Catalysts for hydrotreating solvent refined coal (SRC-II)
by Ronald James Ramer

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Chemical Engineering
Montana State University

Abstract:
Solvent Refined Coal (SRC-II) from Pittsburg and Midway Coal Mining Company's Fort lewis Washington pilot plant was hydrotreated with commercial and Montana State University fabricated catalysts. Twenty-two trickle bed reactor tests and ten batch autoclave tests were executed.

The liquid products obtained from these tests were all analyzed for nitrogen content. Periodic samples were tested for sulfur content and distillate yields were measured whenever possible.

A coking reactor seems to reduce catalyst deactivation for nitrogen removal. Nitrogen removal was found to be greatest for run times up to two hours.

Catalyst 3 (12.6% MoO_3, 10.3% WO_3, 2.8% NiO, 6.8% CoO) was the best catalyst in removing nitrogen and sulfur. The average pore diameter of the base (Norton 6176) is 152 Å. It removed nearly 90% of the nitrogen and 78% of the sulfur over a two-hour period. This represents a final sample with 0.12 weight percent nitrogen and 0.16 weight percent sulfur. Distillations done on two hour runs produced a 95-96% distillate yield under 700°F.

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Signature Ronald J Ramos

Date August 3, 1979

Patent Applied For.

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by

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A thesis submitted in partial fulfillment
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ABSTRACT

Solvent Refined Coal (SRC-II) from Pittsburg and Midway Coal Mining Company's Fort Lewis Washington pilot plant was hydrotreated with commercial and Montana State University fabricated catalysts. Twenty-two trickle bed reactor tests and ten batch autoclave tests were executed.

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INTRODUCTION

As the United States heads toward the twenty-first century, its demand for energy grows(1). As crude oil supplies decrease while prices increase, alternate sources of power become more and more lucrative(2). As the existing proposed solutions to this problem are studied, coal seems to be the most promising, immediate, solution.

It is estimated that coal accounts for about 80 percent of the total energy from oil, coal, and gas in the United States(1). Much of this coal would be relatively easy to obtain, as it lies in relatively thick beds under less than 1000 feet of overburden(3). Because the transportation system of the United States is almost exclusively dependent on liquid fuels, converting coal to a liquid fuel becomes most favorable(4,5).

Coal liquefaction processes are being looked into: Solvent Refined Coal (SRC), Exxon Donor Solvent (EDS), H-Coal, and Synthoil are a few examples. But, in the United States, each of these is merely in the development stage. Coal processes require large capital investment, abundant water, and have environmental and social problems (6). Along with these problems, coal is not of consistent

composition ranging from sub-bituminous and bituminous, to anthracite. Therefore, a strong energy policy must be taken now, otherwise coal liquefaction processes will not be economically competitive by the year 2000(7)!

This research is an attempt to upgrade the tar-like material obtained from the modified PAMCO SRC process, (SRC-II). The SRC-II is catalytically hydrotreated to remove unfavorable heteroatomic molecules (sulfur and nitrogen specifically) and improve the overall product. The reasons for the removal is to prevent catalyst poisoning in further refining steps and to reduce pollution effects of any final fuel made from the SRC-II.

BACKGROUND

SRC Process

Of importance to this work is the SRC process operated by Pittsburg and Midway Coal Mining Company. A 50 ton per day pilot plant is operated at Fort Lewis, Washington. Figure 1 shows a schematic diagram of the SRC-I process(8).

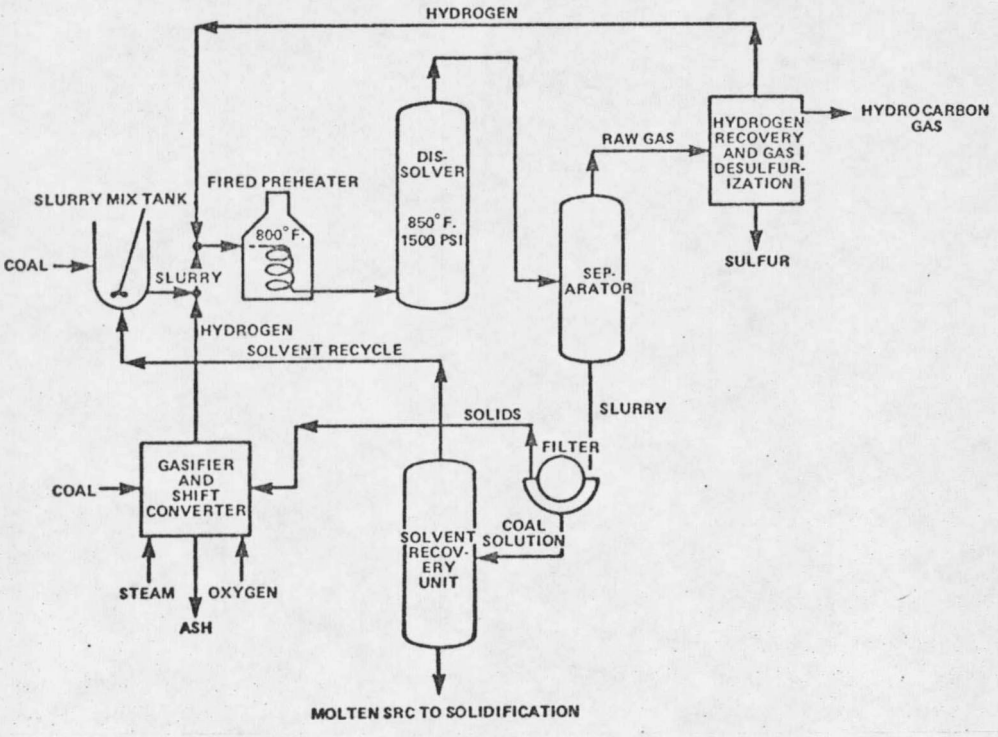

FIGURE 1. SRC-I PROCESS SCHEMATIC

The coal (Kentucky # 9) is pulverized and mixed with process-derived solvent in a slurry mix tank. The slurry is combined with hydrogen and is then pumped through a fired preheater and into a dissolver. In the dissolver, the coal is hydrogenated and thus depolymerized, leading to an overall reduction in product molecular weight and the dissolution of the coal. The solvent is also hydrocracked, yielding lower molecular weight hydrocarbons ranging from methane to light oils. The organic sulfur in the coal is hydrogenated to hydrogen sulfide.

After leaving the dissolver, the mixture passes to a separator where the gases are separated from the slurry of undissolved solids and coal solution. The raw gas is sent to a hydrogen recovery and gas desulfurization unit. The recovered hydrogen is then recycled and combined with the slurry from the slurry mix tank. Hydrocarbon gases are recovered and the hydrogen sulfide is converted to elemental sulfur.

The slurry of undissolved solids and coal solution is then separated in a solids separation unit. In a commercial scale plant, the solids would be sent to a gasifier-converter where they would react with coal, steam, and