REGENERATIVE PROCESS FOR DESULFURIZATION OF HIGH TEMPERATURE COMBUSTION AND FUEL GASES

QUARTERLY PROGRESS REPORT NO. 2
JULY 1 - SEPTEMBER 30, 1976

PROCESS TECHNOLOGY DIVISION
DEPARTMENT OF APPLIED SCIENCE

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Abstract

Laboratory facilities and equipment have been acquired and are being installed. The feasibility of using dicalcium silicate as a SO_2 sorbent at about 800°C has been determined. A preliminary flow sheet describing the process has been prepared. Tasks for the next quarter are planned.

Regenerative Process for Desulfurization of High
Temperature Combustion and Fuel Gases

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Progress made during the reporting period is summarized as follows:

1. Laboratory facilities and equipment have been acquired and installed. The following experimental equipment is either available presently or will be available shortly for conducting the experimental program.

a. A flow reactor system built on a Mettler TA-1 Thermoanalyzer (simultaneous TGA-DTA), complete with a corrosive gas handling system and a controlled water vapor generator. The system will be used to obtain kinetic data up to 1650°C at 1 atm.

b. A flow reactor using a Sartorius semi-micro automatic recording balance has been built for kinetic studies up to 1200°C at 1 atm. This system could be pressurized to 2200 psi if needed.

c. A pressurized, high-temperature flow reactor using a Cahn R-100 automatic recording microbalance is being constructed. This system will enable kinetic studies at below 1650°C and 10 atm.

d. Hg porosimeter

e. BET surface area instrument.

f. Low temperature plasma asher.

In addition, the following materials have been acquired:

a. Greer limestone and limestone No. 1359 from Argonne National Laboratory;

b. Tymochtee dolomite from Duff & Son, Inc. (Huntsville, Ohio);

c. Various ranks of coal from Penn State University Office of Coal (PSOC) and PERC.

2. Feasibility of the sulfation reaction (2 in the following) at 800°C has been determined, using the $(\text{CaO})_2 \cdot \text{SiO}_2$ formed in Reaction 1:

The data was obtained using a temporary integral-type reactor (by heating-reaction-cooling and weighing) and are shown in Figure 1 (attached). The rates are not high but are in the same order of magnitude as that with limestones. Also, the reaction system was free of water vapor which has been shown to catalyze, in trace amounts, the sulfation of limestones drastically. Nature of the product of reaction (2) has not been examined as yet.

3. A preliminary process flow sheet describing the process has been prepared and is shown in Figure 2.

The following tasks are planned for the next quarter:

- a. The product of Reaction (2) will be analyzed.
- b. Feasibility of the following complete first cycle will be tested at atmospheric pressure:

The study will include preliminary particle strength test and chemical characterization.

c. Work will be initiated on development and standardization of the micro-analytical techniques. The techniques will include strength test, size analysis, porosity and surface area, using mgs. of sample.

d. Kinetics of the regeneration and sulfation reactions using Greer limestone and Illinois No. 6 coal ash as well as the pure C_2S will be initiated.

e. Work on process design will be initiated.

Figure 1. Rate of the reaction:

Temp=800°C, Pressure=1 atm, SO_2

and O_2 =1.4% each; balance N_2 .

$(\text{CaO})_2 \cdot \text{SiO}_2$ was formed by reacting CaSO_4 (drierite) and coal ash (Ill.

No. 6 bitum.) at 950°C. Size of

$(\text{CaO})_2 \cdot \text{SiO}_2$ =710-1000 μ .

ADVANTAGES

- 1- LOWER TEMP. REQ.
- 1- LESS MAT. PROBS.
- 2- NO RED. GAS REQ.
- 3- RECOVERY OF SO₂ AT HIGHER CONC. (NO. RED. GAS)
- 4- BY PRODUCT C₂S POSS.

IN FBC

IN REGENERATION

	TEMP.	
	°F	°C
(1)	1500-1650	816-896
(2)	≥ 1400 -	≥ 760
(3)	1750-1950 < 1832	954-1065 < 1000
(4)	1832	1000 °C

Figure 2. Brookhaven regenerative hot gas desulfurization process.

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