Desulfurization of Flue-Gasses

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Overview

A novel flue gas desulfurization (FGD) system achieves removal of sulfur dioxide (SO_2) from industrial exhaust streams at efficiencies that can greatly supersede technologies currently in use. The chemical process is highly selective to SO_2, and consumes much less reagents, therefore reducing the cost of desulfurization.Â

Techniques to capture SO_2 from coal-burning and metallurgical plants have not changed in nearly 40 years. Once implemented, the technology presented here can become significantly more efficient and environmentally friendly than existing techniques, since no slurry waste is created from the wet sorbents typically used to capture SO_2.

The novel system can selectively recycle SO_2 from poor-sulfur (<1-2%) waste gas into useful sulfur-based compounds, which can be resold; utilizing a carbonate eutectic melt. This procedure can also be aimed to generate elemental sulfur, an inert and non-toxic compound which can be long-term stored until required for further use. At the same time, gases are purified from nitrogen oxides.

The Need

Sulfur-rich gases are used to produce elementary sulfur or sulfuric acid, but there is no technology for sanitary cleaning of the poor-sulfur gases. Existing SO2 scrubbing technologies generate significant amounts of hazardous waste by-products and require expensive reaction materials. Furthermore, in the future newly constructed power and metallurgical plants will be required to adhere to stricter pollution-control regulations that previous technologies cannot meet.

As an example, a 1 GW capacity coal-burning plant utilizing wet-scrubber methods yearly produces > 1000 metric tons of gypsum, contaminated with multiple compounds. This gypsum is not always usable for other purposes and represents a chemical waste product. While there exists a need for a highly efficiency process, the greater demand is for a process which does not generate large quantities of unusable waste.

Currently, the world consumes 80% of the coal it mines, and every year an increasing amount of coal is unearthed. The demand for coal-fired electric plants, steel foundries, and cement factories will not decrease in the near future; however, the extent of regulation will unquestionably rise with the growing awareness of environmental impact. This new technology developed by the Weizmann institute provides the opportunity to drastically reduce SO_2 emission at lower cost while creating the potential to reduce the costs furthermore by using recycled sulfur products.

The Solution

Convert SO_2 from a industrial flue-gas emissions into elemental Sulfur by installation of a reduction chamber utilizing a carbonate eutectic melt as the reaction medium.

- Reduce SO_2 emissions
- Create a reusable sulfur product from a previous waste

This novel system for efficient capture and recycling of SO_2 is the next generation of SO_2 scrubbing. It can potentially meet the stricter limitations required by new atmospheric controls and environmental laws.

Technology Essence

The significant enhancement of this scrubbing technique is the sequentially operable scrubbing zone and regeneration zone, which communicate with one another via molten eutectic mixture of lithium, sodium and potassium carbonates. In the scrubbing zone, an ingress flue gas interacts with the molten carbonates, resulting in chemical absorbance of the SO_2 and in discharge of reaction gases. In the regeneration zone, either chemical or electrochemical melt regeneration takes place, resulting in formation of sulfur containing vapor which is cooled down for converting the sulfur-containing vapor into a liquid and solid phase for a further collection and utilization.

The technology developed by Prof. Igor Lubomirsky and his team introduces three essential improvements over past techniques: (i) the removal of sulfate from the melt is achieved at expected operating temperatures of an industrial scrubbing tower (480-550Â°C), which drastically reduces corrosion of metal components, (ii) the reduction of sulfates by natural gas or carbon dioxide rather than by carbon powder represents a simpler, one-step process, which results in a high reduction rate and allows for the reaction chamber to be small (few tens of m^3 for 1GW coal plant), and (iii) the removal of sulfate in the form of COS, rather than H_2S, provides considerable freedom in choosing the final sulfur product â€“ either sulfuric acid or elemental sulfur.

Applications and Advantages

Advantages

- Reduce reagentsâ€™ costs compared to current techniques
- Significantly higher efficiency, gases after processing contain several ppm SO2
- Eliminate hazardous waste by-products
- Potential generation of revenue from recycled Sulfur waste

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Applications

- Integrate into industrial fossil-fuel burning facilities which include:
  - Power plants
  - Cement factories
  - Metallurgy Plants

Development Status

Prof. Igor Lubomirsky and his team at the Weizmann Institute of Science developed a Proof-of-Concept prototype which has shown this process is scalable to industrial levels. A prototype has been successfully incorporated into an existing coal-burning power plant as well.

Market Opportunity

Despite an increase in alternative energy sources across the world, coal remains the most prominent energy source accounting for about a third of the worldâ€™s energy consumption, with a stable long term growth. According to a report from 2017 coal remains the largest electricity generation source in the US and a prominent energy source in the APAC region with a nearly 50% market share.

The market potential for this technology is largely driven by legislation to reduce greenhouse gases and sulfur emissions. Implementation of the Paris Agreement is expected to raise the future demand for FGD systems.

According to recent reports, the FGD market is expected to reach $23.69 billion by 2020. The FGD System technology is expected to reach $9.54 billion by 2020 growing at a CAGR of 5.0%. The largest increase of the FGD market is anticipated at the APAC region growing at a CAGR of 7.7%.

Patent Status

USA Granted: 8,852,540 USA Granted: 10,625,204