Section 7

CHEMICALS FROM COAL: A RELIABLE AND ECONOMICAL ALTERNATIVE

E. C. Horton
K. Gockenbach

Tennessee Eastman Company
P.O. Box 511
Kingsport, TN 37662

I. Introduction

We're happy to be with you today to talk about chemicals from coal. At Tennessee Eastman Company, we're making an important intermediate chemical utilizing coal gasification and small molecule chemistry. Before we get into an explanation of our new plant, I'd like to give you a brief description of our company.

Tennessee Eastman Company is a major producer of chemicals, fibers, and plastics. It is located in Kingsport, Tennessee, which is also the headquarters for the Eastman Chemicals Division of Eastman Kodak Company. Eastman companies employ a total of 12,250 people in Kingsport. Other domestic Eastman Chemicals Division plants are located in Texas, South Carolina, Arkansas, and New York.

Today as we talk, I'll use Tennessee Eastman Company and TEC interchangeably. References to Eastman, Eastman Chemicals Division, or ECD include all of the company's manufacturing and marketing organizations.

One of the major intermediate chemicals produced at TEC is acetic anhydride. It is used primarily in the manufacture of cellulose acetate, which is the building block for photographic film base, cigarette filter tow, and various fibers and plastics. We refer to these as acetyl products. Acetyl products account for more than 30 percent of Eastman Chemicals Division sales.

Traditionally, acetic anhydride has been produced by Eastman through several processing steps beginning with ethane and propane. Since 1970 Eastman has been actively researching new, more economical, processes for the production of acetic anhydride. TEC's chemicals from coal project is the result of this research.

The new plant is designed to produce 500 million pounds per year of acetic anhydride, about half of TEC's requirements. In addition, the acetic anhydride plant coproduces 150 million pounds per year of acetic acid, approximately 20 percent of Eastman's total acetic acid production. The new plant also produces enough methanol to meet the entire requirements of the Eastman Chemicals Division. Coal, water, oxygen, and acetic acid are the major raw materials.

II. Description of Plants

The new complex consists of nine interrelated plants (Figure 1).

The complex is divided geographically into two areas - synthesis gas production and chemicals production. The two areas are joined by pipelines carrying synthesis gas for methanol and carbon monoxide for acetic anhydride.

Synthesis gas production facilities start with the coal handling and slurry preparation plant. Approximately 900 tons of high-sulfur coal from nearby Southwest Virginia and Southeast Kentucky mines are wet ground each day into a slurry containing 60%-70% solids. This slurry is stored in two large feed tanks from which it is pumped to each gasifier.

Oxygen for gasification is provided by three air separation plants owned and operated by Air Products and Chemicals, Inc. These plants, located adjacent to the Eastman plant, also provide nitrogen for Tennessee Eastman.

The gasification plant (Figure 2) utilizes two Texaco gasifiers to produce both shifted and process (or unshifted) synthesis gas streams.

FIGURE 1: CHEMICALS FROM COAL COMPLEX

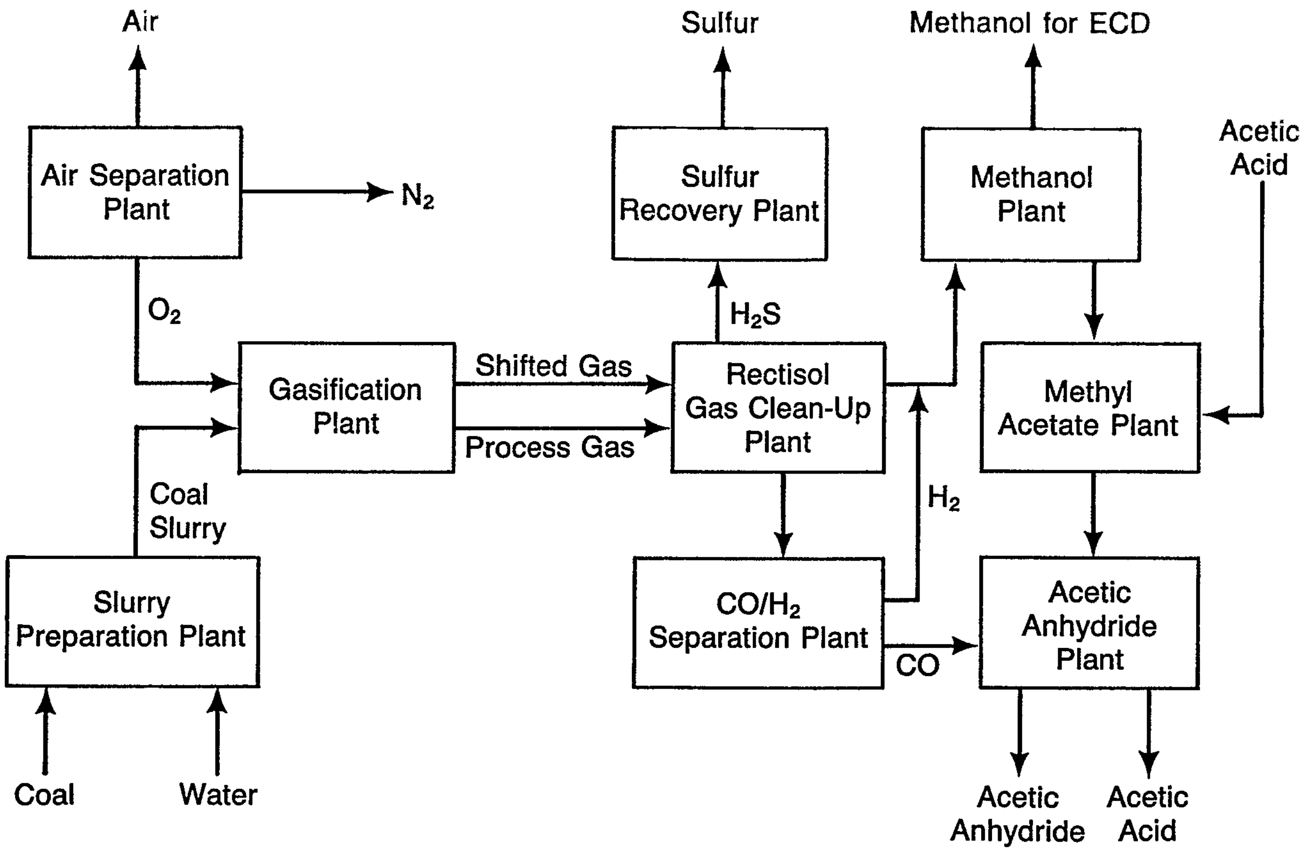
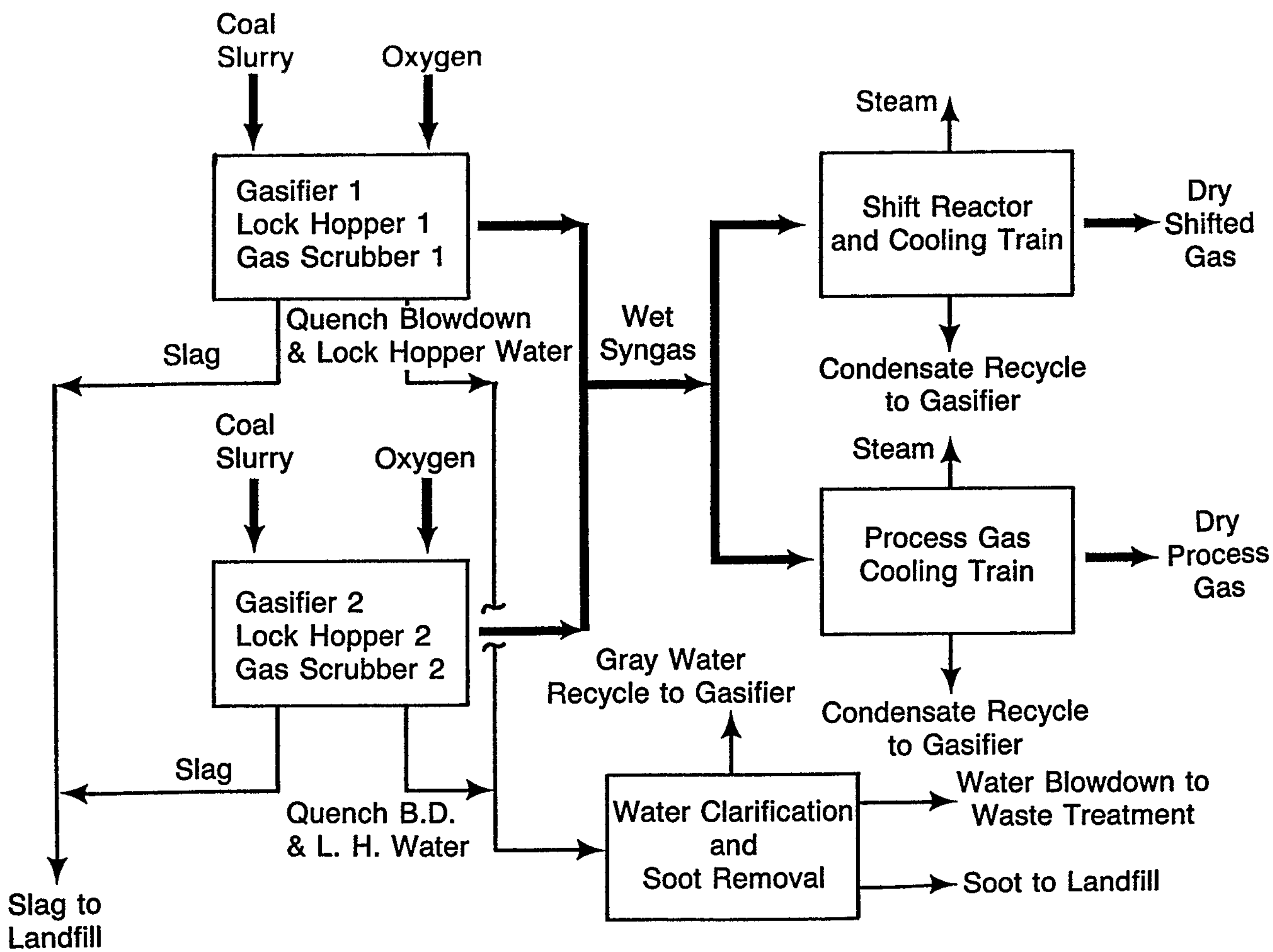


FIGURE 2: GASIFICATION PLANT



The two gasifier systems and both cooling trains are located in a five story structure. Water recovery, soot removal, and slag handling are located in the yards area adjacent to this structure.

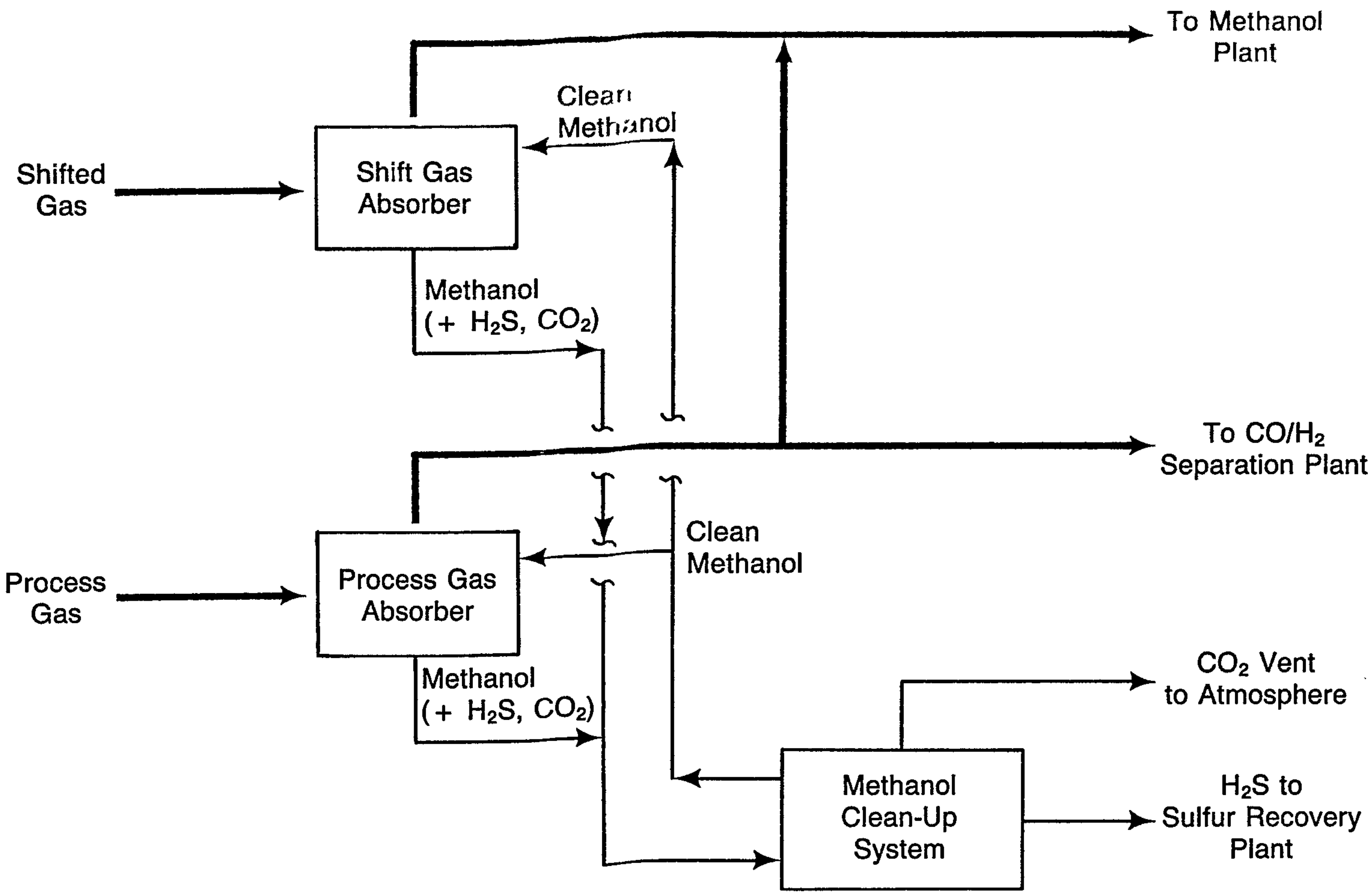
Coal slurry and oxygen are reacted in the gasifier at approximately 2500°F and 1000 psig. Resulting synthesis gas is scrubbed to remove soot particles before processing in the gas cooling trains.

The wet syngas then splits to form two raw gas streams: (1) shifted gas, which has been through a water gas shift reactor, cooled, and water removed to produce a hydrogen-rich stream, and (2) process gas, which has only been cooled and separated from the condensate. Steam generators in the two cooling trains produce 200,000 lb/hr of process steam for use in the chemical plants. Ash and small amounts of unburned carbon are removed through a lock hopper system and conveyed to truck trailers for landfilling. Lock hopper flush water and gasifier quench blowdown water are cooled, clarified, and recycled. A small amount of clarifier overflow is removed from the process as blowdown to control dissolved solids and chloride content. The clarifier bottoms are filtered and the resulting solids are landfilled.

Hydrogen sulfide and carbon dioxide are removed from the shifted and process streams by two absorbers in the Rectisol gas clean-up plant (Figure 3). Carbon dioxide removed from the syngas is vented to the atmosphere. Hydrogen sulfide is removed and routed to the sulfur recovery plant.

Part of the process gas is mixed with the shifted gas to control composition in the feedgas stream to the methanol synthesis plant. The remainder of the process gas is sent to the CO/H_2 separation plant for processing.

FIGURE 3: RECTISOL GAS CLEAN-UP PLANT



The CO/H_2 separation plant cryogenically separates the process gas in a cold box to produce the carbon monoxide which is then compressed and fed to the acetic anhydride plant. Hydrogen separated by the cold box makes up the remainder of the feedgas to the methanol synthesis plant.

The sulfur recovery plant consists of two Claus plants and a single SCOT plant. The Claus/SCOT combination recovers 99.7% of the sulfur present in the synthesis gas. The high-quality sulfur from the process is sold to sulfuric acid manufacturers.

The methanol plant, licensed from Lurgi, is designed to produce 365-million pounds of methanol per year. Most of this methanol is used to produce the methyl acetate requirements of the complex. The remainder is used for other processes in Eastman Chemicals Division and Kodak's Photographic Division.

The methyl acetate plant reacts methanol and acetic acid by a proprietary Tennessee Eastman process to produce methyl acetate requirements for the new acetic anhydride plant.

The acetic anhydride plant reacts methyl acetate and carbon monoxide in a proprietary TEC catalyst system to produce 500-million pounds per year of acetic anhydride. As we noted earlier, this is roughly half the TEC requirement for this important chemical intermediate. This facility increases Eastman's acetic anhydride and acetic acid production capacity. We have also reduced our internal use of acetic acid. As a result, we have additional product available for sale.

III. History of Operation

Next, I'd like to review the operating history of the plant.

During the start-up phase, the gasification and gas clean-up plants were operated to produce methanol while construction of the acetic anhydride plant was completed.

Gasifier 1 was started on June 19, 1983. After initial debugging of gas production plants, methanol was first produced one month later on July 19, 1983. Gasifier 2 was first started on August 12, 1983, and operated continuously for twelve days on its first run.

During the start-up phase lasting three and one-half months, the gasifier was operated 50% of the time. This includes a three-week outage to repair expansion joints on heat exchangers which failed prematurely.

Initial operation of the entire complex began with the first production of acetic anhydride and acetic acid on October 6, 1983, and lasted for nine months. During this period, the gasifiers were on stream 85% of the time and the acetic anhydride plant operated 75% of the time. Acetic anhydride production and methyl acetate production were below nameplate capacity due to equipment problems. Although other problems were identified and solved during this time period, some items were identified which could not be resolved without a shutdown. A two-week planned shutdown in July, 1984, was scheduled to install improvements necessary for full capacity operation.

Major jobs completed during the July, 1984, shutdown included:

1. Modifications in the acetic anhydride process to achieve capacity operation

2. Modifications in the Rectisol gas clean-up process to achieve required methanol syngas and carbon dioxide vent quality

3. Modifications to the refrigeration system for the Rectisol process to increase reliability

4. Valve replacements in the gasification/gas cooling process to increase reliability

5. Heat exchanger replacement in the process gas cooling train to increase reliability

6. Modifications in the methyl acetate plant to achieve capacity operation

As just explained, many of the problems experienced in the first year of operation were equipment, not process, related problems. One third of the plant shutdowns in 1983-84 were a direct result of equipment or component failure, including:

1. Gate, globe, and ball valves which leaked through, leaked at the bonnet or packing, or were difficult to operate, even at low pressure

2. Heat exchangers which failed due to improper design of expansion joints and improper heat treatment of tube bundles

3. Faulty coaxial cable connectors to programmable controller wiring

Improvements installed during the July shutdown led to the desired results . . .

For the last half of 1984, the gasification plant was on stream 97 percent of the time. During the same period, the acetic anhydride plant was on stream 95.5 percent of the time. Chemical production rates averaged the following percentages of nameplate capacity:

-methanol	80 percent (Limited By Demand to 82%)
-methyl acetate	112 percent
-acetic acid	104 percent
-acetic anhydride	105 percent

Although the longest single gasifier run during this time was 28 days, by switching gasifiers, we were able to continuously provide gas for chemical plant production for 80 consecutive days.

Not long ago a major trade journal reported that "Eastman has had problems with the chemicals from coal plant and doesn't like to talk about it." The article indicated we might not be satisfied with the results. Nothing could be further from the truth.

Actually, the company is quite pleased with our operating experience .

The success of Eastman's chemicals from coal project has demonstrated the following:

1. Operating experience at Tennessee Eastman shows it is possible to operate a reliable, efficient coal gasification complex using existing, proven technology in a safe and environmentally acceptable manner.

2. It is possible to manufacture chemicals from coal more economically than from traditional petroleum-related feedstocks.

   Our plant was designed and constructed on schedule and within budget. Original projections were met during the 4th quarter of 1984; and return on investment from the new complex has been favorable.

Where do we go from here? While we have announced no definite plans yet, we're evaluating alternatives for expansion of the chemicals from coal complex.

Proposals include producing our remaining requirement of acetic anhydride from coal and manufacturing other chemicals based on CO/H_2 chemistry.

We believe our experience with coal gasification, coupled with our knowledge of carbon monoxide chemistry, gives Eastman a unique position in the chemicals, fibers, and plastics markets.

Eastman may have been the first company within the USA to use modern coal gasification processes to produce chemicals, but we won't remain the only company to use the technology to manufacture industrial chemicals. We do expect, however, to remain at the forefront of this promising technology.

Our scientists and others developed several of the processes that made production of acetic anhydride from coal a reality. These key technologies are available for licensing, and of course, we're working to develop processes to produce other chemicals from coal.

Today I've given you a brief description of our chemicals from coal complex. I've described the individual plants and reported on our first year in operation.

We're pleased by the results of our initial period of operation. We're confident there will soon be other chemicals manufactured from coal. We're pleased that as a result of our success, other companies are now exploring further development of this promising technology.