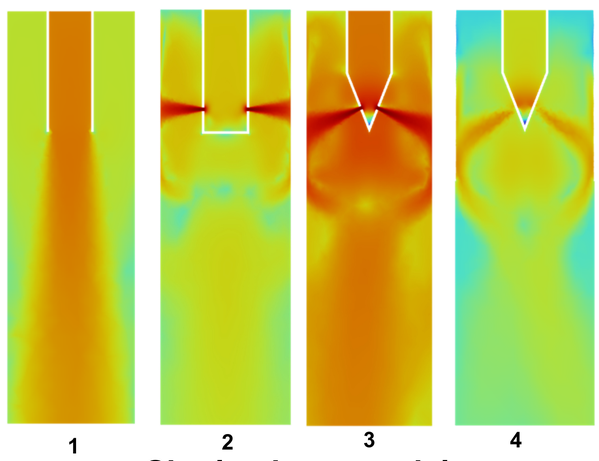
H_2O_2 day at KIT | March 03rd, 2026

Motivation

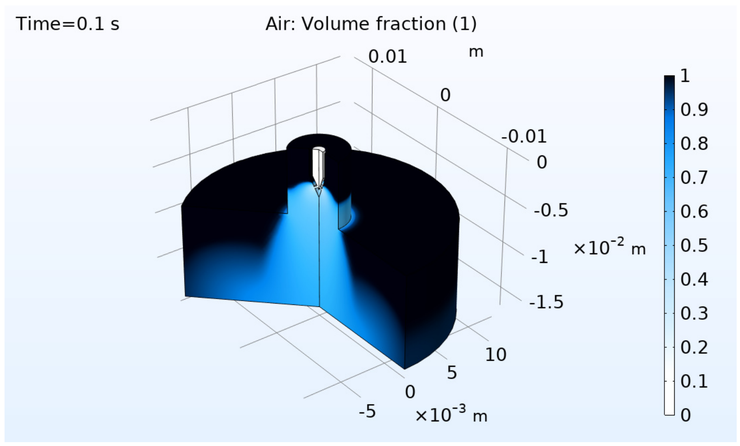
- To achieve compact and efficient H_2O_2 production in **microgravity**, **computational fluid dynamics (CFD)** is employed to predict H_2O_2 generation and guide reactor design optimization.
- To **enhance mixing performance**, optimized nozzle configurations are developed using both single-phase and multiphase CFD models.
- To **prevent hydrogen peroxide dissociation**, cooler configurations are designed and evaluated through CFD analysis.



How can nozzle configurations be optimized to enhance mixing performance?



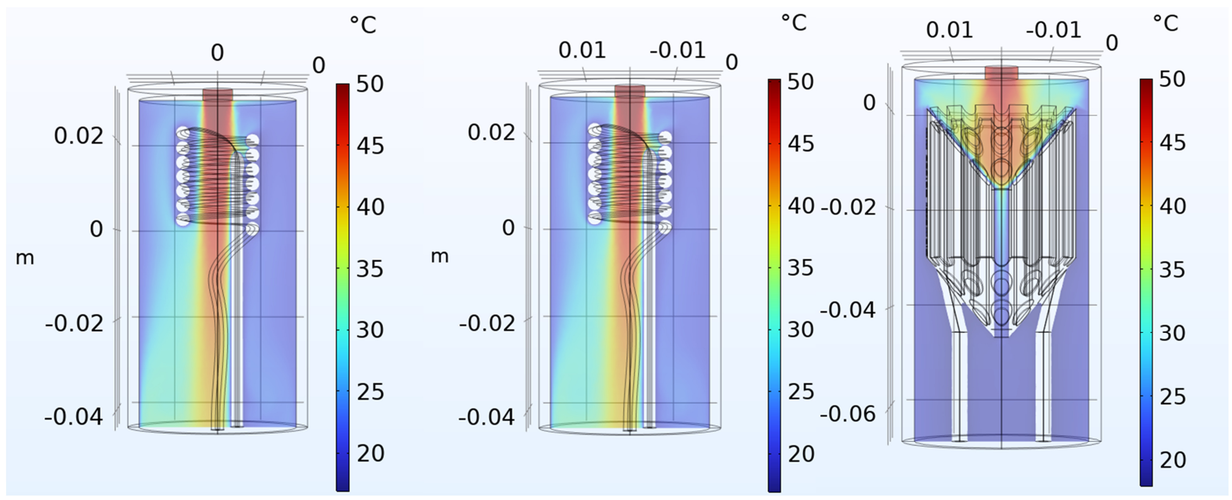
Single phase model



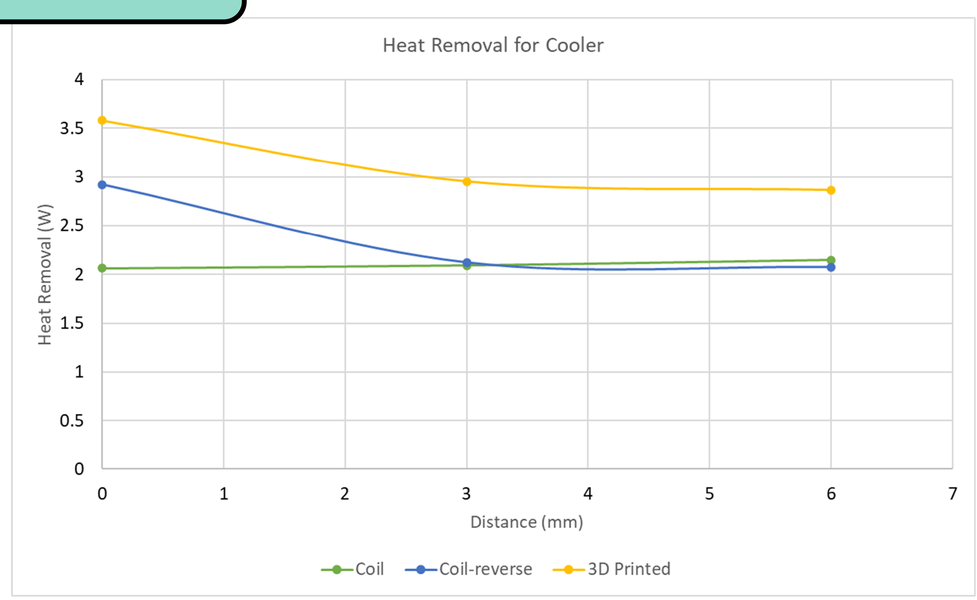
Two phase model (gas-liquid)

- Single- and two-phase CFD models enable the design and analysis of mixing nozzles.

How does cooling performance vary among different cooler configurations?



Coil Coil-reverse 3D-printed



- Heat transfer models reveal reactor temperature distribution in microgravity, guiding **cooler design optimization**.

Outlook

- Experimental validation will be performed after nozzle fabrication.
- The quench system will be optimized for improved heat transfer performance.
- A full reactor prototype will be developed.
- Plasma and reactive models will be developed to support prototype design under microgravity conditions.

Highlight 1
The optimized nozzle configurations demonstrate strong gas–liquid mixing.

Highlight 2
Single- and two-phase CFD models predicts microgravity nozzle behavior.

Highlight 3
Heat transfer modeling supports cooler design optimization.

[1] Hernandez, M.S. et al. JACS In press
[2] Burlica, R., Shih, K. Y., & Locke, B. R., 2010, Industrial & Engineering Chemistry Research. [DOI: 10.1021/ie100038g]
[3] Radhakrishnan, K. et al., 2018, Acta Astronautica [DOI: 10.1016/j.actaastro.2017.12.012]

[1] [2] [3]