Master's Thesis

Simulation of the Combustion of Aluminum in Steam

STFS

MOTIVATION

At the Simulation of reactive Thermo-Fluid Systems research group, we study the combustion of metallic fuels as chemical energy carriers, which offer a sustainable alternative to fossil fuels. While aluminum powder is already used in high-performance applications such as rocket engines, there are still significant gaps in understanding the underlying physical and chemical processes, as well as in numerical modeling. In particular, the gas-phase combustion of evaporated aluminum with air or steam differs significantly from other metal fuels and requires further investigation.

TOPIC & CONCEPT

This thesis focuses on the numerical simulation of a single aluminum particle to better model its evaporation and combustion processes. Key aspects include:

- Evaporation of aluminum and subsequent oxidation of aluminum vapor with steam,
- Formation aluminum oxide nano-particles,
- Deposition of aluminum oxide on the particle surface and resulting changes in particle shape.

The work will involve extending existing numerical models, particularly in the areas of:

- Transport of nanoscale combustion products,
- Dynamic evaporation processes,
- Temporal evolution of particle size and morphology.

https://doi.org/10.6084/m9.figshare.27289704.v1

PROFILE & TASKS

We are looking for a motivated master's student with a strong interest in numerical fluid dynamics and reactive flows. Prior experience in at least one of the following areas—CFD, modeling, or programming—is advisable but not strictly required. If you lack experience in some of these fields, you should be highly motivated to quickly develop the necessary skills.

Tasks:
- Familiarizing yourself with existing numerical models and relevant literature,
- Implementing and extending models within an OpenFOAM-based simulation framework,
- Running and analyzing simulations to validate the developed models.

Requirements:
- Interest in physical modeling and numerical simulations,
- Experience with or willingness to learn OpenFOAM,
- Familiarity with Linux environments and programming in C++ (for model development) and Python (for data analysis and testing) is a plus,
- Independent and structured working style.

If this topic interests you, contact us!

Pascal & Johannes
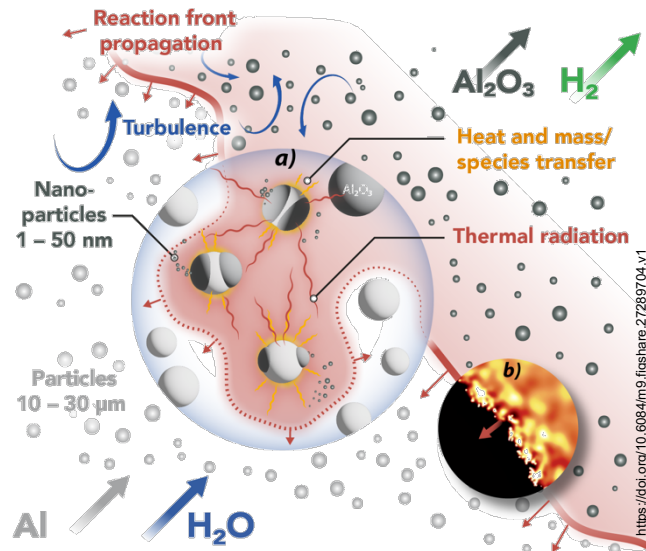
Not quite your topic? Check out other topics from our group!

Interested? Then get in touch with us!

Start: Immediately (17.02.2025)

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