

- [54] **METHOD FOR FEEDING DRY COAL TO SUPERATMOSPHERIC PRESSURE**
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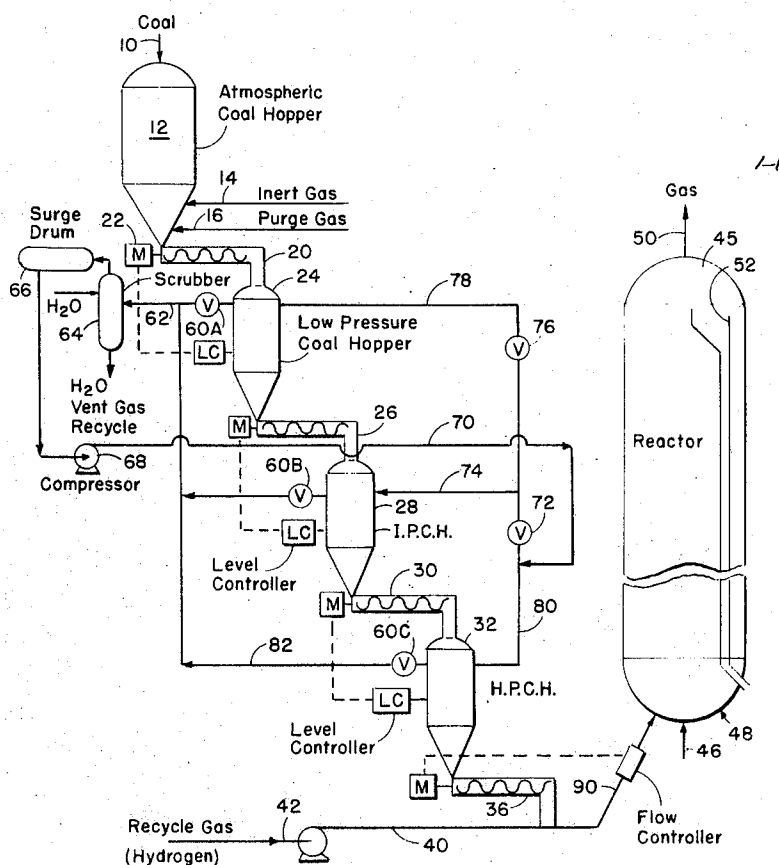
References Cited			
UNITED STATES PATENTS			
2,831,587	4/1958	Rearick	214/17 B
3,519,555	7/1970	Keith et al.	208/10
3,226,204	12/1965	Stotler et al.	48/202 X
3,175,890	3/1965	Textor	48/203 X

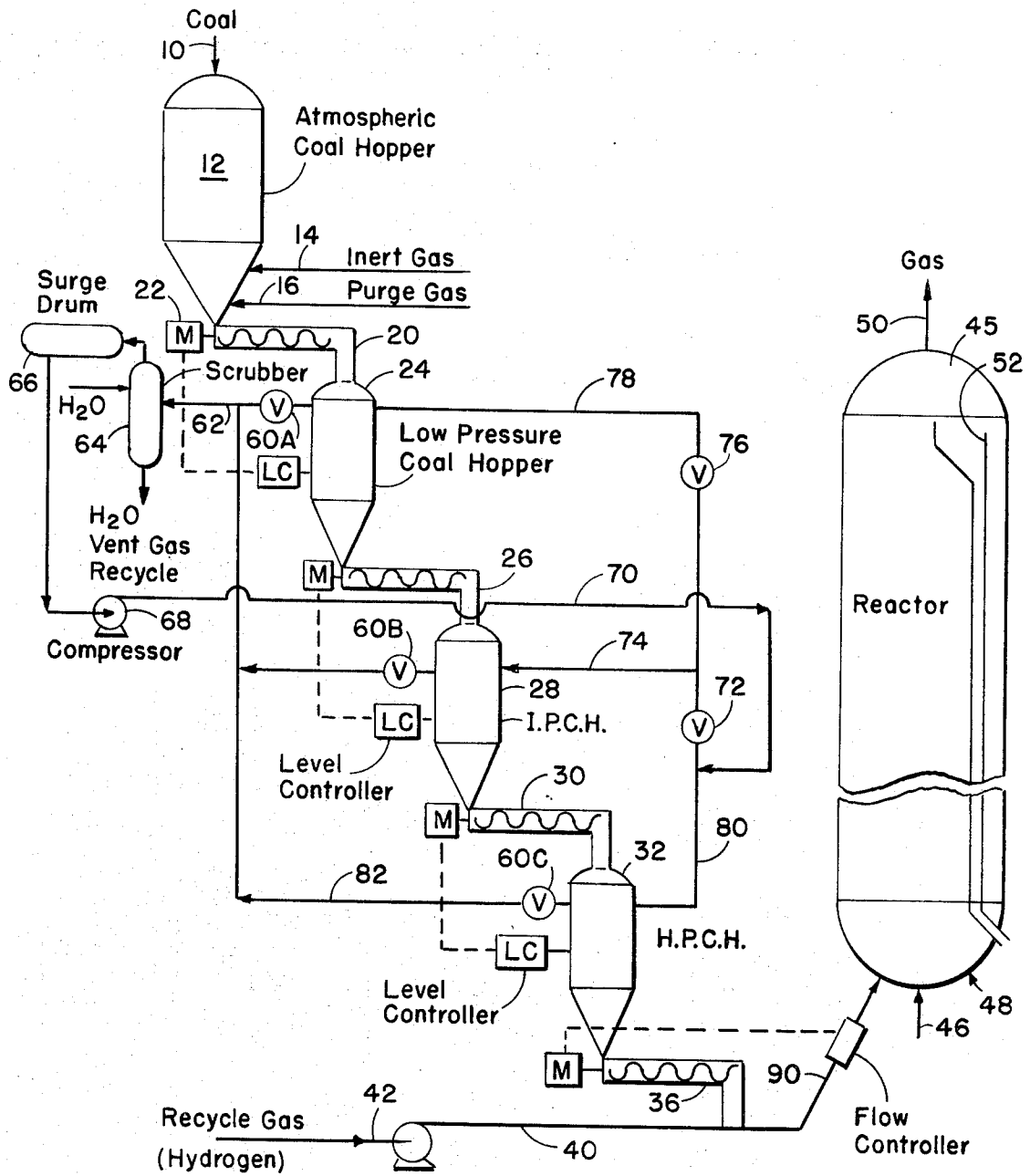
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[57] **ABSTRACT**

A method for continuous feeding of dry coal particles from essentially atmospheric pressure to the superatmospheric pressure level of a coal gasifier or coal liquefaction reactor is achieved by a series of screw feeding devices each partially boosting the pressure level of the coal in stages to provide the dry coal at reactor pressure.

2 Claims, 1 Drawing Figure





METHOD FOR FEEDING DRY COAL TO SUPERATMOSPHERIC PRESSURE

BACKGROUND OF THE INVENTION

In the gasification of coal to produce synthesis gas for the manufacture of hydrogen or ammonia and to produce pipeline gas, the coal is gasified at pressures ranging from 400 to 1200 psig. In the hydrogenation of coal to produce liquid hydrocarbons the coal is liquefied at pressures ranging from 500 to 3000 psig. The coal, usually as pulverized particles, can be charged to these superatmospheric pressure systems as dry particles by the conventional lock hopper system. Here the coal is fed to a lock hopper at essentially atmospheric pressure. The lock hopper is then pressurized with a high pressure gas stream from the coal conversion system. The coal which is now under a pressure higher than the gasifier or hydrogenation system pressure is then transferred through piping to the coal conversion system. The lock hopper now empty of coal but filled with pressurized gas is then depressured to essentially atmospheric pressure and the coal charging cycle is repeated.

This method for feeding the dry coal has the disadvantage of a high loss of pressured gas during the depressuring part of the charging cycle and large lock hopper volumes are required for commercial coal gasification and liquefaction plants due to intermittent feeding from the lock hoppers.

Another method for feeding pulverized coal to a pressurized system is by mixing the pulverized coal with a liquid such as water or oil to produce a slurry which can then be pumped into the superatmospheric pressure system. This method has the disadvantage of low throughput for a given slurry pump and an expensive slurry pump design to provide a pump in which erosion is minimized. It also suffers the disadvantage that the liquid used to prepare the slurry must be recovered, usually by vaporization and recondensation, in the system so that it can be recycled back to be used to charge additional coal to the system.

In this invention a method is provided for feeding dry pulverized coal continuously to a system operating at superatmospheric pressure whereby the lock hopper volume, and the loss of pressurized gas are minimized and since the coal is fed dry no recovery of slurring liquid is required.

SUMMARY OF THE INVENTION

Dry pulverized coal is fed continuously to a coal gasifier or coal hydrogenator operating at superatmospheric pressure by the use of a series of screw pumps each operating against a differential pressure and with intermediate pressure surge hoppers whose pressures are maintained essentially constant with a small gas bleed stream.

DESCRIPTION OF THE DRAWING

The drawing is a schematic flow diagram of equipment for feeding coal to a coal conversion reactor.

DESCRIPTION OF PREFERRED EMBODIMENT

A coal such as bituminous, semibituminous, subbituminous or lignite or a similar material such as shale, is initially elevated to the inlet 10 of the atmospheric coal hopper 12 as by elevator, not shown. Preferably, such

coal has previously been surface dried and ground to a desired mesh as hereinafter described.

The coal fines discharging into the atmospheric coal hopper 12 may be purged of air if desired with inert gas at 14 and with purge gas from the coal liquefaction system at 16.

The coal then enters the screw feeder 20 which is appropriately driven by motor 22 and by which the coal can be boosted to 215 psig and discharged into the low pressure coal hopper 24. Ultimately, the coal then discharges into the next suitable screw feeder 26, thereby increasing the pressure to 430 psig.

In turn, the coal discharges into the intermediate pressure coal hopper (IPCH) 28 and in due course drops into the third screw feeder 30. Thereby the pressure on the coal is thus raised to the pressure in the high pressure hopper (HPCH) 32 of approximately 645 psig. From this high pressure coal hopper 32, the coal then discharges into the screw feeder 36 again to be boosted in pressure and discharging into the transfer line 40 at approximately 750-850 psig.

The transfer line 40 is fed with recycle gas from the coal liquefaction system at 42 which transports the coal in a dense phase condition into the coal reactor 45.

As described in U.S. Patents Nos., RE.25,770 and 3,519,555, which relate to coal liquefaction, the environment within the reactor 45 is liquid phase as a result of the feed of hydrogen at 46 at such temperature and pressure as will convert the coal to liquid condition. Some supplemental liquid may be introduced at 48 if desired. The reactor 45 can contain an ebullated bed of catalyst to promote the rate of conversion.

The conditions in reactor 45 being such as to continuously convert the solid coal to liquid and gas, the gas is removed at 50 and the liquid and unconverted coal are removed through the down pipe 52.

The type of screw feeder shown in the drawing at 20, 26, 30 and 36 is a high speed screw pump which can pump the solids against a pressure differential in the order of 215 pounds per square inch. Hence, if the reaction chamber is at 750 psig, four stages are adequate whereas if a higher pressure is desirable, additional screw pumps can be used. Such pumps are commercially available from Fuller Co. (Fuller-Kenyon pump) and from Robbins & Meyers (Moyno pump).

A particular advantage of the screw pump is that there is a continuous uniform increase in pressure with no substantial gas loss or solids backflow. The operation is continuous which is particularly beneficial in the hydrogenation of coal or the gasification of coal.

To maintain appropriate pressures in the respective coal hoppers, we have shown a gas circulating system wherein the gas from coal hoppers 24, 28 and 32 pass through back pressure control valves 60 A, 60 B and 60 C respectively and into line 62 to scrubber 64 where it is appropriately scrubbed with water. The gas then enters surge drum 66 from which it can be recompressed by compressor 68 into the line 70.

Under control of valve 72, appropriately pressurized gas will pass through line 74 into the intermediate pressure coal hopper 28 and under control of the valve 76 and line 78 into the low pressure coal hopper 24. By line 80, it will pass into the high pressure coal hopper 32. The solids levels in coal hoppers 24, 28 and 32 are controlled by the speed of the screw feeding device. The speed of screw feeder 36 is controlled by the flow

of gas and solids to reactor 45 in line 90 as by a flow controller.

As a result of such operation, there is a minimum loss of recycle gas which may, of course, be recovered by suitable means from the gas overhead line 50.

A comparison of the dry feed with a slurry feed for a 100,000 BPSD refinery indicates a saving of capital investment of nearly 70% (\$7.2 MM vs. \$2.3 MM).

The operation cost for charging the coal shows an annual savings of nearly 70 percent (\$2.8 MM vs. \$0.9 MM) which, based on gasoline cost, would show a saving of about 0.14 cents/gallon gasoline.

Preferred operating conditions in the coal liquefaction reactor would be in a pressure range of 500 to 3000 psi hydrogen partial pressure, a temperature range in the order of 750°-900°F, a typical hydrogenation catalyst such as cobalt molybdate on alumina, the coal being predried to a moisture content not to exceed five weight percent, and with a coal size of less than one-fourth inch.

Preferred operating conditions for a coal gasifier, such as disclosed in U.S. Pat. No. 2,634,198 and No. 3,226,204, are as follows:

Temperature; 1100°-1800°F;

Pressure; atmosphere -1450 psig, usually above 450 psig.

While we have shown and described a preferred form of embodiment of our invention, we are aware that modifications may be made within the scope and spirit thereof.

We claim:

1. In a method of hydroconversion of coal wherein the coal in particulate form and hydrogen are passed upwardly through a reaction zone in a liquid phase environment under hydrogenation conditions of temperature in the range of 750°-900°F and hydrogen partial

pressures in the range of 500 psi to 3000 psi with the removal of liquid and gaseous effluent from the reaction zone, the improvement which comprises:

- a. drying and grinding the coal to a moisture content of not to exceed five weight percent and a grind less than ¼ inch;
- b. mechanically boosting the pressure on said coal solids in stages from atmospheric to reaction zone pressure by use of high speed screw pumps;
- c. introducing said pressurized, substantially dry coal particles into the reaction zone independent of a carrier liquid; and
- d. simultaneously measuring and controlling the weight flow of coal particles into the reaction zone to provide a constant weight flow of coal into the reaction zone.

2. In a method of gasification of coal wherein the coal in particulate form and reactant gases are passed upwardly through a reaction zone under conversion conditions of temperatures up to 1800°F and pressure up to 1450 psig for the gasification of the coal, the improvement which comprises:

- a. drying and grinding the coal to a moisture content of not to exceed five weight percent and a grind less than ¼ inch;
- b. mechanically boosting the pressure on said coal solids in stages from atmospheric to reaction zone pressure by use of high speed screw pumps;
- c. introducing said pressurized, substantially dry coal particles into the reaction zone in the absence of a carrier liquid; and
- d. simultaneously measuring and controlling the weight flow of coal particles into the reaction zone to provide a constant weight flow of coal into the reaction zone.

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