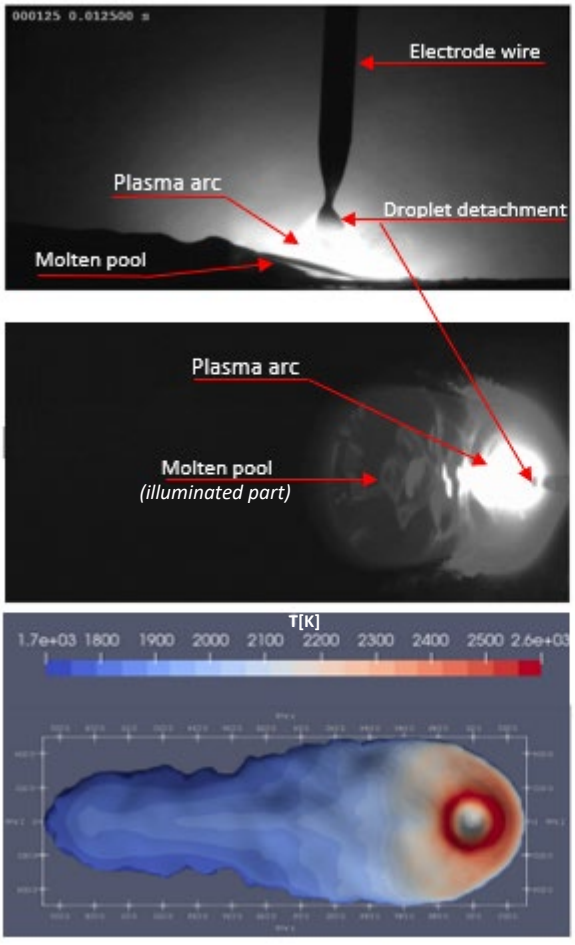
MSc Thesis project: CFD modelling of weld pool in GMAW
- a study on the effect of chemical composition and welding parameters.

Project in collaboration with Chalmers, ESAB (Göteborg), Production Technology West (Trollhättan).

Context: Due to its high productivity, the Gas Metal Arc Welding (GMAW) process has been the predominant welding method. The welding quality depends on various parameters, such as welding current, electrode feed rate, travel speed, and shielding gas. A comprehensive dynamic model of the GMAW process would provide many helpful insights on key process parameters leading to the improvement of weld quality.
In such a model, three major coupling events need to be considered: (1) the generation of arc plasma, (2) the dynamic process of droplet formation, detachment, and impingement onto the weld pool, and (3) the dynamics of the welding pool under the influences of arc plasma and the periodical impingement of droplets. Due to the complexity of the welding process, many existing numerical models only focused on one or two events of the GMAW process while simplifying the rest of the events.



Side view of GMAW process (high speed imaging)

Top view of GMAW process (high speed imaging)

Top view of GMAW process (OpenFOAM simulation)

Figures in courtesy of Pradip Arial, PhD student, Production Technology West, University West

The structure and properties of the welds are strongly affected by heat transfer and metal flow in the weld pool and alloying element loss from the weld surface. Although the diagnostic techniques for measuring pool temperatures are currently being evaluated and developed, direct reliable measurements of velocities, temperatures, and species concentrations in the weld pool are extremely difficult since the weld pool is small in size and often covered by an intense plasma. Important support can be to simulate with CFD the weld pool by modeling of the essential physical features of the welding process.

Aim: The present project aims to

- Acquire and document the state of the art knowledge on the effect of chemical composition and process parameters on weld pool within both experimental and modelling fields with particular emphasis on slag formation.
- Participate in experiments conducted in the ESAB research lab. for acquiring data useful for model validation
- Model implementation for the diffusion of chemical species in an existing thermo-fluid solver for melt pool in OpenFOAM, and test the implementation.
- Run test cases and analyse the results.

Student profile:
Suitable background is students in master program of Mechanics, Physics, Mathematics or relevant. Great interest in programming, modelling within the framework of Computational Fluid Dynamics (CFD). Safety is important for the experimental part. Other experience in C++, OpenFOAM, CFD modelling, Linux are preferable.

Administrative information:

- Suitable number of students: 1-2.
- Number of credits: 30 points per student
- Time plan: starting in January 2021 and finishing in June 2021 with approximately 20 weeks.
- Support team for students:
    - Examiner: Håkan Nilsson, email: hakan.nilsson@chalmers.se
    - Academic assistant supervisor: Isabelle Choquet, email: isabelle.choquet@hv.se
    - Industry supervisor: Alireza Javidi Shirvan, email: Alireza.Javidi@esab.se, tel: 070 952 9851
    - Send your CV and application letter to Alireza.Javidi@esab.se
- Physical location: At Chalmers with travels to ESAB Göteborg (with possible adjustments according to the regulation imposed by the Covid situation)

NB. In the continuation of this MSc project, a PhD thesis will be open in international competition on CFD modelling to study the formation of slag inclusions in GMAW.