United States
Environmental Protection
Agency

Air and Energy Engineering
Research Laboratory
Research Triangle Park NC 27711

Research and Development

EPA/600/S7-87/022 Feb. 1988

EPA

Project Summary

Chemically Active Fluid Bed Process for Sulfur Removal During Gasification of Carbonaceous Fuels

Z. Kowszun

This report covers the work done during the final 3 years of a 9-year program to evaluate the CAFB process for gasification and desulfurization of liquid and solid fuels in a fluidized bed of hot lime. A range of alternative fuels, including three coals and a lignite, were gasified in a 3 MWt pilot scale gasifier, and small scale batch tests were conducted, all in support of the design of a demonstration plant to be retrofitted to a 20 MWe natural-gas-fired power generation plant. Direct assistance was given in the start-up and troubleshooting of the 20 MWe unit, and a design study was completed on the potential use of a pressurized CAFB process to fire a high efficiency gas turbine. The pilot plant studies demonstrated the feasibility of simultaneous gasification and desulfurization of a range of coals and a low grade lignite. Best results were obtained using a cannel coal from New Mexico. Batch and continuous gasification tests gave much useful process and equipment information for the 20 MWe design, and the pressurized CAFB studies indicated potential for commercial viability once gas turbine inlet temperatures could be raised to 1427°C.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The fifth (and final) phase of the experimental work on the Chemically Active Fluid Bed (CAFB) process, under EPA contract 68-02-2159, was carried out between May 1976 and May 1979. In parallel, a separate study of Pressurized CAFB (PCAFB), under contract 68-02-2115, was subcontracted to and carried out by Esso Research and Engineering Co. (since then renamed Exxon Research and Engineering Co.). Objectives for this work were reassigned at the beginning of Phase 5 of this project in that the major effort was directed toward the gasification of Texas lignite to support a demonstration plant to be engineered by Foster Wheeler Research Corporation for Central Power and Light Co. (CP/L) at the La Palma power station, San Benito, Texas. Part way through Phase 5, a further reassignment combined Phases 5 and 6 and shortened the time interval for the experimental work.

Runs 11, 12, and 13

Most of the work described in this report was carried out in a 3 MWt continuous pilot plant, which was constructed during the previous reporting

period and consisted principally of Runs 11, 12, and 13. Early in this reporting period, as data collection and analysis improved, it was found that batch unit gasification results on lignite did not correlate with those from the continuous plant so that the batch unit was reserved for equipment development and testing (distributor nozzles, injectors, cyclone drains, screw feeder, pressure tappings, thermocouples, etc.) and operational tests (hot stone fallback, agglomerate formation, solids and gas sampling, etc.), but not for process variable evaluation as originally intended.

Run 11 spanned the period between December 1976 and January 1978 and was spent mostly on exploratory work, with considerable plant and operational conversions as the lignite gasification process was "learned," culminating in a continuous run (January 23-28, 1978) gasifying Texas lignite: no oil was used during that week. During these tests the following were achieved; however, not simultaneously: carbon gasification, >70%; carbon utilization, >90%; desulfurization, >60%; and regeneration of sulphur, >50%. Carbon gasification and desulfurization, unfortunately, moved in opposition; i.e., best carbon gasification results corresponded to poor desulfurization. A number of operational and equipment problems were discovered (flame detection, fines handling, coal feeding problems), and some problems were solved or alleviated sufficiently to allow continuous operation. Most of the operating procedures used later were established during this period.

Between Runs 11 and 12, training sessions were held for CP/L, and a film of some potentially hazardous operations was produced.

Run 12, carried out in a much modified plant, consisted of five test periods of about 1 week each of continuous gasification. These tests covered: a comparison of BCR 1359 (the usual limestone) with Texas limestone; a gradual changeover from combustion to gasification on oil to simulate the proposed San Benito changeover procedure; gasification of Texas lignite; comparisons of different limestone size ranges, wet with dried, and with and without fines reinjection; operation at different temperatures; and combined gasification of lignite with simultaneous oil injection. All were successful, but with occasional surprising results. Also gasified was a British coal (subbituminous, low melting point ash) which caused several bed fusion incidents, but the tests furnished sufficient data to allow extrapolation to a safe continuous operating range.

Run 13 consisted of three test periods, used mostly to repeat in more detail and follow up some of the more interesting operating regimes of Run 12; viz., the San Benito start-up and combined lignite/oil operation which appeared to combine the best features of both operations. The last test in the series was used to carry out a number of short exploratory tests: comparison of overhead with into-bed low level injection, gasification of <25 mm lignite, gasification of Illinois No. 6 coal and a cannel coal from New Mexico, as well as another test on the British coal. The best gasification results were on <12 mm Texas lignite which gave carbon gasification over 90% with simultaneous desulfurization of 50%. The best exploratory test was on the high sulfur N.M. cannel which gave an excellent product gas with little tar, desulfurization in excess of 90%, with simultaneous gasification of 70% and an indication of possible improvement.

Support Items

In parallel with the continuous plant operation, batch plant and rig work was carried out on various supporting items:

a. Operational: agglomerate formation, solids sampling, and fluidization tests.

b. Mechanical: distributor nozzles (prototype San Benito, non-fallback high turndown), screw feeders, fines reinjectors (plain eductor, venturi eductor, J-valve), and rotary valves.

Conclusions

Considerable operational experience was gained, some of which was put to good use at San Benito as on-site operational advice.

Z. Kowszun is with Esso Research Centre, Oxfordshire, OX136AE, England.
***Samuel L. Rakes** is the EPA Project Officer (see below).*
The complete report, entitled "Chemically Active Fluid Bed Process for Sulfur Removal During Gasification of Carbonaceous Fuels," (Order No. PB 88-112 222/AS; Cost: $56.95, subject to change) will be available only from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650
The EPA Project Officer can be contacted at:
Air and Energy Engineering Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

United States
Environmental Protection
Agency

Center for Environmental Research
Information
Cincinnati OH 45268

U.S.OFFICIAL M.S
PENALTY FOR PRIVATE USE $300
U.S.POSTAGE
$0.22

Official Business
Penalty for Private Use $300

EPA/600/S7-87/022

0000329 PS

U S ENVIR PROTECTION AGENCY
REGION 5 LIBRARY
230 S DEARBORN STREET
CHICAGO IL 60604