COAL TO GAS VIA THE LURGI ROUTE

W. V. Hartman
Vice President
Peabody Coal Co.

I would like first to qualify or disqualify myself, as the case may be, as an expert in coal gasification. I am primarily a coal miner. Normally, we in the coal business wrestle with the problem of mining conditions, equipment performance and availability, labor relations and that will-of-the-wisp, "How to make a profit." In the last 7 or 8 years, however, the factors which contribute to the complexity of a mining operation have multiplied. Under environmental pressures, it is necessary for the coal industry to look to new means to survive. More than 90% of the coal in the United States is classified high sulphur. EPA's deadline, which prohibits the burning of so-called high sulphur fuels in 1975 is a frightening prospect.

We have a current shortage of gas and a serious shortage predicted in the near term. As of now we import approximately 25% of our oil and projected imports will increase to between 45 and 50% by 1980.

These facts emphasize the necessity of finding a way, in addition to the generation of electricity, to convert our only remaining significant domestic fuel source into an environmentally acceptable form. An ideal solution would be to convert coal to pipeline quality gas. The product could be intermingled with natural gas in transmission lines and used in existing equipment.

Figure 1 shows an F.P.C. map, which depicts the various gas pipelines within the continental United States. In many cases the pipelines cross and are adjacent to large coal reserves.

We, like many other energy companies, have made exhaustive searches into the various means by which the coal to gas conversion can be accomplished. The production of pipeline quality gas is normally viewed as a two step operation: (1) the actual gasification reaction, which produces a relatively low BTU gas, and (2) the enrichment step to pipeline quality.

The first step, or the actual solid to gas reaction, is what we are primarily concerned with here today. As one looks through the history of this technique the Lurgi process stands out. Originally developed in the 1930's, the German process was counted upon heavily during World War II to provide the basic energy feed materials

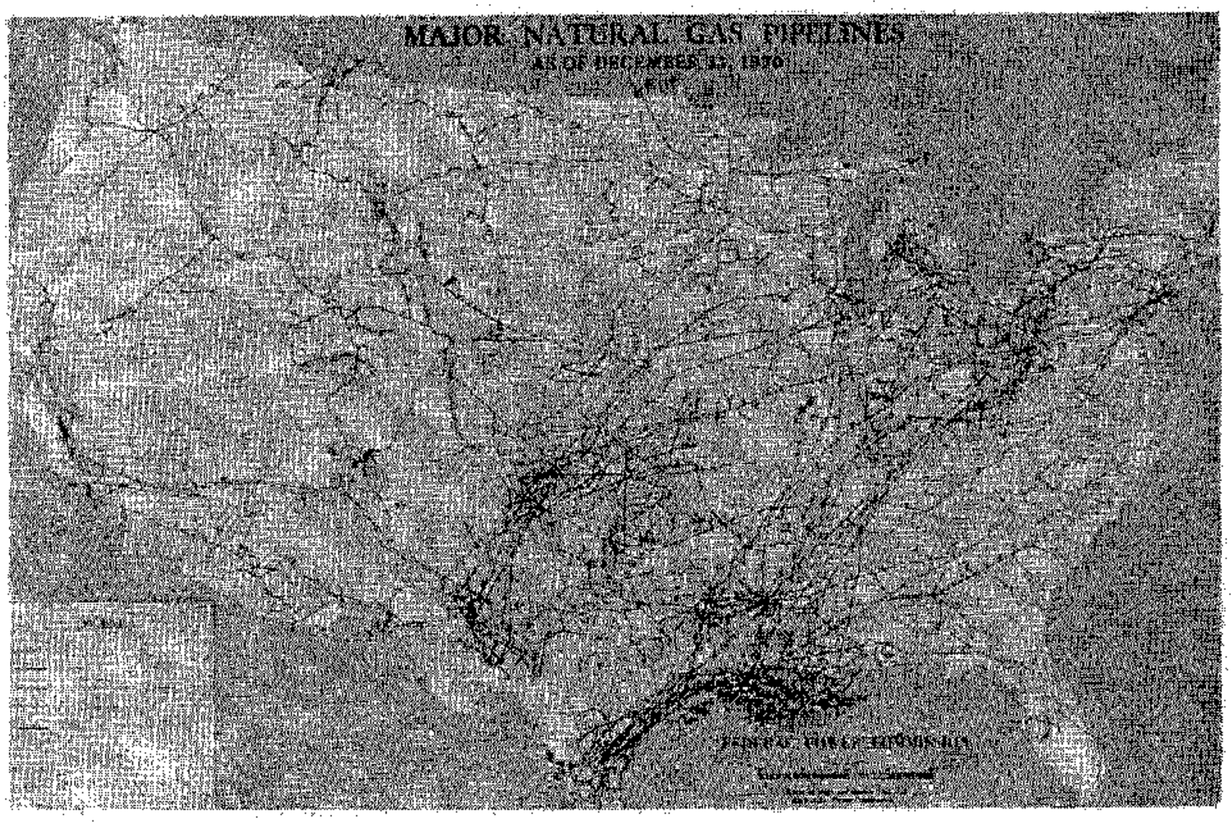

FIGURE 1.

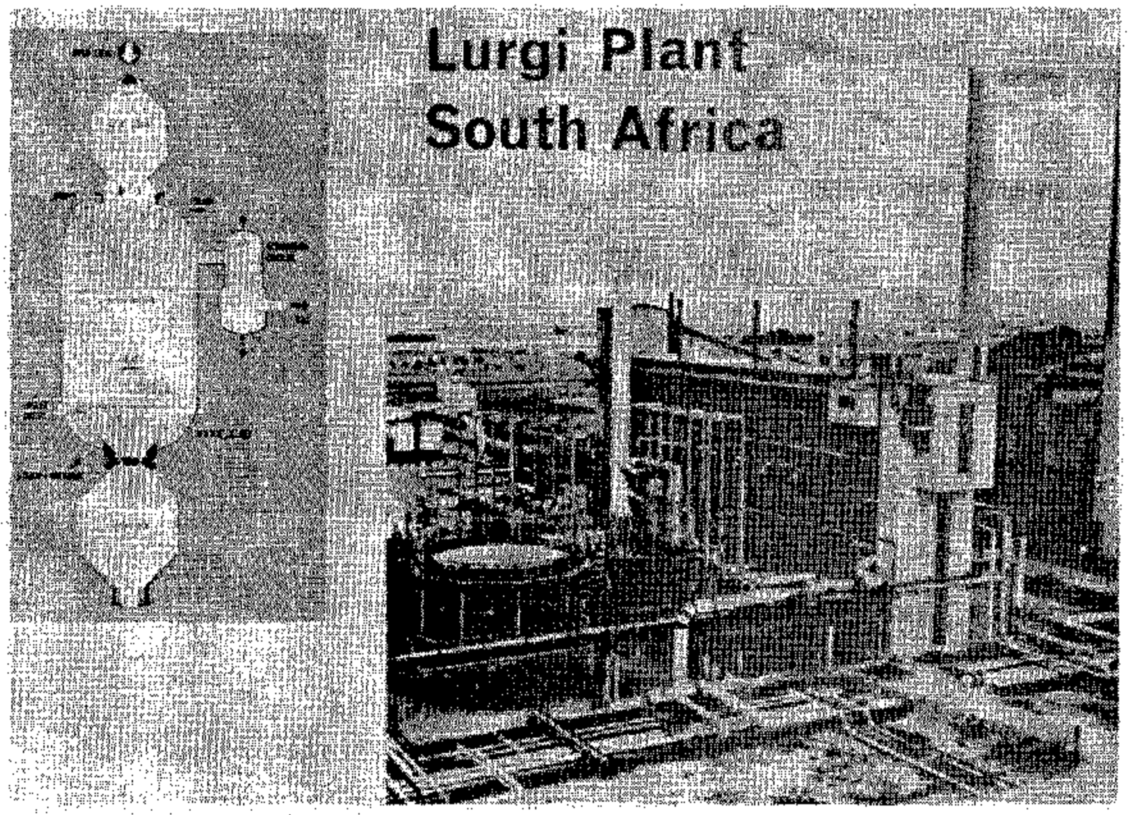

FIGURE 2.

for the German war machines. Lurgi has built 2 gasification plants, comprising 58 pressure gasifiers with a total gas output of 15 million standard cubic meters per day.

One of these, the Sasol plant, shown in Figure 2, comprises 13 gasifiers and produces 6 million cubic meters per day, of purified synthetic gas for an oil from coal plant in South Africa. This plant is the largest gas from coal producing plant in the world. I visited Sasol earlier this year and was impressed with the efficiency with which it is operated when one considers that it was built in 1955. Figure 2 depicts the coal gasification section of the plant, the left hand side of the figure is a diagram of a Lurgi gasifier.

Figure 3 shows an enlarged diagram of the gasifier. This vessel operates at approximately 375 psi. The gasification reaction occurs within the center portion of the vessel. Coal is introduced through the coal lock by means of plug valves which separate the coal lock from the gasification zone. When coal is to be introduced into the gasification zone the pressure is equalized in the coal lock and coal is permitted to fall into the distributor and down to the gasification bed. The ash grate rotates and is powered by an outside drive. Steam and oxygen are introduced into the gasifier, the quantities and pressures of each are carefully controlled. The reaction zone is enclosed by a water cooled jacket which keeps the vessel walls below the softening temperature. After the gasification reaction is complete the ash leaves the reactor in a manner similar to that in which the coal enters into the

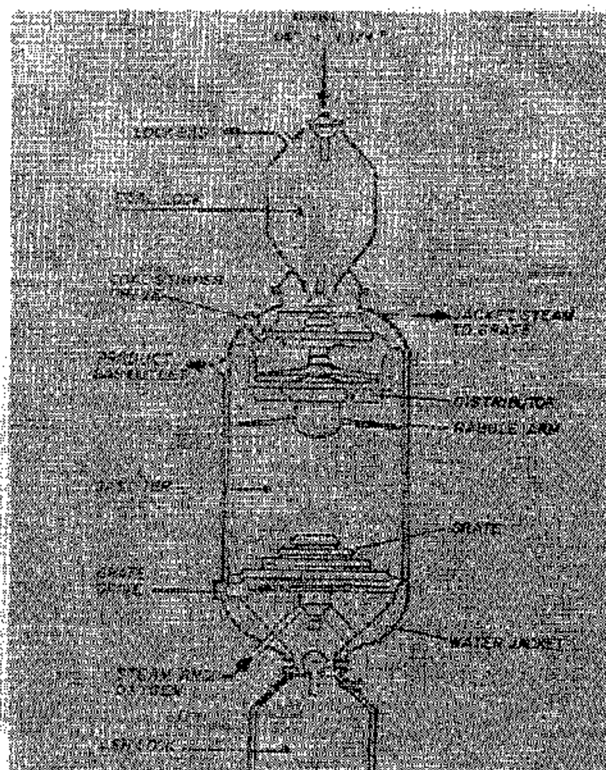

FIGURE 3.

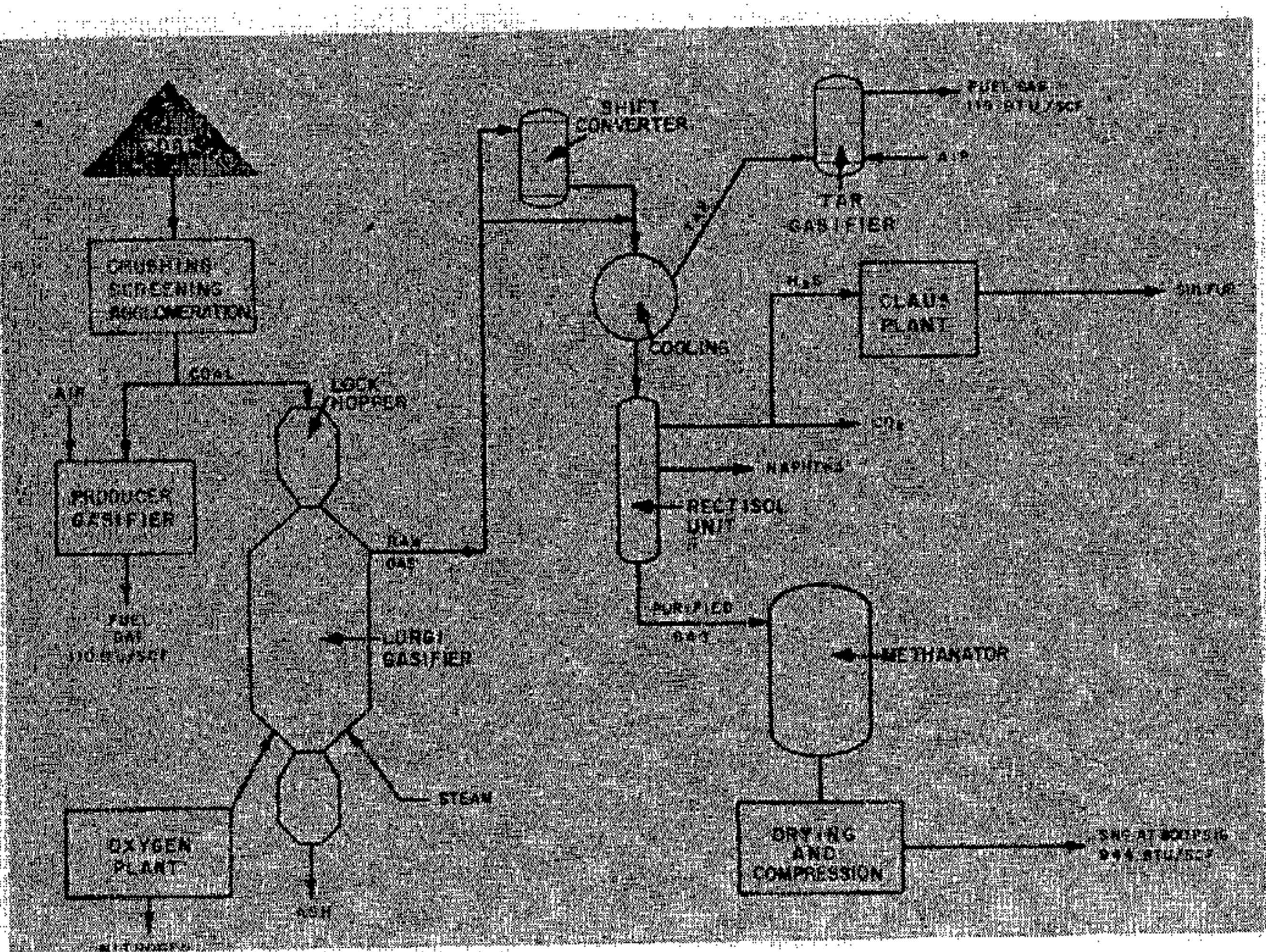

FIGURE 4.

center retort. Again, by equalizing pressure within the ash lock, opening the plug valve and permitting the ash to drop out, the coal feed and ash removal control functions are performed by hand and under close observation.

The product gas coming from the gasifier will have a BTU content of approximately 360 to 400 BTU's per cubic foot. If air is used instead of oxygen, the BTU of the product gas is considerably reduced to around 140 to 170 BTU per cubic foot. This is primarily due to nitrogen dilution. Figure 4 shows a schematic of the entire plant. The first stage gas leaves the Lurgi gasifier and passes through various tar removal and clean up vessels and finally to the methanation phase where it becomes a suitable substitute for natural gas.

For a moment let's look at the enrichment step which will provide the final ingredient for our substitute natural gas technology. Lurgi currently is operating a small 100 cubic meter per hour reactor at Sasolburg. The initial indications are encouraging, however, much work is still needed to confirm its commercial application.

In addition to Lurgi's efforts and several domestic programs, a dozen or so companies including Peabody are funding a methanation project being carried on in the British Isles. We are confident that one of these projects will be successful and the risk involved in the scale up from the project sized vessels to commercial sized vessels will be minimized. A sketch of a commercial plant is shown in Figure 5.

In most of the research projects being carried out in this country, the improvements promised are in the initial gasification step. Successful development of any of these technologies would still be dependent upon the methanation step in order to make satisfactory quality gas. I know of no process which would continually, in one step, produce a gas of pipeline quality. It, therefore, is reasonable to assume that a successful methanation step will be applicable to any initial gasification or first step technique, which might later be developed.

Therein lies one of the keys to the desirability of Lurgi. From a capital investment standpoint, the cost of the first step gasifier section of a gasification complex, would be relatively small when looking at the plant as a whole. The cost of the gas cleanup, oxygen system, and methanation portion might be as much as 75 to 80% of the total cost of the plant in comparison with the coal gasification section costing 20 to 25%.

When we remember that most of the processes under consideration today only offer promises of increased efficiency in this first or gasification section of the plant, it is unlikely that any significant capital savings would be realized. Advocates of as yet unproven new processes point to the possibility of greater operating efficiencies. Hopefully, this would be possible. Another Lurgi advantage is its relative simplicity. The Lurgi gasifier is a large, simple operating and rugged machine. While the vessel itself is large and made up of heavy internal parts, it nevertheless can be maintained by mechanics, welders, etc. and in large measure, operated by regular factory type qualified personnel. Control of the gasifier itself is complex, but with experience and a higher degree of automation, the operation of such a machine in the United States would be relatively simple. In our judgment, the Lurgi gasifier can be automated to a much greater extent than the most recent operating examples.

There is still another factor which must be considered. Lurgi gasifiers have been operating somewhere since the 1930's, sold commercially, debugged, changed, modified and constantly improved. I have been advised that the Sasolburg plant was some 7 to 8 years in modification before the operation became routine. More modern installations of Lurgi gasifiers, such as the one in Westfield, Scotland are of a much improved design than the original Sasol gasifier.

With Lurgi the debugging has been done, however, some improvements are yet to be made, but that traumatic experience of putting a new laboratory technique to commercial application and startup is behind us. In a $400 million gasification complex, new technique startup problems would be formidable.

It is likely that any new process which is developed in the next 5 to 10 years will also have to undergo a similar debugging process, which could delay the commercial usefulness of such process an additional 5 to 8 years.

If these assumptions are correct, it is becoming increasingly clear that Lurgi, by the very nature of its simple construction and the fact that it's been on the scene a long time, point up that it probably has, for this decade, the greatest potential for the coal to gas program. This is not to say that the Lurgi gasifier is without some problems. One major disadvantage is that only sized coal without the minus 1/8 inch size consist can be used. This requires that a pelletizing or agglomeration step must be provided to use all the fines normally associated with commercial coal production.

Other industry and association efforts to develop new techniques for coal gasification are needed. These diverse efforts are necessary if we are to improve the technology, however, in my judgment we have the Lurgi Coal Gasification process with us today and with the final development of methanation it can be a viable, meaningful technique to be used in the near term. By using what we already have to the fullest, the gas shortage can be eased and compliance with environmental deadlines can be approached.

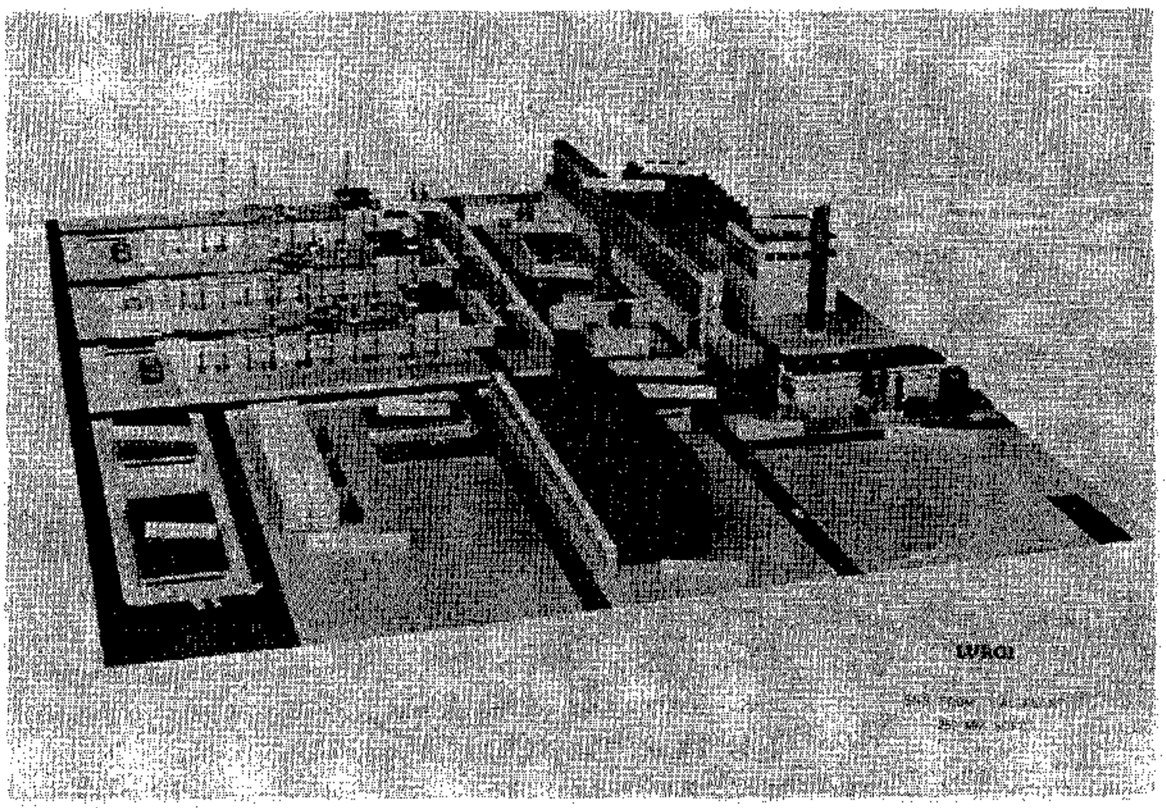

FIGURE 5.