A natural solution for an environmental problematic

Mineral carbonation is one approach proposed for tackling anthropic CO₂ emissions. It mimics the natural reaction of silicates weathering, were the gaseous CO₂ reacts with a divalent cation to form the associated carbonates following the reaction:

$$\text{MeO} + \text{CO}_2 = \text{MeCO}_3 \text{ + Heat}$$

Mineral carbonation advantages/challenges are:

- Various feedstock can be used:
  - Natural minerals: Olivine, Serpentine, Wollastonite etc.
  - Alkaline Wastes: Mining residues, Concrete, Slags, Kiln dusts etc.
- Reaction can be directly performed with flue gases: No need for capture step.
- Value added by-product: Rentability for the processes, waste valorization.

The process:

Use serpentine mining tailings for direct industrial flue gas CO₂ capture and storage.

Pre-treatments:
- Grinding (granulometry < 25µm)
- Magnetic separation: Magnetite (305/t)
- Heat activation: 650°C for 30 minutes

CO₂ capture and storage (3 steps):
- Reaction between the flue gas and the residues in the presence of water (25°C and 10 bars for 15 minutes)
- Filtration: CO₂ & Mg-saturated solution and inert solids
- High purity carbonates precipitation (40°C)

Solids recirculation:
- During the gas treatment step, solids are recirculated.
- A reconditioning step by grinding is required to increase the Mg leaching efficiency.

Many emitters within an acceptable transportation range

Results

Model principal parameters

| Cost model parameters: | Plant treatment capacity: 200t rocks / h |
| Transportation distance: 200 Km |
| Sequestration efficiency: 234 kgCO₂ / t rocks |

Energy unit costs (Electricity):
- Hydroelectricity: 3.5 c / kWh
- Coal: 7.8 c / kWh

Energy unit cost (Heat Activation & Precipitation):
- Nat. Gas: 3.00 $ / Mbtu
- Biomass: 1.54 $ / Mbtu

Economics analysis

Process economics for base case scenario:

<table>
<thead>
<tr>
<th>Capital costs</th>
<th>Net profit</th>
<th>Annual sequestration capacity</th>
<th>Payback Period (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>152</td>
<td>191</td>
<td>246 152</td>
<td>1.39</td>
</tr>
<tr>
<td>143</td>
<td>189 754</td>
<td>263</td>
<td>1.38</td>
</tr>
</tbody>
</table>

Conclusions

Mineral Carbonation can be a feasible and profitable approach for industrial direct CO₂ emissions abatement.

One step capture and storage strategy is a key for Energy consumption reduced. The energy efficiency of the process can be increased.