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(DE94004118)

Development of An Advanced, Continuous Mild Gasification Process for the Production of Co-Products

Quarterly Report
January - March 1994

Glenn W. O'Neal

April 1994

Work Performed Under Contract No.: DE-AC21-87MC24116

For
U.S. Department of Energy
Office of Fossil Energy
Morgantown Energy Technology Center
Morgantown, West Virginia

By
Coal Technology Corporation
Bristol, Virginia

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P.O. Box 880
Morgantown, West Virginia 26507-0880

By
Coal Technology Corporation
103 Thomas Road
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EXECUTIVE SUMMARY

Formed coke development work continued with two coke runs completed in the First Quarter of 1994. Obtaining a low coke reactivity and high strength after reaction were objectives achieved in these two runs.

The continuous coke production system installation is underway. Used equipment from vendors and PETC/DOE will be utilized extensively for this project.

CMGU operations continued with eight test runs. The screws' rotation rate was increased by 40% and the effects are being evaluated. A short test run pyrolyzing vehicle tire rubber was completed with a longer run planned. The spray contact condenser installed in January 1994 has performed well.

TABLE OF CONTENTS

INTRODUCTION

Petroleum currently accounts for over 42% of the total energy consumption in the United States; over 40% of the petroleum consumed in the United States is imported from foreign countries. The remaining oil reserve available in the United States is less than 6% of proven recoverable fossil energy reserves while over 90% of the proven recoverable reserves are coal (1)*. Total coal resources in the United States are estimated to be more than 3.9 trillion tons (2). Just the demonstrated reserves, that is, the deposits that are proven and can be economically mined using today's technologies and mining techniques amount to 488 billion tons. At an annual production rate of 900 million tons per year, the demonstrated reserves alone will last more than 500 years. In view of the very abundant coal reserves and limited petroleum reserves, it would seem prudent to make good use of coal in our evermore difficult pursuit of energy independence.

Devising a continuous reactor system that can deliver a good quality co–products which require only minimal upgrading before being marketed is a major challenge. At present, mild gasification reactor configurations tend to fall into two broad categories: circulating or fluidized bed types characterized by high heating rates (up to 10,000 °C per second, or fixed or moving bed types characterized by slow (on the order of 0.2 to 0.5°C per second) heating rates. Circulating or fluidized–bed types produce high liquid yields at the expense of quality. Fixed or moving–bed types produce better quality liquids but in lesser quantities. An optimum reactor is envisioned as one which avoids the secondary reactions associated with slow heating rates and the quality problems associated with high heating rates. Importantly, an optimum reactor would be capable of processing highly caking coals. The reactor concept under investigation in this effort is an advanced derivative of a reactor once used in prior commercial practice which approaches the characteristics of an optimum reactor.

It is important that a mild gasification reactor interface easily with the subsequent product upgrading steps in which the market value of the products is enhanced. Upgrading and marketing of the char are critical to the overall economics of a mild gasification plant because char is the major product (65 to 75% of the coal feedstock). In the past, the char product was sold as a "smokeless" fuel, but in today's competitive markets the best price for char as a fuel for steam generation would be that of the parent coal. Substantially higher prices could be obtained for char upgraded into products such as metallurgical coke, graphite, carbon electrode feedstock or a slurry fuel

*Numbers in parentheses indicate the reference listed at the end of this report.

replacement for No. 6 fuel oil. In this effort, upgrading techniques are being developed to address these premium markets. Liquid products can similarly be upgraded to high market value products such as high–density fuel, chemicals, binders for form coke, and also gasoline and diesel blending stocks. About half of the non–condensible fuel gases produced by the gasification process will be required to operate the process; the unused portion could be upgraded into value–added products or used as fuel either internally or in "across the fence" sales.

The primary objective of this project is to develop an advanced continuous mild gasification process and product upgrading processes which will be capable of eventual commercialization. The program consists of four tasks. Task 1 is a literature survey of mild gasification processes and product upgrading methods and also a market assessment of markets for mild gasification products. Based on the literature survey, a mild gasification process and char upgrading method will be identified for further development. Task 2 is a bench–scale investigation of mild gasification to generate design data for a larger scale reactor. Task 3 is a bench–scale study of char upgrading to value added products. Task 4 is being implemented by building and operating a 1000–pound per hour demonstration facility. Task 4 also includes a technical and economic evaluation based on the performance of the mild gasification demonstration facility.

TASK 1. LITERATURE SURVEYS AND MARKET ASSESSMENT

Objective

The objectives of this Task are: (1) to identify the most suitable continuous mild gasification reactor system for conducting bench-scale mild gasification studies; (2) to identify the most feasible chemical or physical methods to upgrade the char, condensibles and gas produced from mild gasification into high profit end products; and (3) to assess the potential markets for the upgraded products from this process.

Summary

This task was completed and the Topical Report was submitted and approved by the DOE in January 1988 (3).

TASK 2. BENCH-SCALE MILD GASIFICATION STUDY

Objective

The objective of Task 2 is to study mild gasification in bench-scale reactor(s) to obtain the necessary data for proper design of the one ton/hour mild gasification screw reactor in Task 4.

Summary

After much consideration, it was concluded that it would not be necessary or desirable to build a bench-scale reactor. Instead, data and experience from Dr. David Camp's single screw reactor at Lawrence Livermore National Laboratory provided much useful information for the design of the reactor for this project. In addition, the information available from the literature on the eight years of operation of the Hayes process at Moundsville, West Virginia and the earlier Lauck's screw reactor supplied valuable process design data.

TASK 3: BENCH SCALE CHAR UPGRADING STUDY

Two coke runs were made this quarter. The first was made using Iaeger B coal for both the char and the binder coal. The results of this test were a CRI of 33.5 and a CSR of 61.9. The second was made for evaluation by Inland Steel. This test was No. 174 and had a CSR of 74.7 and a CRI of 23.5. This coke was made with the single objective of doing well on the reactivity and strength after reaction which it did.

A summary has been compiled (attached) showing the various coals used to make metallurgical grade coke on this project. These 12 different coals illustrate the versatility of the CTC coking technology.

After carefully monitoring the used equipment market as well as the PETC/DOE excess inventory, work has begun on the continuous coke extension. The following key components have been identified and ordered. These are:

Component	Vendor
Kiln	Universal Process Equipment
Calciner	Universal Process Equipment
Hot Oil Heater	Universal Process Equipment
Heated Mixer	Scott Equipment
Briquetter	Komarek, Inc.
Motor Control Center	PETC/DOE
Roll Crusher	PETC/DOE
Weigh Belt	PETC/DOE

Next quarter, layout, erection, and structural drawings will be made. Support components such as conveyors, bucket elevators, and air locks will be ordered and construction will begin in April, 1994.

TASK 4. 1000 LB./HR. CONTINUOUS MILD GASIFICATION UNIT (CMGU)

Eight test runs were completed in the First Quarter of 1994 including an initial short discarded vehicle tire rubber run. Test runs' objectives also included: (1) recycling char to obtain very low volatile char; (2) evaluation of Iaeger blend coal as a pyrolyzer feed stock and the resulting char for formed coke production; (3) determination of the effects on heat transfer with a 40% increase in screws' rotation rate which is still being studied; and (4) pyrolyzing Pocahontas 3 Coal for evaluation of the char in production of low reactivity coke.

The increased heat transfer rate at the faster screws' rotation rate has not been obtained thus far. No operations problems have occurred at the higher rate and longer test runs will be required to fully evaluate this change.

The spray contact condenser installed in January has performed well up to coal feed rates of above 1000 lb./hr. The spray nozzle installation design permits easy installation and evaluation of different nozzle designs. The current set-up is two opposing Bete non-clogging nozzles which provide increased liquid spray-off gas contact.

Glenn W. O'Neal
Project Manager

CTC/CLC COKE'S QUALITY DATA WITH VARIOUS FEED COALS

Reference No.	Feed Coal for Char	Binder Coal	CRI	CSR	Analysis Lab
36	Hagy	H&K	31.0	62.1	UEC
36	Hagy	H&K	33.1	53.7	NATIONAL STEEL
41	Hagy	Knox Creek	34.3	57.4	UEC
147	Pocahontas	Knox Creek	30.4	67.0	UEC
155	Penelec Blend	Knox Creek	34.1	48.9	CTC
160	Sewell	Knox Creek	31.7	61.2	CTC
161	Koppers Blend	Koppers Blend	32.8	53.3	CTC
161A	Koppers Blend	Koppers Blend	28.8	58.9	CTC
162	Koppers Blend	Koppers Blend	33.7	55.8	CTC
162A	Koppers Blend	Koppers Blend	27.6	68.5	CTC
162B	Koppers Blend	Koppers Blend	30.0	65.9	CTC
167	Poca #3	Koppers Blend	34.4	54.3	CTC
168	Quinwood	Lady H	35.8	52.2	CTC
170	Lady H	Koppers Blend	31.3	63.2	CTC
171	Lady H	Koppers Blend	34.5	55.2	CTC
172	Cedar Grove	Koppers Blend	32.2	59.4	CTC
173	Iaeger Blend	Iaeger Blend	33.5	61.9	CTC
174	Pocahontas	Iaeger Blend	23.5	74.7	CTC
Large Briquette	Koppers Blend	Koppers Blend	31.7	61.2	CTC