Carbon Removal at Pulp Mills via Sodium Spiking

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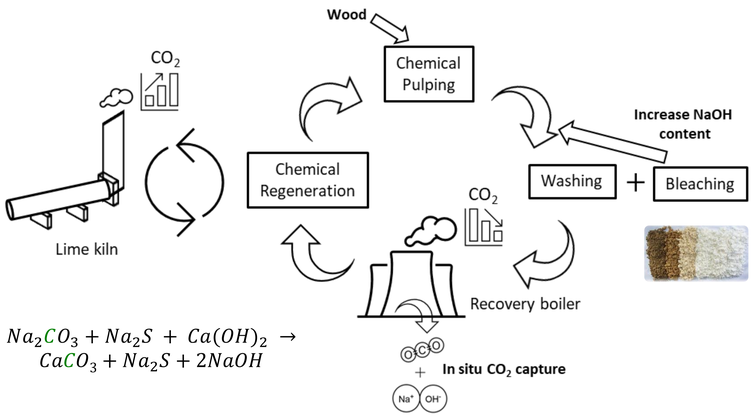
Project Background

- Pulp and Paper mills in the US represent a huge opportunity for biogenic CO_2 capture, utilization, and sequestration[1].
- Millions of tons of CO_2 are captured in pulp mill recovery boilers per year in the form of molten Na_2CO_3.
- The main motivation is to capture CO_2 cheaply in the recovery boiler via mineralization, and subsequently purify it via the oxy-fuel lime kiln



$$Na_2CO_3 + Na_2S + Ca(OH)_2 \rightarrow CaCO_3 + Na_2S + 2NaOH$$

$$CaCO_3 + Heat \rightarrow CaO + CO_2$$

$$CaO + H_2O \rightarrow Ca(OH)_2$$

$$\mathbf{2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O}$$

Hypothesis

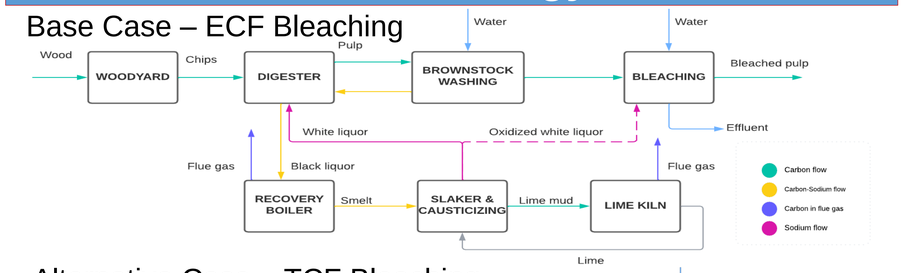
The extent of CO_2 capture in recovery boilers can be increased via sodium spiking or enhanced total chlorine-free bleaching, which will ultimately enable higher rates of CO_2 capture at the lime kiln

Objectives

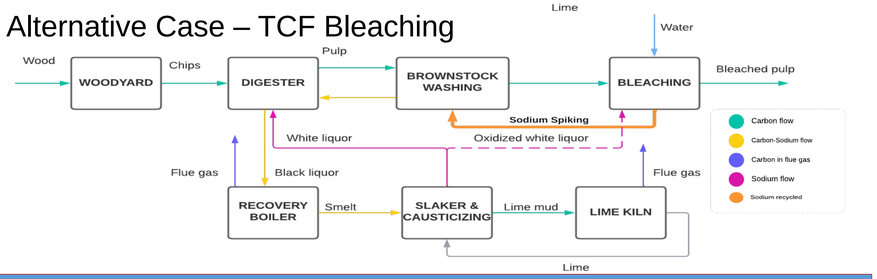
- Develop WinGEMS process models for various degrees of sodium spiking in a kraft pulp mill
- Quantify the extent of CO_2 capture via mineralization in the recovery boiler based on sodium and carbon balance
- Understand the maximum allowable sodium level and associated the bottleneck in the process

Methodology

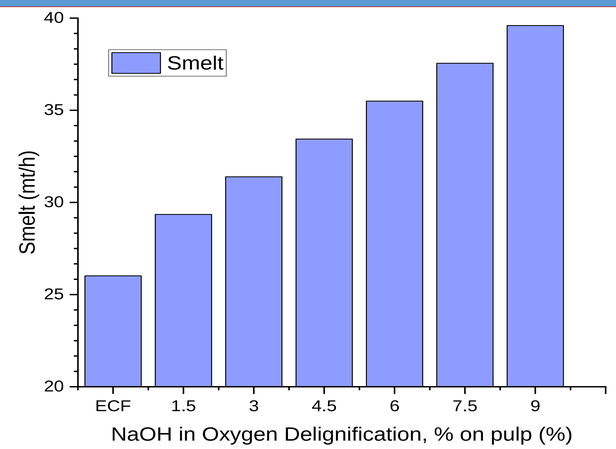
Base Case – ECF Bleaching

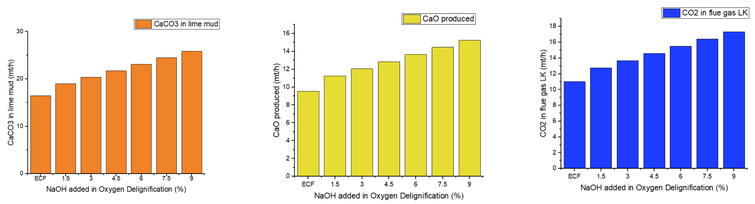


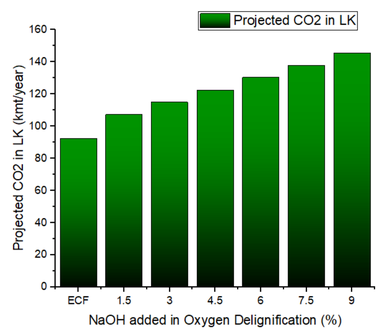
Alternative Case – TCF Bleaching



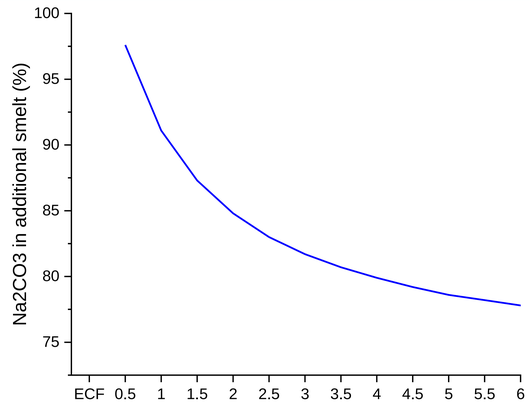
Results







Results-II

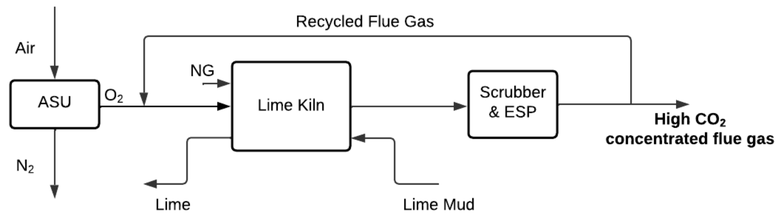


Conclusions

The extent of CO_2 capture in recovery boilers can be increased via sodium spiking, and the opportunity exists to lower costs of CO_2 sequestration via increased capacity in the lime kiln.

The Lime Kiln may produce CO_2 that is pure and comparatively clean. However, the amount of CO_2 produced by lime kilns must be increased to improve economic viability in carbon capture. Sodium spiking can be used as a pathway to maximize the carbon dioxide in the Lime Kiln available to capture.

Further Work



Acknowledgements

The authors are grateful to the U.S. Department of Energy For supporting the project Integrating Carbon Capture, Utilization, & Sequestration into Chemical Pulp Mills (DE – EE0009413).

[1] Sagues, W. J., Jameel, H., Sanchez, D. L., & Park, S. (2020). Prospects for bioenergy with carbon capture & storage (BECCS) in the United States pulp and paper industry. Energy & Environmental Science, 13(8), 2243-2261.