IN-SITU DESULFURIZATION OF COAL GAS
WITH CaO-BASED SORBENTS

Javad Abbasian, Institute of Gas Technology, Des Plaines, Illinois 60018, USA

ABSTRACT. Calcium-based sorbents, such as limestone and dolomite, are viable candidates as sulfur-capturing agents in an in-situ coal asification/desulfurization process. The effect of limestone addition on the hydrodynamics of a fluidized-bed gasifier and desulfurization of the product gas have been studied. The hydrodynamic characteristics of coal char/limestone mixtures, such as solid mixing and fines retention, have been studied in a 0.2-m diameter fluidization column. The results indicate that a superficial gas velocity of 0.6 cm/s is sufficient to produce a well-mixed bed of limestone/char mixture in the gasifier. The presence of limestone does not appear to affect the fines retention while the bed height has a significant effect on the fines elutriation from the fluidized bed gasifier. Reaction rate data pertaining to the reaction between calcium-based sorbents and hydrogen sulfide have been obtained by a thermogravimetric technique in the temperature range of 650° to 1050°C. The results indicate that calcium-based sorbents can be used effectively for capturing sulfur during the gasification of high sulfur coals.

Keywords. Sorbents, Coal Gas, Desulfurization, In-Situ, Limestone, Dolomite

1 INTRODUCTION

Coal is mainly used for power generation. More than 50% of the electricity used in the United States is generated by coal-fired power plants. Because of the abundance of coal supplies in the US, depleting petroleum reservoirs and public concerns about the safety issues of nuclear power plants, coal will continue to remain as the most important feedstock for the power industry.

Conventional pulverized coal-fired power plants are inherently 30% to 35% efficient. Because of the ever-increasing and more stringent government-imposed limitations on sulfur emission, Flue Gas Desulfurization (FGD) has been commonly practiced to meet the air pollution standards. Implementation of FGD systems, has
resulted in higher capital and operating costs, and lower overall plant efficiency, leading to a higher cost of electricity.

Emerging technologies, such as the Integrated Gasification Combined Cycle (IGCC) and Integrated Gasification Fuel Cell (IGFC) are among the leading contenders for power generation in the future. These technologies are based on coal gasification rather than combustion and can reach overall plant efficiencies in the range of 40% to 45%. These emerging technologies, because they essentially eliminate the need for coal preparation to reduce its sulfur content, are creating a renewed interest in high sulfur coals. Several IGCC-based processes are currently in the demonstration stage under the sponsorship of the U. S. Department of Energy's Clean Coal Technology (CCT) Demonstration Program.

In these advanced coal based power generation processes, calcium-based sorbents such as limestone and dolomite are added to the gasifier to capture hydrogen sulfide as calcium sulfide (CaS). This is necessary to comply with sulfur emission standards and to prevent the H$_2$S from damaging turbine blades and other downstream surfaces.

Researchers in the field of chemical reaction have already verified the potential use of these sorbents for sulfur capture. The reaction of hydrogen sulfide with calcined limestone/dolomite is very rapid, and the reaction almost approaches equilibrium. On that basis, it is possible to capture substantial quantities of sulfur and discharge it with ash. Based on the equilibrium considerations, it is feasible to remove up to 90% sulfur by using this process. A limited number of tests conducted at pilot-plant scale have verified the feasibility of this sulfur-removal method.

This paper addresses the results obtained in a study geared toward obtaining engineering data on fluidization characteristics of char/sorbent mixtures, as well as sulfidation reactions related to the gasification process with in-situ desulfurization with calcium-based sorbents.

2 EXPERIMENTAL

2.1 Hydrodynamics

The objectives of the hydrodynamic study was to determine the mixing characteristics of char and sorbent of various sizes in the fluidized bed and to determine whether the sorbent addition to the fluidized bed of char has any noticeable influence on the rate of fines carry-over from the fluidized bed.