Summary

Given the current climate crisis due to the anthropogenic CO2 emissions, industry decarbonisation is key in the transition to climate neutrality. In particular, 7.2% and 0.6% of the total emissions came from steel and paper & pulp industries, respectively. The latter one accounts for approximately 6% of global industrial energy. In order to abate these sectors, Rouge H2 Engineering was found in 2015, after acquiring a patent from Graz University of Technology.

Rouge H2 Engineering has been developing Chemical Looping Technology which is considered as a next generation CO2 capture technology. It can be used in a wide range of reducible gases as feedstock, in order to produce hydrogen along with carbon dioxide sequestration such as gasified biomass, landfill gas, biogas, and blast furnace gases. To do so, in a fixed bed reactor, metal oxide is reduced (usually hematite: Fe2O3) through those gases coming from the aforementioned industries, resulting in CO2 sequestration. Afterwards, there is a reoxidation process of the oxygen carrier with steam, where hydrogen is produced as a product.

In this context, there are two main objectives set out for this master thesis:

From an academic perspective, the goal was to develop a strategy to decarbonize the paper and paper industry using Rouge H2 Engineering Technology, which consisted in the replacement of the boiler of the paper and pulp process for a gasifier. The results were obtained using Aspen Plus, to do so a model was validated thermodynamically, concluding that Fe0.947O is a good intermediate oxidation state of the oxygen carrier. Additionally, the fixed bed reactor was modelled with a finite number of reactors in counter current. It was also determined that the optimal number of reactors are 14 reactors per step (14 reactors for reduction, 14 for oxidation and 14 for air oxidation).

The simulations showed that the carbon capture is over 99.9% for all case studies, with an energy efficiency between 25.26% and 44.47% depending on the case, therefore allowing

the conclusion that Rouge H2 Engineering technology overcomes the current implemented process, Namely, carbon capture using amine-scrubbing is 90% while the energy efficiency with the boiler is 12%. Additional simulation showed that as the operation temperature increases during the oxidations steps, so the energy efficiency using this novel technology also increases, due to a potential reuse of the heat released.

The second main objective of this work was to perform a research market in Latin America, in order to implement Rouge H2 Engineering technology. By applying methodological research to this objective, different stakeholders were contacted which resulted, in particular, in an important agreement with a multinational steelmaking company.