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Structural Comparison of Sodium Bicarbonate and Hydrated Lime for Dry SO_2 Removal.

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INTRODUCTION & AIM

Background: Dry flue gas desulphurisation (DFGD) is essential in mitigating SO_2 from coal fired power stations, waste-to-energy plants or industries utilising coal as a power source. It is imperative to neutralise anthropogenic SO_2 to prevent environmental and human health effects.

South Africa, with only 13 power plants, produces twice as much SO_2 as a country like China, emphasizing the need to retrofit the cheaper DFGD system.

Aim: To compare the structural properties of nahcolite ($NaHCO_3$) and hydrated lime ($Ca(OH)_2$) for dry SO_2 removal

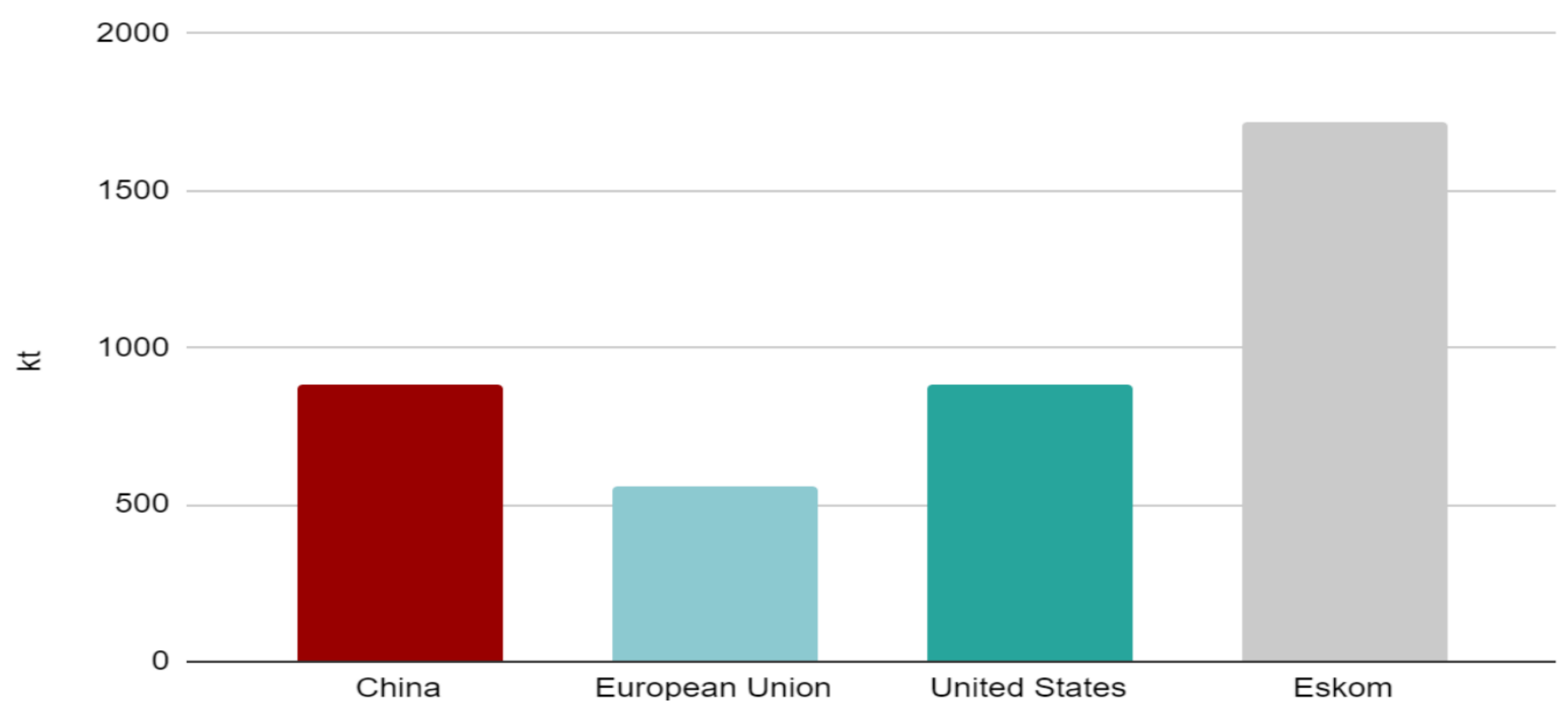

Figure 1: Eskom CFPPs SO_2 generation for the financial year 2019-2020 compared to the United States, European Union, and China (Myllyvirta, 2021).

METHOD

Materials.
Nahcolite, a naturally occurring $NaHCO_3$, from Botash Ltd., and commercial grade $Ca(OH)_2$ Kayla Africa, South Africa.

Characterisation techniques: Scanning Electron Microscopy (SEM), Brunauer-Emmett-Teller (BET) analysis, Barrett-Joyner-Halenda (BJH) analysis, Particle Size Distribution (PSD) analysis, and Fourier Transform Infrared (FTIR) spectroscopy

RESULTS & DISCUSSION

1. BET-BJH screening.

Table 1: Physical properties of the $Ca(OH)_2$ and $NaHCO_3$ from BET and BJH analysis.

Physical property	$Ca(OH)_2$	$NaHCO_3$
BET surface area, m^2/g	**4.2360**	0.2303
BET pore size, Å	601.753	117.312
BJH pore volume, cm^3/g	0.089822	0.000639
*HK maximum pore volume, cm^3/g	0.003861	0.000705

RESULTS & DISCUSSION…Cont

2. SEM analysis

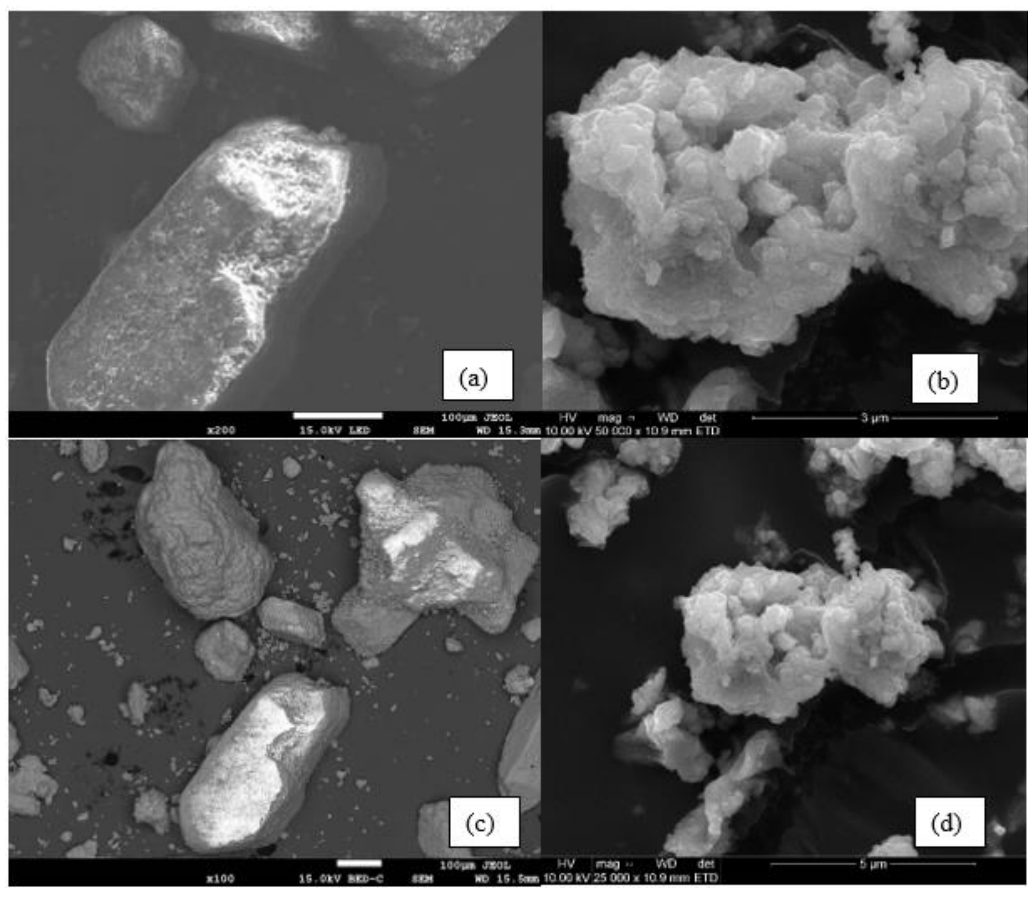

Figure 1: SEM images of $NaHCO_3$ sorbent - (a) and (c) and $Ca(OH)_2$ sorbent - (b) and (d)

3. PSD Data

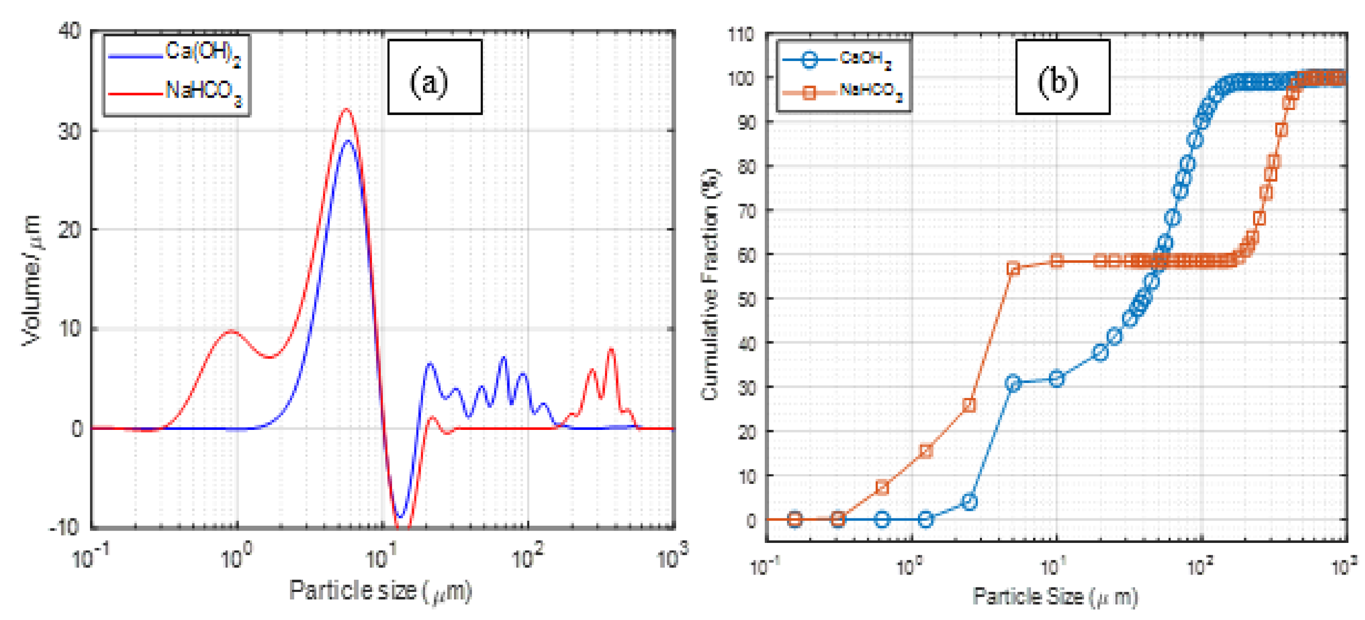

Figure 2: (a) Particle size distribution and (b) reagent cumulative distribution of the $Ca(OH)_2$ and $NaHCO_3$

4. FTIR spectrum.

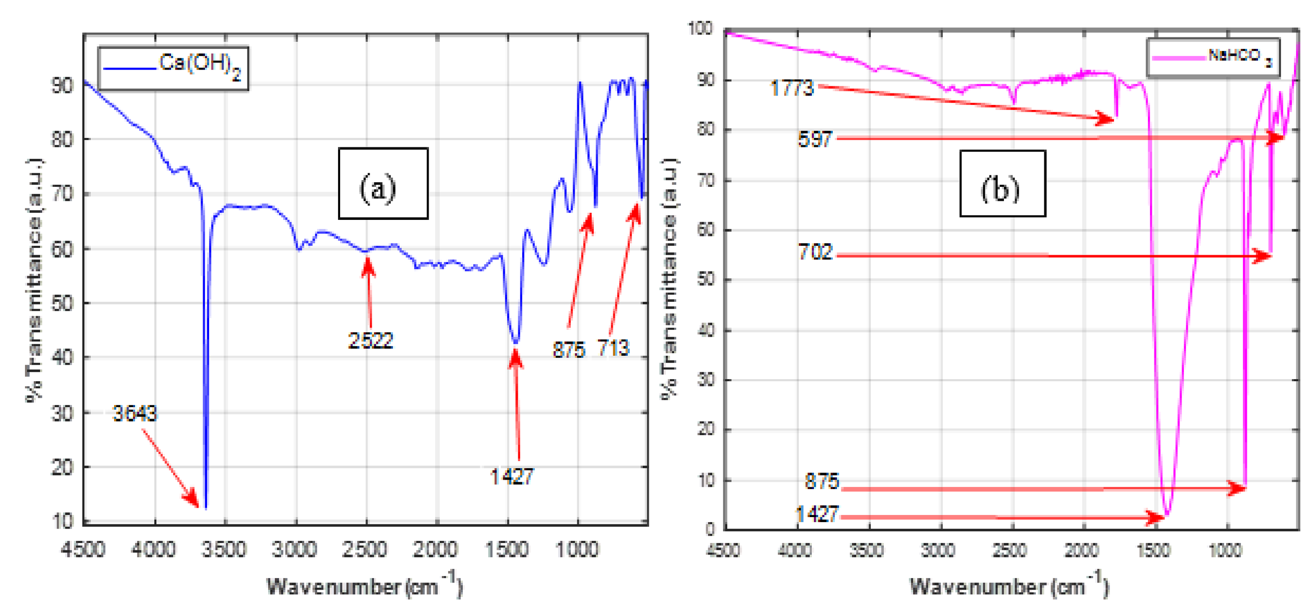

Figure 3: FTIR spectrum of (a) $Ca(OH)_2$ and (b) $NaHCO_3$ (nahcolite).

CONCLUSION

- $Ca(OH)_2$ has superior SSA and pore volume, promoting more gas-solid contact and desirable for SO_2 mitigation
- $NaHCO_3$ has mesoporous intraparticle porosity, encouraging SO_2 diffusion through the particle
- The higher fraction of OH in $Ca(OH)_2$ ensures reactivity is less affected by contaminating CO_3^- groups
- Despite the advantages of $Ca(OH)_2$, raw $NaHCO_3$ cannot be disregarded as a potential substitute for DFGD

FUTURE WORK / REFERENCES

Future works: Evaluate the economic feasibility of using $NaHCO_3$ as a substitute for $Ca(OH)_2$ in DFGD systems.

Myllyvirta, L., 2021. Eskom is now the world's most polluting power company.