Method for Preparing a Slurry of Pulverized Solid Material in Liquid or Supercritical Carbon Dioxide
Technology #15909

Applications

- Entrained-flow gasifiers (EFG)
- High pressure oxi-combustion systems

Problem Addressed

Integrated Gasification Combined Cycle (IGCC) power plants with carbon capture are attractive alternatives to Pulverized Coal (PC) plants for C-lean power generation from carbonaceous fuels such as coal. Entrained-flow gasifiers (EFG) operating at more than 40 bar are at the heart of these plants. These are also widely used for other applications such as the production of synthetic liquid fuels and chemicals from coal.

The feeding system of these reactors has proven to be a challenging and costly component since, unlike a liquid, a solid like coal cannot be pumped to a very high pressure. Currently available technologies based on coal-water slurry or on lock-hoppers are expensive, inefficient, and have pressure and feedstock quality limitations.

Technology

This invention is a Phase Inversion-based Coal-CO2 Slurry (PHICCOS) feeding system that takes advantage of supercritical CO2 with liquid-like density. Coal-water slurry is first prepared in a conventional slurry preparation unit at ambient conditions. It is then pumped to the same pressure as that of the liquid CO2 stream available for slurry preparation. The coal-water slurry is thoroughly mixed with liquid carbon dioxide, forming a water-rich and a CO2-rich phase. Exposure of the coal surface to CO2 leads to phase inversion; the low-ash, hydrophobic coal particles thus accumulate in the lighter CO2 phase whereas high-ash, hydrophilic particles and moisture remain in the denser, aqueous phase. The two phases can be continuously removed from the top and bottom of the mixing/settling vessel, respectively. The aqueous ash-rich refuse leaving the liquid contacting vessel is brought to ambient pressure and dewatered before separating and disposing of the high-ash solid stream. The carbon content of the latter depends on the fraction of organic coal particles lost to the aqueous phase upon phase inversion. After separating its solids content, the refuse water is recirculated back to the coal-water slurry mixing vessel. Low-pressure CO2 desorbed from the refuse during decompression is recompressed in a CO2 compressor.

Advantages

- Operates at ambient temperature without the use of lock hoppers
- Can achieve very high pressures
- Inherently reduces the moisture and ash content of the feedstock, which makes it especially attractive for low-rank and high-ash coal
Categories For This Invention:

Energy
Power Plants

Intellectual Property:

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Publications:

The Phase Inversion-based Coal-CO2 Slurry (PHICCOS) Feeding System: Technoeconomic Assessment Using Coupled Multiscale Analysis
International Journal of Greenhouse Gas Control
2013

External Links:

Reacting Gas-Dynamics Laboratory
http://web.mit.edu/rgd/www/

Image Gallery: