Two-phase CFD models for the simulation of bubbles dynamics and gas introduction in alkaline electrolyzers

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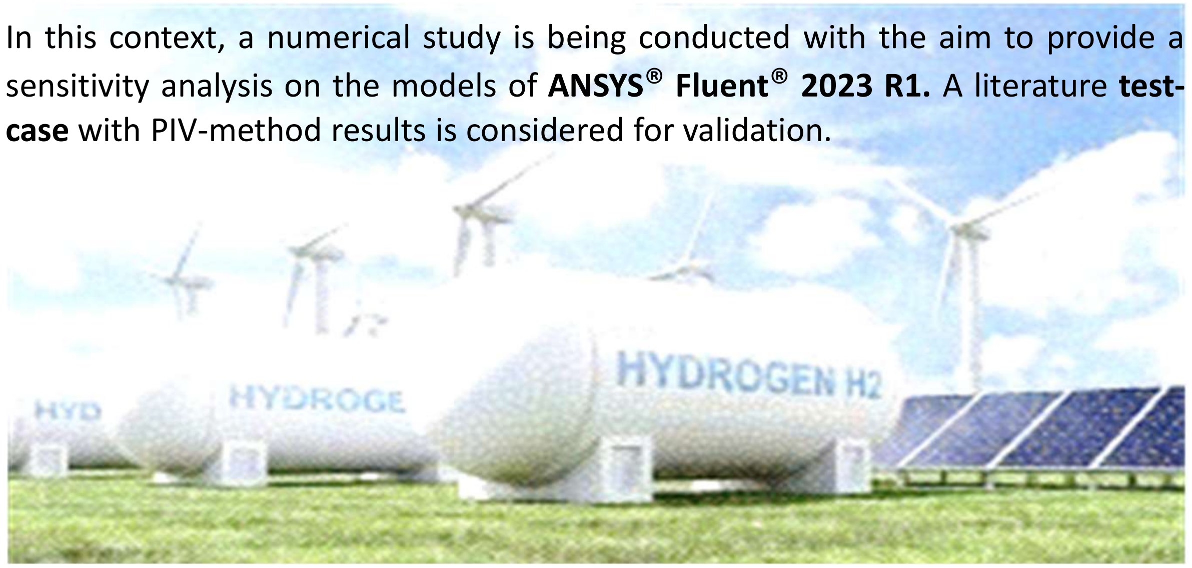
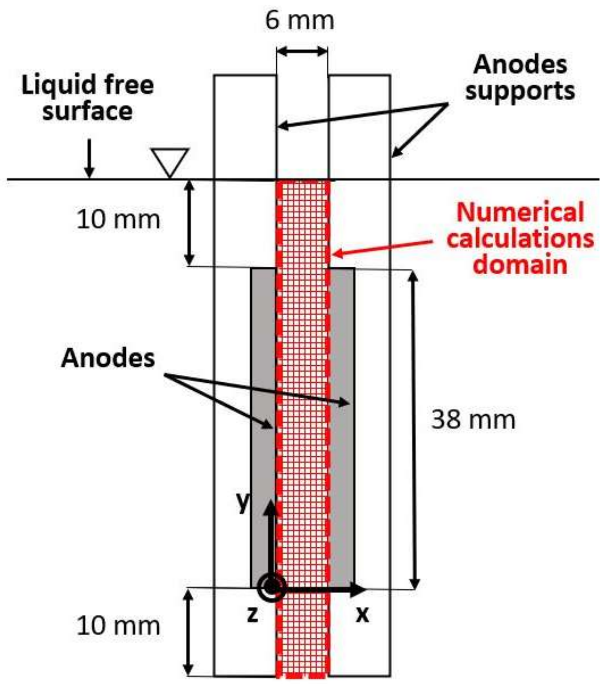
BACKGROUND AND SCOPE OF THE PHD STUDY

To improve on design and efficiency of **green-hydrogen** electrolysis, **multiphysics CFD** simulations are needed. CFD **results validation** with experimental measurements **is rare** and the reliability of the adopted models not assessed yet.

In this context, a numerical study is being conducted with the aim to provide a sensitivity analysis on the models of **ANSYS® Fluent® 2023 R1.** A literature **test-case** with PIV-method results is considered for validation.





CASE STUDY CFD MODEL

- Electrochemical cell, **No Net Flow Configuration**
- Two-phase **Eulerian** model
- **Laminar** and **steady-state** simulations
- **Diameter change with height (UDF)**: d=60÷100 µm
- **Current density**: 130 A/m²

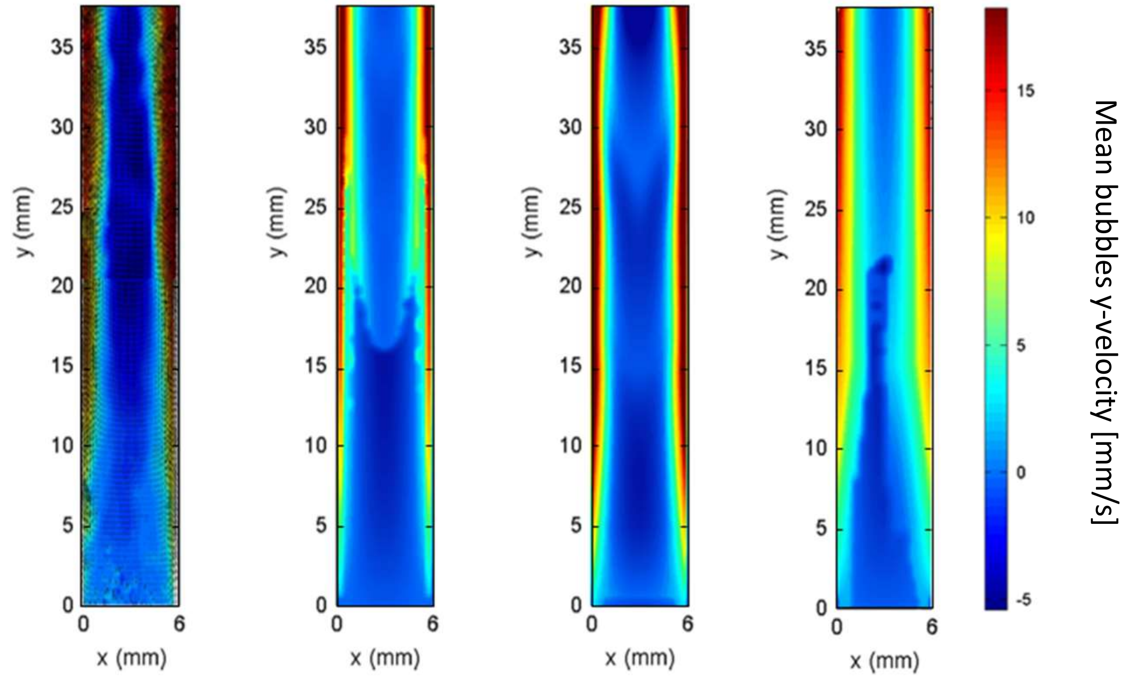
GAS INTRODUCTION CASES

1. Mass **source term** inside thin layers (0.45 mm)
2. Gas **mass-flow inlet** at electrodes
3. **Electrochemical** module: reaction at wall boundaries

$$2OH^-{}_{(aq)} \rightarrow \frac{1}{2}O_{2\ (g)} + H_2O_{\ (l)} + 2e^-$$

SOME OF THE LATEST RESULTS

Below are shown the results of vertical velocity of the bubbles, for the three different approaches of gas introduction. CFD solution is compared to case-study PIV output with agreement in maximum values of velocity. The case relative to the electrochemical module has a better behaviour in allowing the gas to diffuse towards the inner part of the cell.

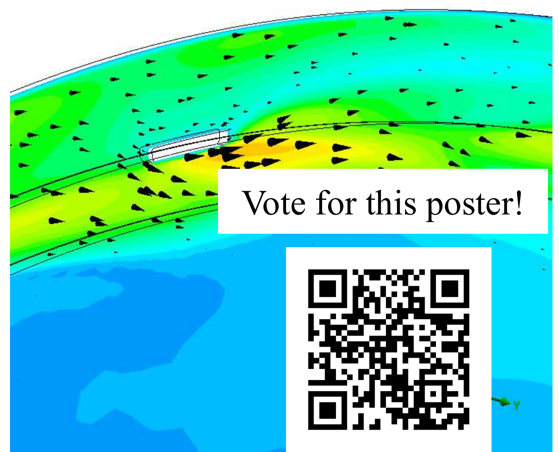


Experimental Output | **Source term** | **Mass-flow inlet** | **Electrochemistry**

CONCLUSIONS AND FUTURE WORKS

Three different models for simulating the gas generation in alkaline electrolysis are to date applied to a literature test-case with the use of Faraday's law.

The electrochemical model is ready to be applied for the CFD simulations on a real electrolyzer cell. An optimization of the geometries and a thermal analysis will also be performed during next year.



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