OHIO COAL DEVELOPMENT OFFICE
ANNUAL PROJECT ABSTRACT
AS OF DECEMBER 2004

1. PROJECT SPONSOR:
Chem. & Biomolecular Eng. Dept.
140 W 19th Ave.,
Columbus, OH 43210

2. PROJECT MANAGER/TITLE:
Prof. L.-S.Fan
Distinguished University Professor
C. John Easton Professor in Eng.,
Professor of Chemical Engineering,

3. OCDO GRANT NO. D4.7

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5. PROJECT TITLE: Sulfidation And Regeneration of Novel Metal Oxide Based Sorbents

6. PROJECT TERM FROM: 9/1/03 **TO:** 8/31/04

7. PROJECT UPDATE ________ --OR-- **FINAL REPORT** ✓

8. BUDGET:

CO-SPONSOR'S NAME	COST-SHARE
OCDO	$ 79,975.00
The Ohio State University	$ 27,406.00
	$
	$
	$
TOTAL PROJECT VALUE:	$ 107,381.00

ABSTRACT

9. OVERVIEW OF PROJECT & OBJECTIVES:

The Ohio coal contains large amount of sulfur. When this coal is gasified in advanced coal-based power generation systems, such as IGCC, the sulfur in the coal forms hydrogen sulfide gas (H_2S). The removal of H_2S is necessary not only for the protection of the gas turbine hardware, but also to comply with the environmental regulations. Coal gas desulfurization to sufficiently low levels at higher pressures and temperatures of above 500^oC is now recognized as crucial to efficient and economical coal utilization in advanced IGCC systems. The primary focus of this project is to investigate the sulfidation/regeneration characteristics of novel metal oxide-based sorbents at high pressures and temperatures representative of advanced integrated coal gasification systems.

10. WORK TO DATE & CONCLUSIONS:

Studies in the project year were focused on synthesis and optimization of high surface area SiC. A high surface area SiC was prepared using sol-gel synthesis technique using an organosilicon precursor (phenyltrimethoxysilane or PTMS). The surface areas achieved were greater than 500 m^2/g with pore volume greater than 0.3 cc/g. The synthesis method was modified by use of different bases and use of a surfactant that led to good control over the pore structure of SiC. More mesoporosity was achieved by the use of NaOH as a base as compared to NH_4OH. However, this SiC was found to have excess carbon and hence studies were conducted where a non-organosilicon precursor (TEOS) was used along with PTMS in order to bring the Si/C ratio closer to unity. There was a slight drop in surface area due to this modification, however, good control over the pore structure was maintained.

The sorbent particles were synthesized through wet impregnation of the metal oxide into the high surface area SiC. Studies were conducted in order to understand the internal structure of the sorbent particles using a FIB-TEM system. It was found that the metal oxide was uniformly distributed inside the particle. Also, depending upon the impregnation procedure and impregnated quantity, the deposited metal oxide layer inside the pores formed different structures. Process simulation was undertaken using a commercial software package (ASPEN PLUS). Process parameters and flow rates were identified using sensitivity analysis.

11. PLANS FOR COMING YEAR:

Future plans are mainly related to the demonstration and commercialization of the technology developed. Efforts are ongoing to develop a plan and invite industrial and governmental partnerships for the same.

12. HIGHLIGHTS/ACCOMPLISHMENTS:

The project has resulted in the development of a new technology for the high temperature removal of sulfur species from syn gas stream in an IGCC power plant. Such a technology will help reduce the associated high costs with IGCC technology as well as increase its efficiency of energy conversion to electricity.

The high temperature H_2S removal is achieved using a supported metal oxide sorbent. The support is a high surface area SiC. During the project term, high surface are SiC was synthesized with high degree of control over pore structure. The metal oxide was impregnated into the high surface area matrix in order to form the sorbent. SEM-FIB-TEM studies showed that the metal oxide was uniformly distributed inside the sorbent particles. The supported metal oxide sorbent was found to remove more than 99 % of the sulfur species in a simulated syn gas at temperatures of interest. The sorbent is regenerable to be used again and again in the desulfurization process. The regeneration process results in a salable sulfur stream that helps offset the cost of desulfurization. The sorbent is found to be regenerable over multiple sulfidation/regeneration cycles. The process is found to reduce the costs of desulfurization by more than 57% over the existing amine based scrubbing process.

13. ARTICLES/PRESENTATIONS:

- Gupta P., Wang W. and Fan L.-S., “Synthesis of High-Surface-Area SiC through a Modified Sol-Gel Route: Control of the Pore Structure”, *Ind. Eng. Chem. Res.* 2004, *43*, 4732-4739
- Gupta, P., Fan. L.,-S., “A New Technique for Studying The Internal Physical Structure of A Supported Catalyst or Sorbent Particle”, ISCRE 18, June 2004, Chicago, IL.
- Gupta, P. and Fan, L.-S., “Novel Supported Metal Oxide Sorbent for High Temperature Gas-Solid reactions”, AICHE Annual Meeting, Nov, 2003, San Francisco, CA.
- Gupta, P. and Fan, L.-S., “High Temperature Syn Gas Desulfurization using Supported Metal Oxide Sorbents”, AICHE Annual Meeting, Nov, 2004, Austin, TX