EXPLORING CLEANER ROUTES OF ALUMINA PRODUCTION:

SIMULATION OF PEDERSEN PROCESS AND CO_2 CAPTURE INTEGRATION VIA CALCIUM LOOPING

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XIII JORNADA DE JÓVENES INVESTIGADORES/AS DEL I3A
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Background

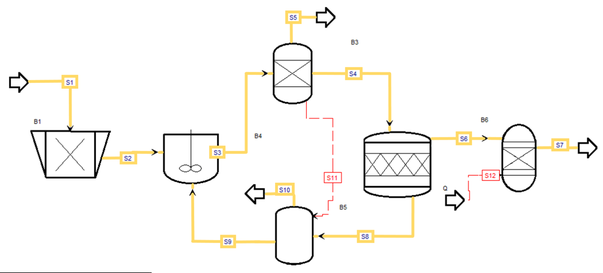
Alumina (Al_2O_3) is a critical raw material for today's society. It is extracted from bauxite ore via the Bayer process. This process is a significant emitter of CO_2 and an important contributor to mineral scarcity because of the generation of big amounts of bauxite residues.

Alternative routes are being explored to produce alumina while avoiding bauxite residues. One of these routes is known as the Pedersen process, which allows the co-production of alumina and pig iron from bauxite.

OBJECTIVES

- Evaluate the energy performance of Pedersen process vs the state of the industry.
- Study the integration of a CO_2 capture plant, exploiting the use of $CaCO_3$.

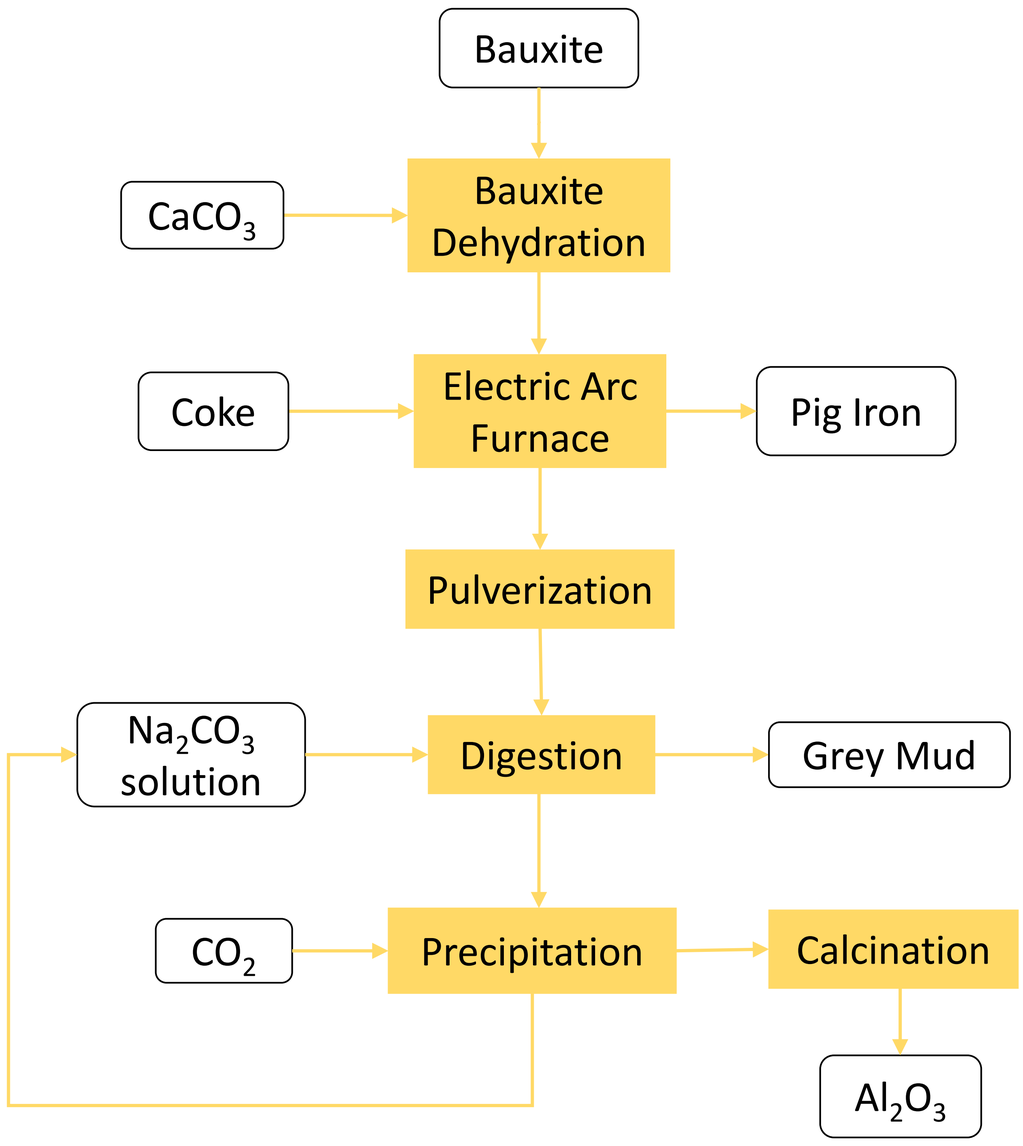
Methodology



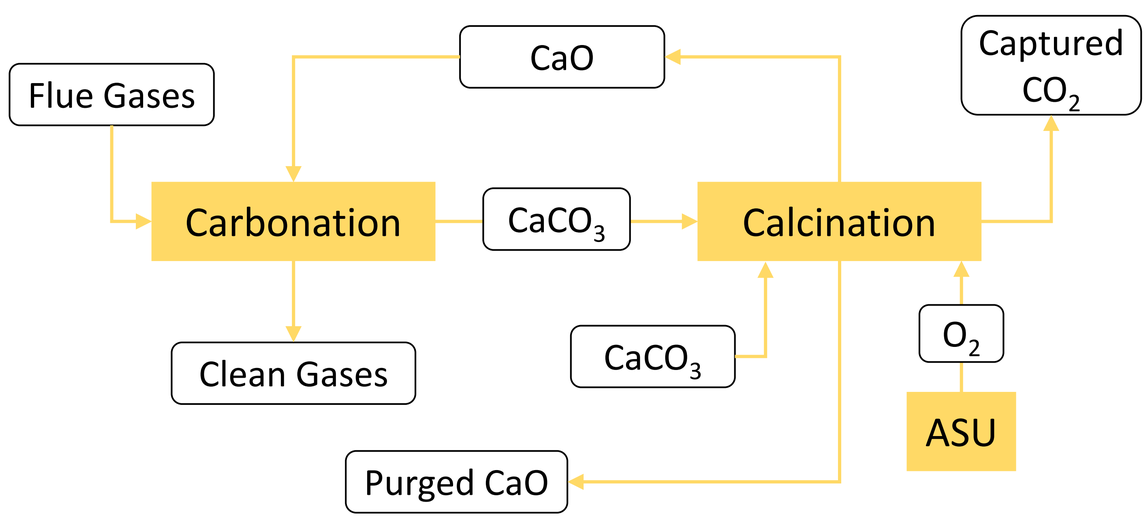
Bauxite Composition[1] (%wt)	
$Al(OH)_3$	80.1
Fe_2O_3	15.7
SiO_2	2.7
TiO_2	1.5

Sorbent Characteristics[2]	
Limestone ($CaCO_3$)	
Purge Ratio	2-50%
% CO_2 Capture	98%

Pedersen Process



Calcium Looping



Results

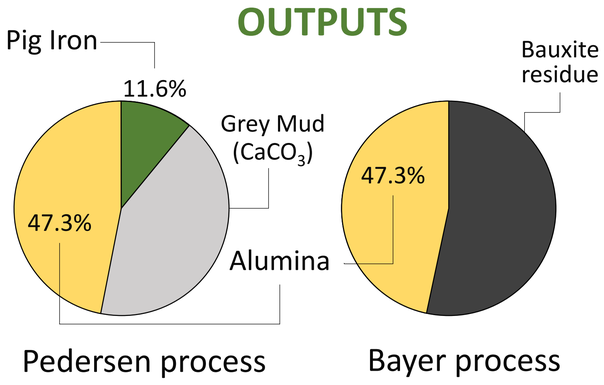
- **0.473 tonnes of Al_2O_3** and **0.116 tonnes of pig iron** can be obtained **from 1 tonne of bauxite**.
- Energy demand is **13.62 GJ per tonne of Al_2O_3**, significantly higher than average **Bayer process (≈10.22 GJ)**.

Calcium-looping integration	Energy Demand	Energy penalty
Single Plant	13.62 GJ/ton Al_2O_3	-
2.6% Purge ratio	20.29 GJ/ton Al_2O_3	7.94 GJ/ton $CO_{2\ avoid}$
33.3% Purge ratio	16.32 GJ/ton Al_2O_3	3.20 GJ/ton $CO_{2\ avoid}$
50.0% Purge ratio	15.01 GJ/ton Al_2O_3	1.65 GJ/ton $CO_{2\ avoid}$

Conclusions

- Energy consumption of Pedersen process is significantly higher than industrial Bayer process, although **economic assessment should indicate its feasibility** considering pig iron co-production.
- Calcium looping stands out as a favourable strategy to mitigate CO_2 emissions. The grade of **substitution of $CaCO_3$ by purged CaO** is crucial to decrease the energy penalty of the capture.
- Findings bring remarkable evidence about the possibilities for smart production of two key raw materials **reducing climate change contributions and mineral scarcity**.

OUTPUTS



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