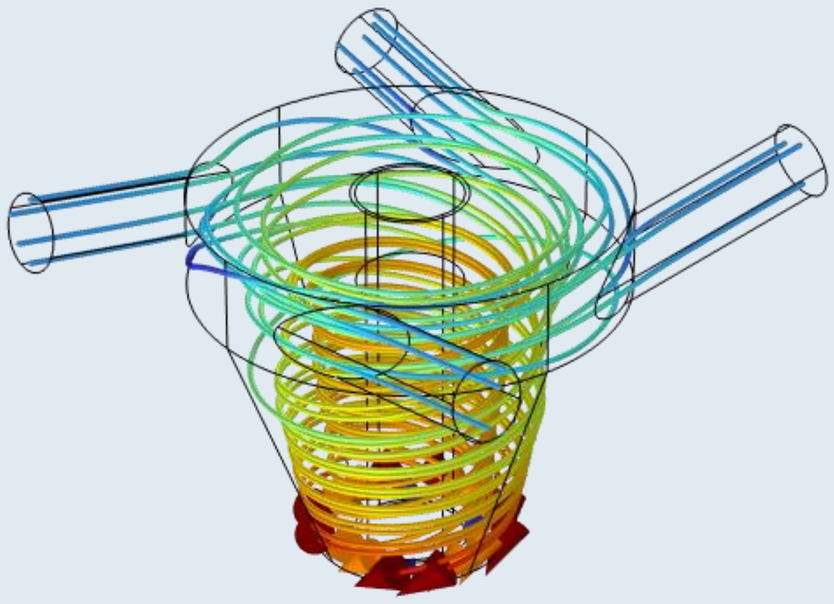


Numerical Analysis of Swirl Formation and Turbulence Modelling in Local Dry Welding Chamber

Underwater local dry-welding (ULDW) chambers require a stable drainage-gas flow to prevent water ingress, thereby ensuring weld quality. In this study, the flow behavior in a novel conical local dry-welding chamber with an angled inlet configuration was investigated. To evaluate the influence of velocity on swirl formation, turbulence development, pressure distribution, and flow stabilization.

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Introduction

Local dry-welding chambers require a stable drainage gas flow to prevent water ingress and hydrogen diffusion, thereby ensuring weld quality. However, unstable flow, recirculation, and insufficient gas coverage can degrade weld quality and allow water ingress into the chamber. Analysing the flow behavior inside the local dry chamber is necessary. The objective of this study is to investigate the influence of velocity and inlet geometry on swirl formation, turbulence development, pressure distribution, and flow stabilization.

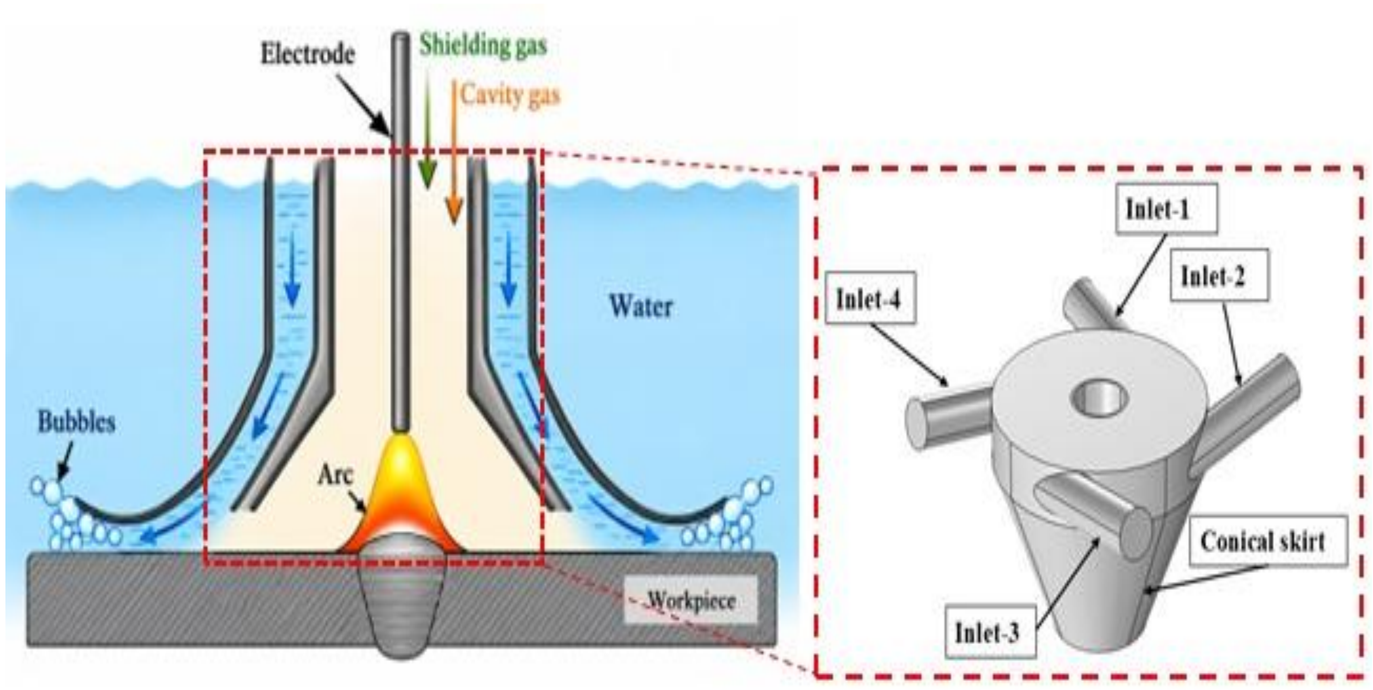


Figure 1. Schematic view of a ULDW and an isometric view of the ULDW chamber

Methodology

COMSOL CFD module and the SST turbulence model, coupled with the Reynolds Average Navier Stokes (RANS) model under stationary conditions, were used. The 3D design of ULDW was fully developed by the geometry section. Air, which was used as the working fluid, with an inlet velocity of 45 m/s, a constant outlet pressure of 0 Pa, an inlet radius of 8 mm, and an outlet radius of 20 mm. The fluid is assumed to be turbulent, incompressible, and Newtonian. Post-processing has been done to extract the results.

Results & Discussion

- The swirl number significantly decreased from 7.6601 at the inlet to 1.1664 at the outlet, with an average value of 4.4903
- It generated a stronger vortex flow field, with a large pressure drop across the outlet due to the velocity's influence.

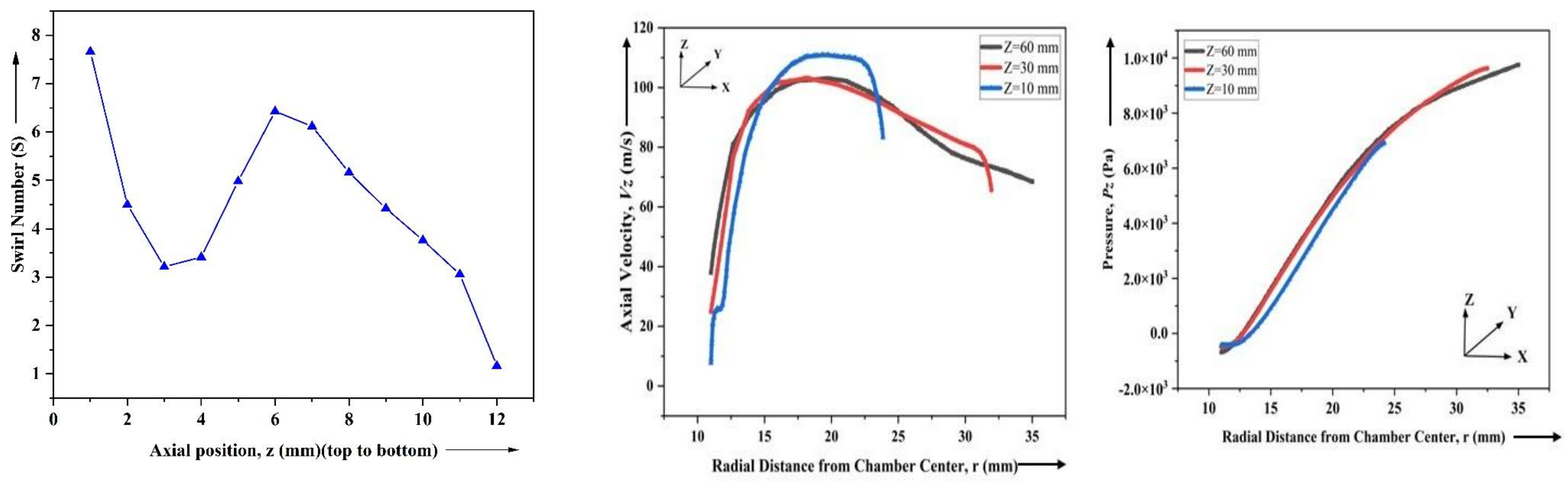


Figure 2. Swirl number, Axial Velocity and pressure variation at the radial distance (top to bottom)

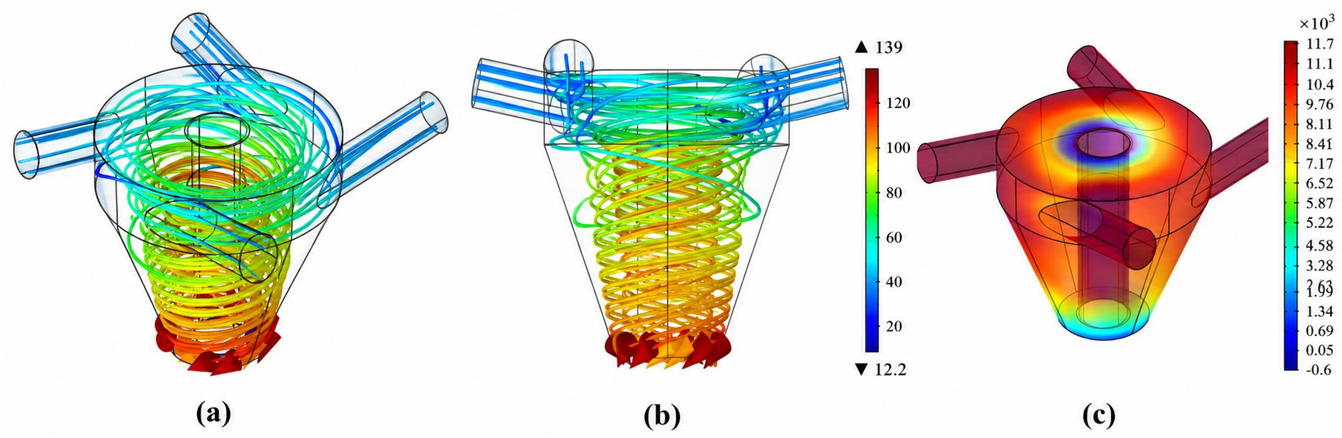


Figure 3. Velocity streamlines and vortex generation (a) isometric view (b) front view (c) pressure drop surface plot

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