CHALMERS
UNIVERSITY OF TECHNOLOGY

STENA

THEORETICAL AND COMPUTATIONAL EXAMINATION OF THERMAL PLASMA RECYCLING OF ALUMINUM SCRAP

Master thesis project at the Energy Technology division, Chalmers.

For 1-2 students from Mechanical, Chemical or Chemical Engineering with Engineering Physics.

Main supervisor: Thomas Allgurén
Supervisor: Farzad Moradin & Adrian Gunnarsson
Examiner: Klas Andersson

Background: Today, a significant fraction of aluminum is produced through recycling of aluminum scrap. Aluminum (Al) recycling requires only about 5% of energy which is being used in aluminum production from ore. This makes aluminum recycling an attractive choice in terms of economic standpoints, environmental benefits, as well as circular economy. Stena Aluminum, located in Älmhult, recycles Al by melting scrap within a rotary furnace in which heat is supplied from the combustion of natural gas with pure oxygen. To minimize oxidation of the aluminum at the surface, salts are added as a protective layer in the furnace. The drawbacks of the technique used today are: (1) a salty slag by-product which is a hazardous waste, (2) a fraction of Al will oxidize mainly due to formation of oxidizing agents in the furnace, and (3) CO_2 emission due to utilizing fossil natural gas. Given those drawbacks, Stena Aluminum has an interest in investigating the possibility of exchanging the present system for a new plasma torch-equipped smelter. Depending on the working gas used in the plasma torch, the Al oxidation within the furnace could be reduced, along with the CO_2 emissions since the plasma torch utilizes electricity instead of fossil fuels. There are, however, several process changes that must be taken under consideration using a plasma torch, such as; the possibility of a significantly higher gas temperature, changed gas and material flows, changed heat transfer, purchasing cost and operational cost. The aim of the proposed master thesis work includes a theoretical study of thermal plasma used in process industry, presenting possible process systems for the Al recycling process in a plasma torch-equipped smelter as well as energy and mass balances of both the present and future plasma system focusing on CO_2 emissions, productivity and cost estimations.

Suggestion for the Master thesis work:

Examine the potential to lower the CO2 emissions the present aluminum recycling process configuration by exchanging the present burner with a plasma torch as well as examine alternative configurations of the recycling process. Changing from a fossil fuel burner to a plasma torch will be connected to changes in gas and material flows as well as on the total heat transfer on the process. The thesis would aim to close the energy and mass balances of the aluminum recycling process on both the product and gas sides of the process and further increase the understanding of the heat transfer using a plasma torch in such industrial processes and to examine suggestions for how the process could be operated using a plasma or other means of electrification.

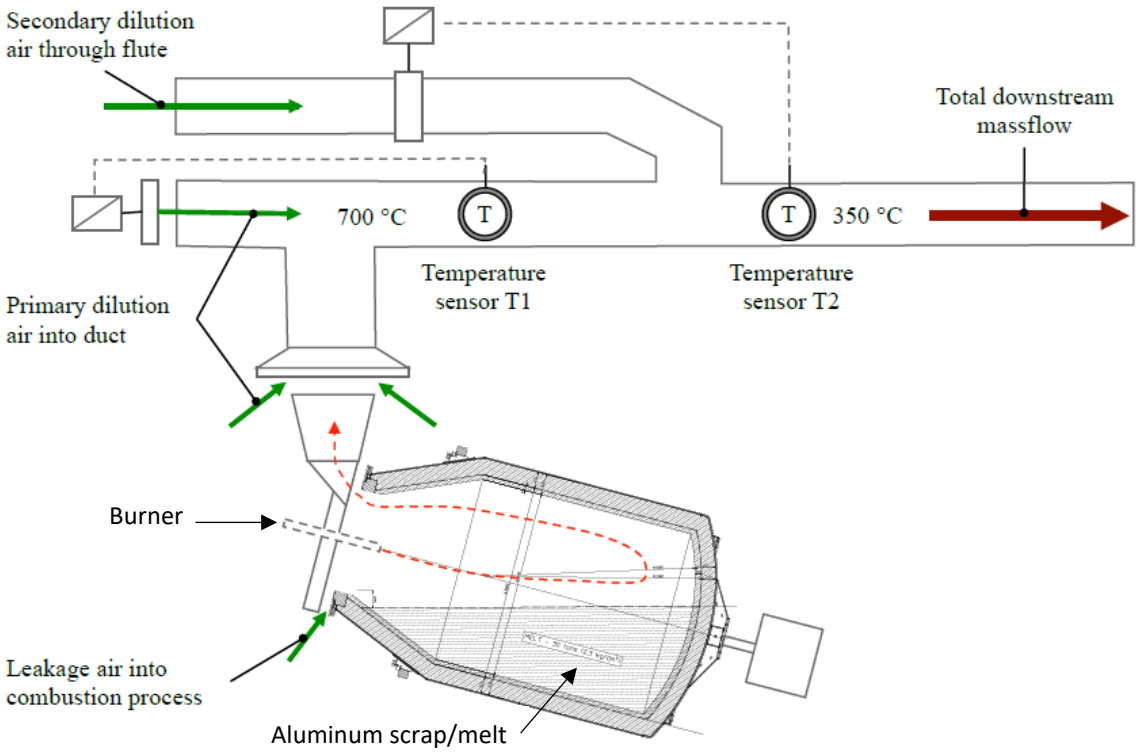
- Literature study of thermal plasma used in various present furnaces and processes to examine:
  - what options are available and the effectiveness of the heat transfer.
  - the possible challenges in using a plasma torch for alumina recycling.
  - the possibility to mimic the present heat transfer conditions or process alternatives using plasma torch.

- Perform energy and mass balance analysis of the system to calculate electrical input, energy consumption, energy lost, recovered and lost aluminum, residues, etc

- Examine possible process variations to lower CO_2 emissions as well as aluminum oxidation

- Master thesis report

The thesis will be conducted at the division of Energy Technology, Chalmers, with supervision from Chalmers and Stena. There might be an opportunity to visit the Stena Aluminium recycling site at Älmhult.



Figur 1. Schematic of the present aluminum recycling process used at Stena Aluminum

Contact info:

Thomas Allgurén – thomas.allguren@chalmers.se