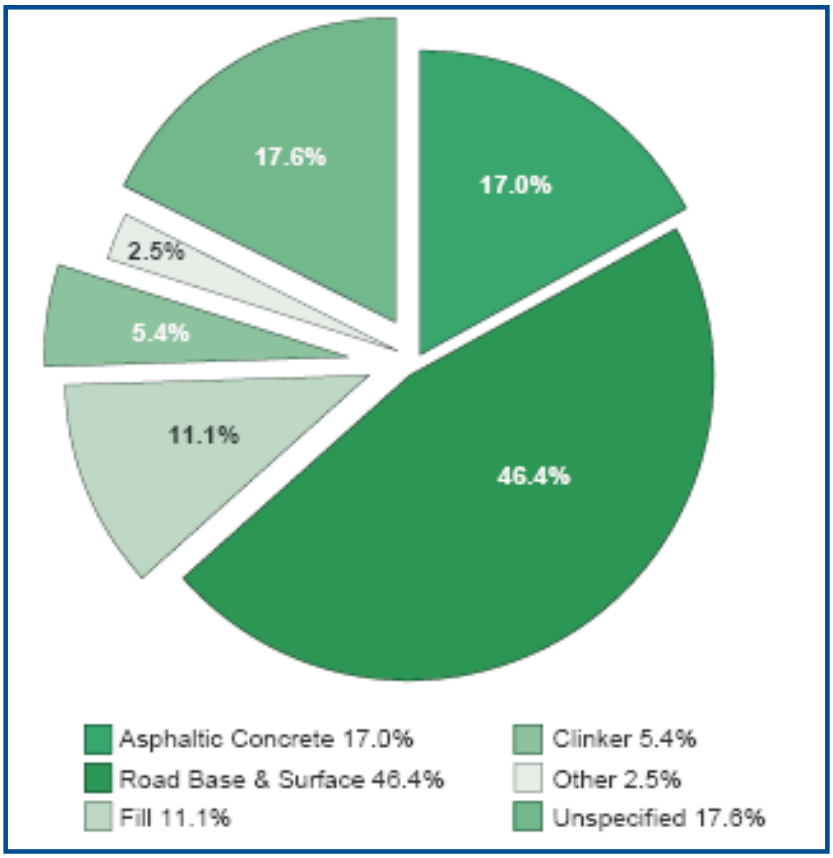
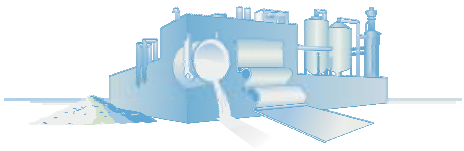
Geological Sequestration of CO_2 by Hydrogen Carbonate Formation with Reclaimed Slag

CO_2 Sequestration Method Could Create Saleable New Products

It is well known that hydrous carbonates form readily at the surfaces of various oxides in the presence of water and ambient CO_2 activity. This project aims to develop a process that improves the kinetics of the hydrous carbonate formation reaction to allow steelmakers to remove CO_2 directly from their furnace exhaust gas. It is proposed to bring the CO_2-containing furnace exhaust stream in contact with reclaimed steelmaking slag in a reactor having an environment near unit activity of water. This reaction will produce carbonate products that are suitable for polymer fillers, agricultural, and construction applications. In addition to removing CO_2, some sensible heat may be recuperated for process or plant services application, reducing the plant's overall CO_2 emissions footprint. The main raw materials for the process are furnace exhaust gases and specially prepared slag.



Current Slag Re-use



Benefits for Our Industry and Our Nation

Using slag to sequester carbon could reduce steelmaking CO_2 emissions by 85% while converting the slag and exhaust gas to potentially saleable products. This method could also capture and concentrate environmentally undesirable trace elements that are present in slag.

Applications in Our Nation's Industry

This process can be used to remove the CO_2 from the steelmaking furnace exhaust gases using slag as a means to sequester the CO_2. There should be a net energy savings, since the process can produce about 920 Btu per pound of slag processed. Further, it can be integrated properly into the exhaust stream of the plant; the sensible heat in the exhaust gas and slag can be recuperated to enhance process kinetics.

Project Description

The goal of this project is develop and demonstrate a process for sequestering CO_2 from steelmaking in either a BOF (Basic Oxygen Furnace) or EAF (Electric Arc Furnace) by producing carbonates from the alkaline earth components of used slag.

Barriers

The technical hurdles this project will overcome include:

- Lack of knowledge about carbonate applications in steelmaking
- Lack of knowledge about kinetic reaction rate of carbonate formation in aqueous systems
- Uncertainty about the main process control parameters to sequester CO_2 from slagmaking

Pathways

The goals of this project will be achieved though: 1) characterizing slag samples obtained from industry participants; 2) producing synthetic slags to tests; 3) determining the maximum degree of carbonization possible for candidate slags; 4) determining viability of carbon sequestration process using carbonates

Progress and Milestones

- Evaluate industrial site for project application and conduct bench evaluation of kinetic factors and trace elements (Complete)
- Compare potential product system and develop kinetics models for industry slag samples and synthetic slag samples (Complete)
- Test slag samples to determine kinetics of carbonation rate and determine gas-phase reaction kinetics (Complete)
- Evaluate bench-scale system

Commercialization

Bench-scale tests will determine slag characteristics that facilitate CO_2 sequestration. After this process is shown to be viable, the project team will evaluate the process for further testing and larger scale demonstration.

Project Partners

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HYLSA
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Mittal Steel, USA
East Chicago, IN

IPSCO
Lisle, IL

Nucor
Charlotte, NC

Praxair
Danbury, CT

The Timken Company
Canton, OH

U.S. Steel
Pittsburgh, PA

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