Turning Coal or Dirty Diesel Power Station FGD's into CO_2 Sinks

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Introduction

The problem of Green House Gas emissions is a global, urgent one as it results in climate change and global warming. One of the most recalcitrant GHG's is CO2, a linear acidic, non-polar molecule that is slightly soluble in water and forms carbonic acid, one of the acids that makes our carbonate beverages so tangy.

Capturing CO_2 at the thermal power station level is a mature one and the technology is robust and available to deploy. Amine solutions are used to capture CO_2 and separate it from N_2 in the flue gas in so called CCUS absorption towers. Reheating the solution releases the CO2 and the amine solution can be sustainable reused.

The only drawback is cost, in terms of APEX and OPEX.

Having worked on dirty coal power stations, I am familiar with FGD technology. A limestone solution is sprayed in an absorber tower which reacts with the SO2 in the flue gas and the toxic gas is safely locked away as CaSO4 – gypsum.

Hereby we present a simple chemical idea in which FGD towers with minimal CAPEX can be transformed to CO2 capture and use systems.

The Context

Global energy-related CO2 emissions grew by 0.9% or 321 Mt in 2022, reaching a new high of over 36.8 Gt. That is 36.8 GIGA TONS or about 37 Billions Tons of CO2 released annually into the atmosphere.

The global cost of climate change damage is estimated to be between $1.7 trillion and $3.1 trillion **per year** by 2050 that is 1700 – 3100 billion $ per annum. This includes the cost of damage to infrastructure, property, agriculture, and human health. This cost is expected to increase over time as the impacts of climate change become more severe.

Simplifying the maths, 1 billion ton of CO2 costs us about 40 billion $ of climate damage.

Just for comparison, one ton of pure NaOH costs between **$550-650/ton** Min. order: 25 tons from AliBaba.

The cost of 1 ton of MgO on Alibaba is = High Purity Magnesium Oxide/Magnesium Oxide Price. $ **145-180/ton**. Min. order: 1 metric ton.

Our Idea

I have worked on dirty coal power stations in Bulgaria and Poland. Besides CO2, ash and NOx, these power stations emit SOx from the sulphur in the coal and to prevent it from reaching the atmosphere and causing acid rain, large FGD – Flue Gas Desulfurization units are used in which limestone solutions are reacted with the SOx in flue gas counter flow towers and the SO2 is eliminated from the flue gas and captured at CaSO4 – gypsum.

Hereby we present a simple chemical idea in which FGD absorption towers can be converted into CO_2 capture and sequestration towers.

The idea is to simply dose a NaOH/soda caustic or MgOH2 solution into the recirculation lines of the FGD absorbers in excess of the total of SO2 + CO2 in the flue gas in order to capture CO_2 and fix it as Soda Ash/Magnesium Carbonate.

The ability of NaOH or MgO to capture CO_2 is a simple known fact. CO_2 can be captured by absorbing it into NaOH aqueous solutions (Stolaroff et al., 2008). In fact, the CO_2 absorption capacity of NaOH solution is higher than that of MEA (Mono Ethanol Amine used in CCUS systems). The theoretical amount of NaOH to capture a ton of CO_2 is 0.9 tons. It is roughly 1 to 1.

Na_2CO_3 and $NaHCO_3$ powders can be obtained by absorbing CO_2 into NaOH aqueous solution via a spray dryer, as has been demonstrated in the literature (Chen et al., 2005; Stolaroff et al., 2008). Furthermore, the addition of CaO to NaOH aqueous solution enhances the CO_2 absorption in a spray dryer.

A patent for a combined flue gas desulfurization and carbon dioxide removal system exists and is owned by Babcock and Wilcox:

https://patents.google.com/patent/US6399030B1/en

However it simply uses Amine solution for CO2 capture which is thus an FGD Cum CCUS system.

Our proposed idea is expected to generate interest in coal and dirty diesel power station users of FGD systems that are interested in improving the green credentials of their power stations. We are interested in partnering with power station operators, engineering organizations and environmental organizations that can test this pilot idea for CCUS.

Conclusion

We strongly believe that the CO_2 GHG emission global problem can be solved using simple chemistry and this will happen in the next 10-20 years as historical lessons from solving global environmental problems teach us. Historically, global environmental pollution

problems appear in cycles of 10-20 years and are also solved in roughly the same time frame. Case in point: acid rain, the ozone layer, PCB's, Sulphur Dioxide and NOx emissions from power stations, Lead in Leaded Petrol etc. Currently micro plastics, GHG's and PFAS are at the forefront of global environmental problems.

Kremesti Environmental Consulting is a small consultancy based out of High Wycombe with a passion for Chemistry and 20 years' experience in water treatment and power station chemistry. We strongly believe that the solution for Climate Change is a chemical one based on simple chemistry. The flip side or root cause of the problem of course is rampant consumerism and population growth.

The founder and managing director, Rami Elias Kremesti, is a published author and keen nature lover. He regularly hikes the Chilterns AONB and is fascinated by how plants convert inorganic chemistry to organic chemistry. The slogan and mission statement of the consultancy *Transmutare Substantiarum Basium In Aurum* was inspired by the great alchemists who believed in transforming base substances into gold. What most people don't know is that the real gold is the human soul…

Portrait of Rami Elias Kremesti