Advanced Modeling of Lubrication in Light Alloy Hot Rolling

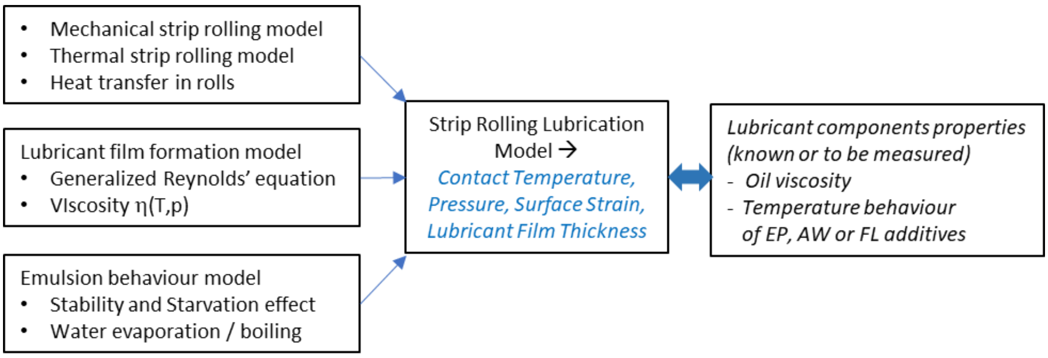
2 year- Postdoctoral Position
Starting beginning 2025

Project Context :

Lubrication plays a critical role in the hot rolling of light alloys, directly influencing friction, wear, and material deformation. With increasing environmental regulations pushing for the use of more sustainable and eco-friendly lubricant components, formulators must make more informed decisions based on objective criteria, such as contact temperature, pressure, and the performance of various additives.

This postdoctoral project aims to develop an advanced numerical model that predicts friction in the hot strip rolling process, with the goal of guiding the formulation of more efficient, environmentally friendly lubricants.

By analyzing the underlying micro-physical mechanisms, the model will predict critical tribological variables—such as lubricant film thickness, contact temperature, and pressure. These predictions will then be compared with the performance efficiency windows of well-established additive families, including the desorption of friction limiters and the decomposition of extreme-pressure additives, to optimize lubricant performance.



Project Overview :

The project will develop a comprehensive model that integrates three distinct but interrelated approaches to predict friction in hot rolling:

1. **Hot Metal Plastic Deformation**: The mechanics of metal deformation govern the local pressure and slip between the strip and the tool. This model will focus on the thermo-mechanical behavior of the metal, where temperature plays a key role in defining material properties. This aspect is well understood through macroscopic models [1].
2. **Lubricant Performance**: The lubricant's ability to separate the tool and strip under high temperatures and pressures is crucial. A micro-mechanical analysis will be used to model tribological phenomena, including the wetting of the hot strip by the lubricant, its impact on film thickness (modeled via a generalized Reynolds' equation [2]), and the conformation of surface roughness asperities on both the strip and the roll [3-6].
3. **Boundary Lubrication and Adhesion**: In situations where the lubricant no longer effectively separates the surfaces (e.g., boundary lubrication), metal transfer from the strip to the roll occurs, altering the surface roughness and increasing friction. This model will include a multifactorial adhesion criterion based on (i) lubricant film thickness, (ii) a critical temperature above which lubricant additives lose efficiency (e.g., thermal desorption), and (iii) surface damage. A transition to a local ploughing friction model will be triggered based on this criterion [7-10].

Integrating these three models will be a pioneering approach in the field of rolling process modeling and will open up new possibilities for optimizing lubricant formulations.

Partners:

This research will be carried out in close collaboration with **TotalEnergies ONE TECH – Solaize Research Center** (69, France), a leader in the formulation of metal forming lubricants.

Location:

- MINES Paris, CEMEF, Sophia Antipolis (06), France (80%)
- TotalEnergies ONE TECH, Solaize (69), France (20%)

Candidate Profile:

The ideal candidate will have:

- A **PhD** in **computational mechanics** or a closely related field.
- Strong programming skills, particularly in **Python**, for high-performance modeling.
- A solid understanding of **mechanics** and an interest in **tribology** and **heat transfer**.
- Prior experience in **tribology** and/or **heat transfer** would be a significant advantage.

This position offers the opportunity to work at the forefront of lubrication modeling in metal forming processes and contributes to the development of more sustainable, high-performance lubricants for industrial applications.

Annual Gross Salary: ~35 000 €

Advisors:

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References:

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