**Background**

Alumina ($\text{Al}_2\text{O}_3$) 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 $\text{CO}_2$ 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 $\text{CO}_2$ capture plant, exploiting the use of $\text{CaCO}_3$.

**Pedersen Process**

1. Bauxite
2. CaCO$_3$
3. Dehydration
4. Coke
5. Electric Arc Furnace
6. Pig Iron
7. Pulverization
8. $\text{Na}_2\text{CO}_3$ solution
9. Digestion
10. Grey Mud
11. Precipitation
12. Calcination
13. $\text{Al}_2\text{O}_3$

**Methodology**

- **Bauxite Composition\(^1\) (%wt)**
  - $\text{Al(OH)}_3$: 80.1
  - $\text{Fe}_2\text{O}_3$: 15.7
  - $\text{SiO}_2$: 2.7
  - $\text{TiO}_2$: 1.5

- **Sorbent Characteristics\(^2\)**
  - Limestone ($\text{CaCO}_3$)
    - Purge Ratio: 2-50%
    - % $\text{CO}_2$ Capture: 98%

**Calcium Looping**

1. Flue Gases
2. Carbonation
3. CaO
4. Clean Gases
5. CaCO$_3$
6. $\text{O}_2$
7. ASU
8. Captured $\text{CO}_2$

**Results**

- 0.473 tonnes of $\text{Al}_2\text{O}_3$ and 0.116 tonnes of pig iron can be obtained from 1 tonne of bauxite.
- Energy demand is 13.62 GJ per tonne of $\text{Al}_2\text{O}_3$, significantly higher than average Bayer process (≈10.22 GJ).

**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 $\text{CO}_2$ emissions. The grade of substitution of $\text{CaCO}_3$ 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.

**REFERENCES**