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COAL GASIFICATION--NEW CHALLENGE FOR THE BEAUMONT ROTARY FEEDER

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ABSTRACT

Energy, its production and consumption, is a prime concern to every individual, all corporations, and the United States Government.

90% of the known fossil fuel reserves of the U.S. exist in the form of coal - much of it having a sulfur content too high for direct burning in conventional power plants without treatment of the coal or the combustion products. The utilization of this coal in an efficient and environmentally acceptable manner is important to help meet our national energy requirements.

The future use of coal may depend on our ability to successfully convert coal to clean gaseous and liquid fuels.

One important part in the coal gasification process is played by the specially designed rotary feeders which - in almost any coal gassification method - provide the regulator and airlock in the feeding of the coal or coal char at high pressure and in some applications at high temperatures. These units must be of an airlock sealed type to withstand the differential pressure.

The coal or coal char is discharged from a reactor or pressurized lock hopper through a rotary feeder into a pressurized transport line. This flow must be controllable - a very important factor in such a process. The rotary feeder, placed between these two systems, plays a very essential dual role.

All these factors constitute a serious challenge to the various materials used in the manufacturing process. A discussion of these issues should be a timely undertaking to professionals in the coal gasification field.

Energy, its production and consumption is a prime concern of every individual, all corporations and the United States Government. Shortages of energy have already influenced the behavior and growth pattern of the nation, and will continue to do so until long term solutions to the problem are achieved.

The continuous increase in the world population and the industrialization of many third world countries combined with the daily increase of energy consumption per capita in the entire world, requires that all countries make long range plans concerning their future energy needs. Research and development, conservation and finding new and more efficient forms of energy are the principle targets for all the industrialized nations in the next 10 to 15 years.

The U.S. has to be in the forefront of this battle.

As President Carter clearly stated in his energy message:

"The heart of our energy policy problem is that our demand for fuel keeps rising too quickly while our production goes down, and our primary means of solving this problem is to reduce waste and inefficiency.

In the same message President Carter paid great attention to our large reserves of coal and the necessity of converting many present user of oil and natural gas to coal.

His message was clear:

"Although coal now provides only 18% of our energy needs, it makes up 90% of our energy reserves" - and calls on all of us to increase the use of coal by 400 million tons - or 65% in industry and utilities by 1985.

As mentioned above, by current estimates - nearly 90% of the known fossil fuel reserves of the United States exist in the form of coal - much of it having a sulfur content too high for direct burning in conventional power plants without treatment of the coal or the combustion products. The utilization of this coal in an efficient and enviromentally acceptable manner is important to help meet our national energy requirements.

The conversion of coal to clean gaseous and liquid fuels will produce the big break-through in solving the energy shortage.

As you well know there are many different methods of conversion and the product of conversion can be oil or gas defined as low, medium or high BTU type.

Today's enviromental regulations say either remove SO2 from combustion gases or remove the sulfur before burning.

One answer: Gasify the coal - then desulfurize the gas.

Presently, different processes to convert coal into gas are beginning to emerge and the research to find more sophisticated one is very extensive.

To find the most economical method to gasify coal is presently one of the most important projects of many major engineering and research companies throughout the United States. The present crisis situation and the outlook for the future show how important the finding of the right solution is, and to find it in record time before all our present resources of energy are gone.

Coal and coal char present some different problems to the engineer in the material handling field.

The equipment must be designed to handle large volumes of coal and to be resistant to its corrosive nature, especially when moisture is present.

Strip mined coal also has impurities such as rock; sand which must also be taken into account.

We are talking about a sizeable capital investment for coal handling equipment even before the gasification stage.

In the future, we feel that the development plants will prove to be much more economical than the development of small coal handling units for each individual user.

Presently, each utility company, hospital, school, etc. has it's own coal handling equipment The future will prove that it will be more economical for these users to obtain the coal in a gasified form than trying either to burn coal or gasify it themselves.

Based on the above, I feel that we are ready to make these large investments to handle vast amounts of coal in some strategically located coal gasification plants.

One important part of the coal gasification process is played by the specially designed rotary feeders. The rotary feeders provide the regulator in the feeding of the coal or char at high pressure and in some applications at high temperatures.

Our Company - Beaumont Birch Co. - considers itself fortunate to have had the opportunity to furnish the rotary feeders for a number of pilot plant and laboratory research units - in the past 5 to 10 years.

We intend to continue furnishing the specialized rotary feeders for any future pilot plants and also transplanting our experience in the rotary feeders field to build larger units for demonstration plants and hopefully in the near future commercial plants.

The Beaumont Birch - special designed rotary feeders were and are used in the following locations and processes:

CO_2 Acceptor Process

A number of 4" size special rotary feeders designed to operate in a high pressure system are used at the demonstration plant in Rapid City, S.D. - developed by Consolidation Coal Co. and built by Stearns-Roger Co.

The rotary feeders handle coal and dolomite, and some units were designed to handle high temperature char.

Cogas Process & Project Coed

Beaumont Birch Co. supplied the necessary rotary feeders for both processes.

The Cogas Process being based on the Coed experience, we developed the first rotary feeder used in the Coed Project.

Westinghouse - OCR Project at Waltz Mills, Pa.

Eleven high pressure rotary feeders especially designed to handle coal, char and dolomite at specified rates, temperatures and pressures are used at the Waltz Mills location.

At Hydrocarbon Research Co. in Trenton, NJ a team of researchers were using 2 - 4" size Beaumont Birch Co. rotary feeders in a pilot plant operation designed on the basis of the Bureau of Mines "Synthane" process for coal gasification under pressure. The two rotary feeders were working alternately. They were used under a pressurized lock hopper at 450 PSI, and were feeding the coal into a super heated st am transport line which discharged the coal into a reactor. The super heated steam transport line was also under 450 PSI pressure, with maximum differential pressure between the two systems of 25 PSI.

These processes and users are the better known but the list does not end here. A number of companies are using our rotary feeders in small coal gasification plants such as a Texas Cement Co.

Or they are doing different studies related to the coal gasification field as:

Argonne National Laboratory in Argonne, Ill., Exxon Co. USA in their research laboratory in Baton Rouge, La. -- C. E. Lummus Co. At Bloomfield, NJ etc.

Presently we are working on some special - 2" size units to be used by Rockwell International - Atomics International Div in their coal gasification pilot plant to operate at Santa Susana Laboratory.

These feeders are designed to operate in a 300 PSI pressure system - between a pressurized lock hopper and gasifier maintaining a minimum amount of leakage across the rotary feeders.

As a sister operation, our feeders are used successfully by FMC Corp. - Industrial Chemical Div in their Kemmerer, Wy. plant in their process to obtain coke.

We consider the process similar, because the feeders have to handle coke dust, or coal. Actually the first unit used by FMC Corp. at Kemmerer, was transferred from FMC's Coed Plant in Princeton, NJ. FMC stresses that it's process at Kemmerer, gives a high quality coke from any single type of coal from anthracite to lignite.

All the jobs have in common the following factors:

1) All handle: coal, limestone, dolomite, char - products almost equally abrasive and in some cases corrosive.

2) They require a very accurate regulation of product fed in order to obtain an optimal reaction.

We are dealing with a product with many built in variables as: bulk density, variable size (from ½" down to mesh sizes).

The feeders are able to react to changes in bulk density and size of product by changing the speed at which they are working.

All rotary feeders are sized based on volume. The displacement figure of every size of rotary feeder is very accurate and in most cases when handling mesh size products the efficiency of the units can be considered 100%.

Even when handling larger size products, by making a few test runs, the efficiency factor of the unit can be established to an exact number.

3) They require a "perfecc seal" or almost perfect seal. Based on our experience in the rotary feeders field, we can estimate rather accurately the amount of leakage which can be expected across the rotary feeder (airlock).

Every unit is tested in our manufacturing facilities for leakage under a differential pressure of 10 PSI or higher if requested.

The amount of leakage varies from less than 1 CFM for a 2" size unit to 3 CFM for a 12" size, plus the volume of the empty returning pockets.

4) - They are custom designed to various pressure systems as required by the process.

5) - They are custom designed to the various temperatures as required in process.

6) - They are sized to the capacity requirements of the process - using in every application the optimal size for the process.

We combined all the design factors for every job, and it resulted in a wide variety of rotary feeders designed - variety reflected in size, material of construction, type of drive, machining details, choice of auxiliary materials as: packing, adjustable blades, etc.

The most common size used until now is the 4", because the capacity requirements were rather small in the pilot plant operations.

In some applications even the 4" size was to large and we had to use only a 2" size unit.

An exception to the above is the 10" size unit furnished to a Texas Cement Co. where they are gasifying coal for their internal use.

As we hopefully step into the next stage of coal gasification - demonstration and commercial units, the size of rotary feeders (airlocks) should grow also.

Based on the experience of some pilot plants, there is a limit to the size of the rotary feeders to be used.

Being a rotating type of equipment with many parts required to be maintained in good condition for constant good performance, the manageable size should be of concern in the future feeder design.

We feel that the 12" size rotary feeder is large enough (capacity 150 cu. ft./hr. for each RPM - 3,000 cu. ft./hr. @ 20 RPM - max. recommended) - but still manageable for this type of application.

The practical experience chooses the use of multiple 12" size units in place of one or two very large units.

Also, the multiple unit approach can alleviate the complete shut-down situation In a multiple unit system the chances of a complete breakdown is rather remote.

The pilot plant units were constructed of:

A - Cast Steel - Type WCA, WCB, WCC with 0.40 - 0.50 carbon, with body hardened to 450 brinell for improving the wear resistance at:

1) CO_2 Acceptor Process - To Handle spent dolomite at 300° F design temperature, 335 PSIG pressure system.

2) Project Coed - To handle pulverized coal at 215° F design temperature 100 PSIG pressure system.

4) Low BTU Gas - Pilot Plant Project at Waltz Mills, Pa. (Westinghouse Co.) to handle coal, char, dolomite at temperatures ambient to 200° F, 300 PSIG system.

5) Atomics International - Santa Susana - To handle coal at ambient temperature 300 PSIG system.

6) C. E. Lummus Co. - Bloomfield, NJ - To handle coal at temperatures ranging from 75 to 100° F, operating pressure 180 PSIG. The unit was designed for a max. pressure system of 300 PSIG.

7) FMC Kemmerer, Wy. - To handle coke at 100 and 350° F and 100 PSIG pressure system.

B - Series 300 Stainless Steel at:

1) Coed Process - To handle char at 600° F.

2) CO_2 Acceptor Process - To handle fresh dolomite and fresh lignite at 600 and 700° F - 320 PSIG pressure system.

3) California Research Co. - To handle char at 1600° F.

4) Argonne National Laboratory, Argonne, Ill. - To handle crushed coal, limestone, different types of coal (Pittsburgh, Illinois and San Juan), lignite (South Dakota type)

At ambient temperature in a 135 PSIG system with zero or very small differential pressure across the feeder.

5) Exxon Res. & Dev. Co. - Research Laboratory, Baton Rouge, La. - To handle char at 1200° F.

At Linden, NJ - To handle coal at 300° F.

6) Low BTU Gas - Pilot plant project - To handle fly ash, dolomite, spent dolomite, ash, gas fines, and char at 600° F, 300 PSIG pressure system.

7) FMC Kemmerer, Wy. - Coke Processing Plant - To handle coke at 400° F.

On the above jobs - for temperatures 600° F and above a type 309 or 310 stainless steel was used which combined successfully the wear and heat resistance.

Below 600° F, type 304 stainless steel was used.

Without ever materializing as a job, we were actively involved in the design of <u>very</u> special rotary feeders to be used in the <u>bi-gas process</u> - feeders for handling both coal and char.

The extreme conditions - 1200 PSIG system and 600° F for coal and 1200 PSIG system and 1600° F for char presented some very difficult problems concerning the choosing of the right material of construction, example HH, HK type stainless steel.

Even for the pilot plant operation the size of the rotary feeders was rather large.

The body and the end plates had to be designed with extremely thick walls; large and very thick flanges. The large size of these castings can cause machining and handling problems. The approximate weight of the pilot plant unit designed to handle char at 1600° F, 1200 PSIG system is 11,000 lbs. For a good performance at these conditions we also had to design a very sophisticated type seal.

In order to design a commercial size rotary valve for the bi-gas and synthane processes - we recommend the design, manufacturing and testing of a pilot plant size rotary valve. Only after building and testing such a special rotary valve, will we be able to learn about the problems and try to improve the critical wear points of the unit.

When we speak of rotary feeders constructed of, we mean that the major cast parts: body, rotor and end plates are cast from the respective material.

1) All the materials entering in the construction of the rotary feeder as shaft, bearing, adjustable blades and packing seals should be chosen to be the optimal type for the design conditions.

In all the fields - metals, plastics, packing etc. day by day new developments occur in producing a better, more wearable type of product.

There are some wear points concerning the type of materials used or specific design but the new impulse given to R & D in the coal gasification should eliminate all these points and generate an optimal unit for the application.

In many applications the rotary feeders provide the regulator in the feeding of the coal or coal char at high pressure and in some applications high temperatures.

2) The rotary feeder is placed between a pressurized lock hopper and a pressurized transport line. The rotary feeder not only provides a seal between these two systems, it also regulates the flow of coal or coal char from one system to another.

In most cases the rotary feeder is driven by a variable speed drive which changes the capacity of the rotary feeder by changing the output speed of the variable speed drive.

The development of SCR drives - using DC motors opens the road for even a wider regulation of speed, capacity and volume.

In many pilot plant applications the pressure in the lock hopper and the transport line may vary as required by the specific process - from 150, 250, 375 to 450 PSI, having a maximum differential pressure between the two systems of 25 PSI.

Also the temperature especially for coal char handling, may be very high 600, 700, 900, 1200 or in some cases even 1600° F.

As mentioned previously for pilot plant operations, in most cases the rotary feeders are made of type SAE 1045 cast steel having the body hardened to 450 Brinell for a better wear resistance.

The connecting flanges, inlet and outlet are designed for the pressure rating of the specific system.

To achieve the airlock properties of the rotor, the major part of the rotary feeder, is equipped with two sets of adjustable tips and the feeder is also provided with two different types of seals - periphery and shaft seals.

When the operating temperature is higher than 600 - 700° F, we recommend the use of different type of stainless steel - type 309 or 310

If the pressure and temperature requirements combined require an even higher quality type of material, we recommend the use of stainless steels with high allowable stress at elevated temperatures.

Example - Cast HK (25 CR:20 Ni) This alloy has become highly popular for steam reforming and ethylene pyrolysis plants - for good reason - it not only provides high tensile strength and excellent resistance to hot gas corrosion in the crucial 1500 - 2000° F range, but offers outstanding rupture and creep properties. At 1600° F, for example, HK's 10,000 hour rupture strength is approximately 4000 PSI as compared with about 2500 PSI for it's closest wrought equipment.

Similar to HK, all heat resistant alloys - HH HT & HX would be used extensively in making the rotary feeders used at high temperatures and high pressures

For long term service, materials should be ductile, easily cast and welded if necessary, small grained, able to retain an erosion resistant smooth surface, resistant to high temperature and high pressure;

H_2S (Hydrogen Sulfide) H_2 Attack: and immune to stress corrosion cracking. A good candidate for use could be as mentioned chrome-moly alloys with and without protective coatings.

Coal, especially that found in the Eastern part of the United States contains substantial sulfur. Knowing that the need for coal is much bigger in the East than in the other parts of the Country, we have to be prepared to deal with the excessive sulfur. During processing, much of this is converted to hydrogen sulfide which becomes increasingly corrosive to carbon steel at temperatures greater than 450 - 550° F. We can draw upon the experience of petroleum refineries, which have collected extensive data on hydrogen sulfide corrosion at temperatures from ambient to about 1000° F and at operating pressures to 3,500 PSI.

The combination of H_2S and H_2 is particularly troublesome, since the 5 CR - ½ MO and 9 CR - 1 MO steels, commonly used to resist sulfur corrosion at moderately high temperature show little improvement over carbon steel as their resistance to H_2S/H_2 atmospheres. A chromium content of at least 12% is required. The series 300 of austenitic stainless steels (min. 18 CR - 8 Ni) have excellent resistance and are normally specified for the H_2S/H_2 enviroment.

At temperatures between 800 and 1550^{o} F the austenitic stainless steels tend to sensitize and precipitate carbides along grain boundaries. Based on that experience at high temperature it is necessary to add stabilizing elements such as columbium, tantalum or titanium to tie up the carbon.

Another route to go to improve the life of the major components could be hard chrome plating, coating with wear - abrasion - corrosion resistant type agent, etc.

Although the way to obtain high BTU gas is by using high pressures, high temperatues, from a maintenance and cost point of view it is recommended to use the rotary airlock feeders at lower temperatures and less harsh conditions.

Tungsten carbide could be the answer for a critically wearing surface, however, even tungsten carbide can be destroyed within 500 hours of operation. With good maintenance and high quality workmanship a 2000 - 3000 hours service can be reached.

Because of the critical nature of rotary feeders - airlock - valves performance in coal gasification plants, a program to develop improved units - especially concerning material of construction should be the major item in the next R & D program.

As we know, there are many methods in use to gasify coal with some methods the operating conditions are not excessive.

In Coed pyrolysis, coal is heated in fluidized bed reactors. In successive stages over a temperature range of 600 to 1100^{o} F at a pressure of 10 PSIG. Char gasification takes plate at temperatures up to 1800^{o} F. No serious material problems were experienced at the Coed Pilot Plant during the course of it's operation in 1970-74 at Princeton, N.J.

The greatest challenges to the Materials Engineer exist in the construction of the critical parts of a coal gasification plant as: high temperature reactor, hot gas quench systems etc. In the coal handling equipment, the major problem appears to be erosion caused by highly abrasive coal particles. This is compounded by the fact that the coal oil slurry must be fed continuously or semi-continuously into the high pressure, high temperature reactor assembly in direct linkage with the rotary feeder.

Wear of the rotary - airlocks - valve system must be minimized to prevent loss of pressure and temperature. Even in the limited number of hours operation in the pilot plants more conventional wear resistant stainless and alloy steel did not prove to be completely adequate.

The finding of the ideal material of construction should be the major challenge especially when the pilot plant will be transformed in demonstration and commercial size plants.

In coal char handling there is also a corrosion factor present. Alloys such as incoloy alloy 625, hastelloy alloy "C" which displayed high resistance to hot corrosion and stress at high temperature could find a considerable use in the manufacturing of major components in contact with coal char.

The good performance of the rotary feeders consists of three major features:

1. Choosing the right material of construction.
2. Using the right combination of materials for the adjustable tips to achieve a continuous tight seal (almost rubbing type contact) between the body and the rotor with the edges equipped with the blades.
3. Using the right periphery seal. Seal provided between the body bore; rotor shoulder at both ends, consisting of packing rings or manufactured rings and following rings. In the case of using packing for periphery seals the follower ring is adjustable without taking the feeder apart.

The shaft seal-standard on most rotary feeder designs has only a secondary role in the Beaumont feeder design. The shaft seal has to perform well only if the periphery seal fails.

The ideal seal - minimum leakage it can be obtained only when a pair of adjustable tips are used - a base blade - flexible type manufactured of nylon, adiprene, teflon, ryton, vespel, etc. and a supporting blade facer tip made of hardened steel, tool steel, stainless steel etc. If the flexible type of blade can not be used due to temperature limitations, a rubbing contact never can be achieved due to the metal to metal contact.

We are very optimistic that the temperature limitations in using plastic based products is raised higher as days go by, and by the time that a feeder for a commercial coal gasification plant will be built we will have the necessary type of material for blades to use up to 1200 - 1500° F. Already Du Pont's Vespel product raised the temperature limitation to 800° F, although the cost of vespel presently is too excessive for use as adjustable blades.

Also concerning the periphery seals, we hope that with our R & D program, we will be able to develop a longer lasting type seal- minimizing the cost of maintenance and replacement.

It is very important that the rotary feeder be used in the conditions to which it was designed for. If the design temperature is much higher than the operating temperature, we will face an excessive amount of leakage. Machining clearances are calculated to the design temperature figures. The sealing material used as packing may become flexible only at certain temperature. If the feeder will never reach that temperature the packing may remain rigid not being able to provide an adequate seal.

The Beaumont type airlock rotary feeders have some specific design characteristics:

The inlet of the body will be fitted with a V-shear plate.

This device, an integral part of the body reduces shock or the horsepower requirements. It also reduces by approximately 90% the amount of material sheared in passing through the feeder. A specially designed outlet (part of the body) permits the continuous discharge of material from the feeder.

The feeder rotor is welded to an oversize steel, stainless steel or special alloy shaft, and both the rotor and shaft are machined while turning on centers. This construction and method of machining assure the rotor of always being concentric on the rotor shaft. It also prevents the rotor from ever working loose on the rotor shaft. With this design, the seals (periphery) and adjustable rotor blade tips are the only parts of the rotor coming in contact with the feeder body.

As mentioned previously, the periphery seals are adjusted through plugged holes in each feeder end plate with a torque wrench supplied with the feeder. The torque wrench is to obtain the maximum seal with the minimum drag on the motor.

With a good preventive maintenance program related to the adjustment and replacement of seals and blades a maximum service and good performance could be obtained from the feeder.

Each end plate is equipped with pipe connections used to inert gas or air between the end plates and the end of the rotor to balance the pressure within the feeder, or to scavenge out the space with air steam, etc.

By using these purge connections, we are able to keep the abrasive - corrosive fine powdered material out of the seal area. The life of the seal is drastically shortened if the product handled would leak into the seal area acting as a wearing agent. The parts which are in contact - body, rotor, seal have an acceptable lifetime and will wear out only if an outside wearing agent as fine coal would act as a friction agent.

The cover plate over the service door on the returning side of the feeder is also fitted with two pipe plugs - these plugs can be removed and pipelines connected for relieving the pressure or purging out the returning empty rotor pockets.

We have followed very closely the performance of the rotary feeders used in different existing pilot plant operations, and below we wish to summarize some of the conclusions learned:

The wear and the maintenance requirements of every rotary feeder is in direct relation to the working conditions as:

The wear was progressive with the size of the unit.

Temperature of the material handled - the unit should be used at the designed temperature assuring this way the ideal clearance between the different rotating parts. Also knowing the correct operating temperature will enable us to use the right type of material for cast parts, adjustable tips, and packing.

In one pilot plant project material as "Ryton" used for adjustable tips proved to provide the best wear resistance. On one job after 6 weeks use the tips did not show any wear.

It is very important that before starting to use any rotary feeder a very concentrated maintenance study should be made in order to know as well as possible both the ways of adjusting the units and also the replacing of different parts.

We strongly recommend that the person who would be in charge of the maintenance of these units should visit our shop and actually witness the assembly process testing and adjustment.

The periphery seals can be maintained for a very long time in good working conditions by purging the space between the end plates and the rotor with gas air - at a 1 - 2 PSI higher pressure than the inlet (equal on both end plates).

The shaft seals taking a secondary role to the periphery seals do not represent any maintenance problem.

It is an established practice (in order to cut maintenance cost) that each time the tips are replaced the packings are replaced also.

Consulting a few users of our units in different pilot plant projects the following running time without maintenance was found.

CO_2 Acceptor Process

100 hours continuous running time was obtained with the complete plant operating.

Cogas - Coed

The unit used for coal handling required adjustment about every 2 - 3 weeks.

The coal char handling unit did not require any adjustment for a period of 2 - 3 months.

Coke Handling

The units are running almost 4 - 5 months without any adjustment.

The conclusion which we could draw from these experimental units can be summarized as: If our recommendations concerning operation and maintenance are closely followed and after a short learning period in every new job the rotary feeders can be operated continuously with good performance for approximately 90 days.

As the units grow in size the wear of the major cast components as the body can be reduced by sleeving it with a much higher quality material as chrome plated sleeve inconel, etc. The cost of a sleeve represents only a fraction of the new body cost.

We are sure that many specialists involved in the coal gasification jobs, consider the rotary feeder a troublesome type of equipment. It has been found in some cases that the blade tips wear rapidly with the result that coal or coal char flushes through without satisfactory flow control. In addition in some cases the seals failed due to abrasion from coal particles.

Due to the fact that the rotary valves are a critical component of a lock hopper system being a controlled rate feed device our job is to improve both the grade of materials used and also to minimize or completely eliminate the weak points.

We feel confident that with Beaumont Birch Co's long history in manufacturing rotary feeders and other types of equipment for material handling systems, especially coal, we will succeed.

Our rotary feeders played a major role in obtaining good performance in different coal gasification projects, and we hope to continue to do so when we face the next step - commerical size plant.

In the commercial size plants we would like to make the following comments and recommendations concerning size and type:

CO_2 Acceptor Process

In handling either lignite, western sub-bituminous coal or dolomite, our 12" size S.T.T. Mark II periphery sealed type feeder would be able to give a good performance. This statement based on the facts learned from using our 4" size similar rotary feeders at the pilot plant working based on this process - at Rapid City, S.D.

We feel that the 12" size is large enough - but still manageable for this type of application.

We would recommend certain improvements to improve wear resistance and reduce leakage, in order to have a better flow control.

Bi-Gas Process & Synthane Process

In order to be able to recommend the use of a rotary feeder in this application - a test unit is required to be manufactured and experience gained for a scale up unit.

The test unit should be tried with both char and coal.

We c[illegible]t conclude our notes about the rotary feeders without men[illegible]oning the important part the complex drive systems play in both existing pilot respectively laboratory units and for the future use in demonstration and commer[illegible]al units.

The drives have to be able to translate the variation in weight to variation in speeds, with a rather high percentage of accuracy.

We are dealing with a product with to many variables and a 100% designed system has to have ways to deal with it. The variation in size and bulk density require that the rotary feeder adjust itself instantly. A fast change in speed of the feeder would deliver the right amount of coal or coal char into the reactor.

There are no limits concerning the sophisticated control systems which can be used in the coal gasification field.

In some aspects coal gasification represents a challenge to solve all the problems which we may be facing today.

But with a joint effort and especially economic backing the existing problems can be solved. Today's technology - concerning especially materials, presently is at such a level that there are no unsolvable problems.

The usual cliche - we could put a man on the moon why can't we in this particular case - successfully and economically gasify or liquefy coal - the answer is we can. We hope that the next few years will be the years when coal gasification plants will be a common site be that a power plant, industrial user or any other facility which would either replace the scarce oil or natural gas.

We hope that the discussions at this conference already may give some solutions to the problems which today may delay the construction of the commercial size coal gasification plants.

We are ready for the challenge and so I think is the entire industry.