

**Development of an Advanced Continuous  
Mild Gasification Process for the  
Production of Co-Products**

**Quarterly Report  
July - September 1995**

Glenn W. O'Neal

October 1995

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 Research Corporation  
Bristol, Virginia

**MASTER**

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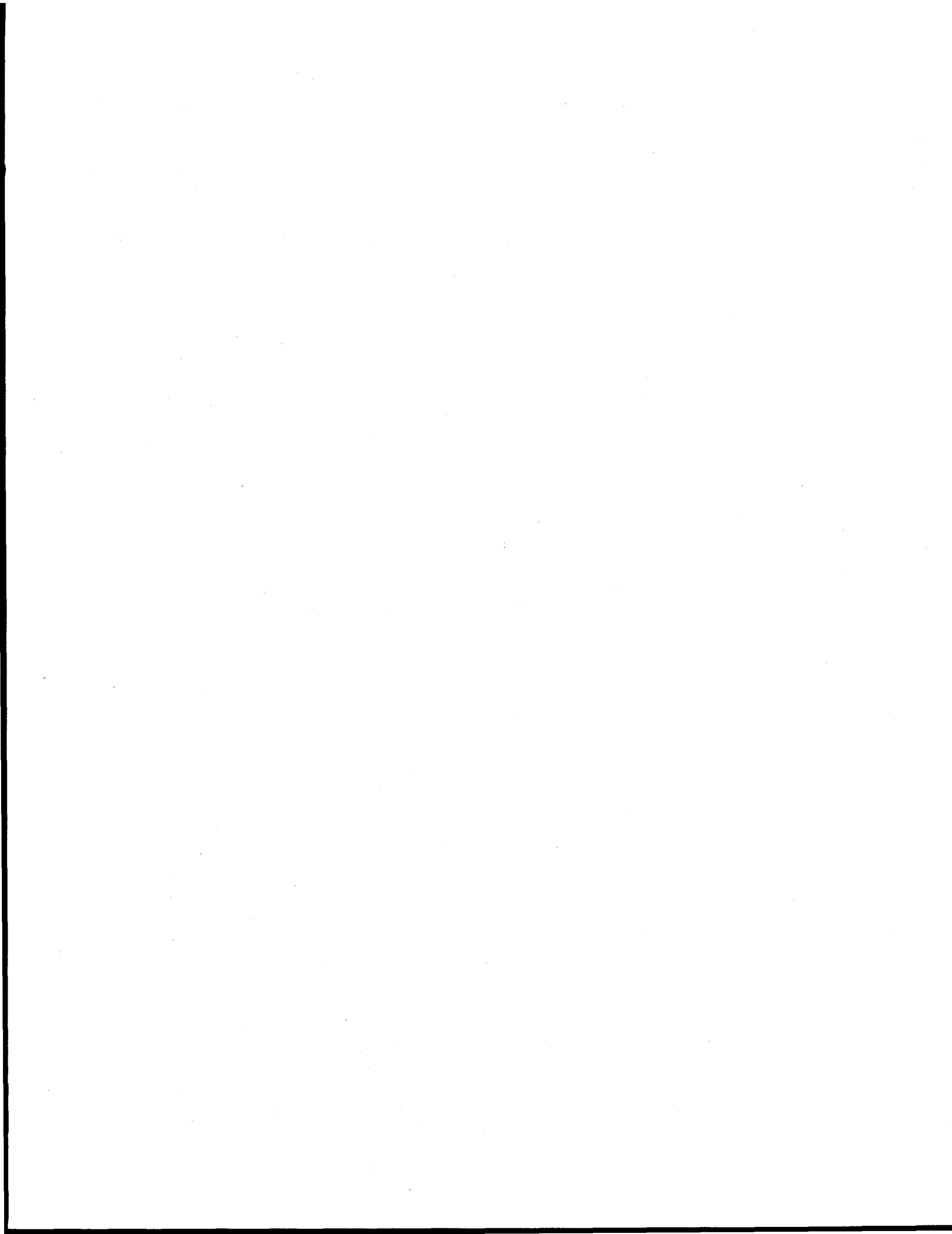
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## **EXECUTIVE SUMMARY**

Eight tons of CTC/DOE formed coke of 6" x 5" x 4" size were produced in the PDU. This coke will be tested at 100 percent formed coke charge in a commercial size foundry. A scheduled test run was postponed due to production requirements at the foundry.

Foundry coke was produced from weakly coking Colorado coal. Blending of this coal with 40 percent of stronger caking, higher rank coals was required.

Western coal from the Rosebud seam was pyrolyzed to upgrade this low rank, high moisture coal. The objective is to improve the coal as a fuel and to determine if an acceptable char or coke can be produced from this coal.

## 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<sup>1</sup>. Total coal resources in the United States are estimated to be more than 3.9 trillion tons<sup>2</sup>. 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

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<sup>1</sup>T. R. Scollon, "An Assessment of Coal Resources," CHEMICAL ENGINEERING PROGRESS, June 1977, pp. 25-30.

<sup>2</sup>J. M. Eggleston, "Bituminous Coal Marketing," presented at the Third U.S.A.-Korea Joint Workshop on Coal Utilization Technology, Pittsburgh, October 5-7, 1986.

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-condensable 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.