

[54] METHOD OF COAL PRETREATMENT

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[56] References Cited

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2,906,608	9/1959	Jéquier et al.	48/202 A
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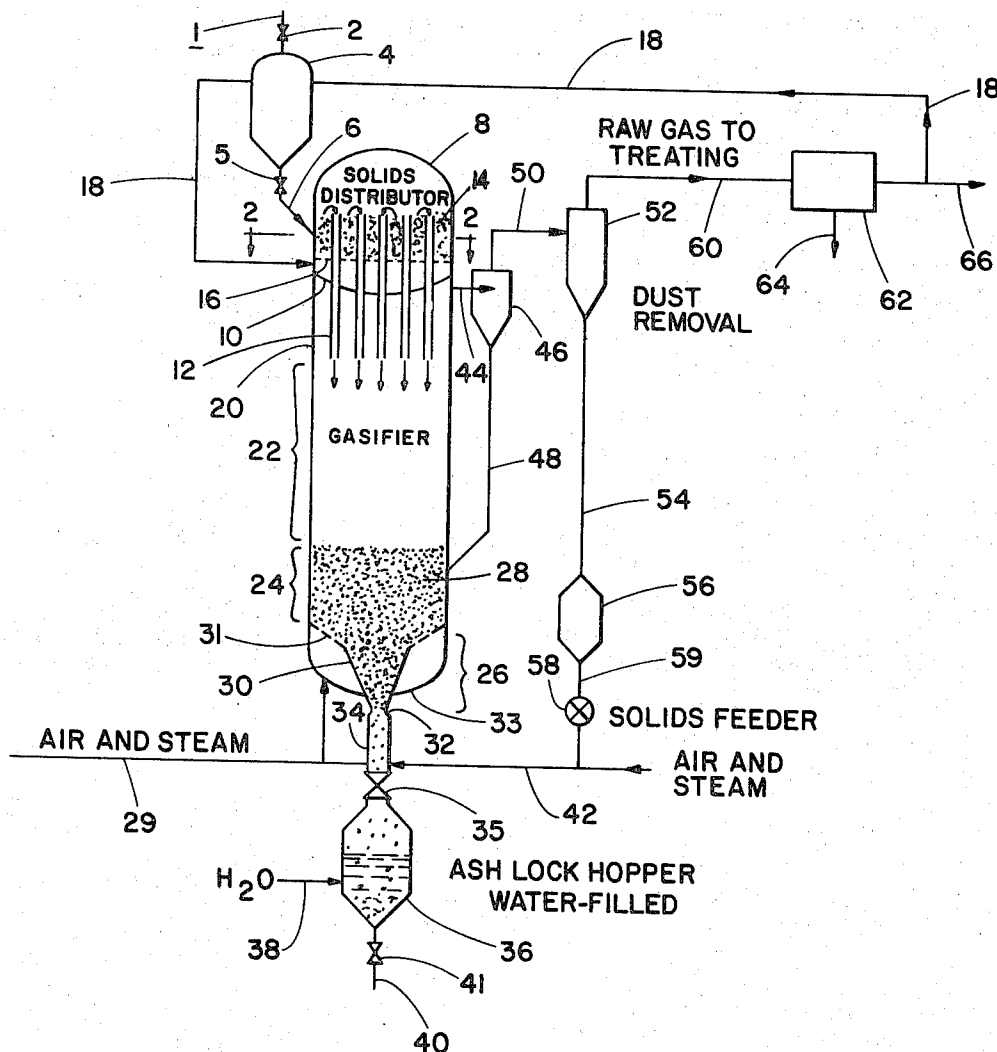
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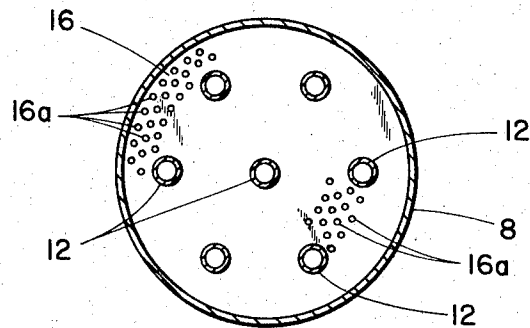
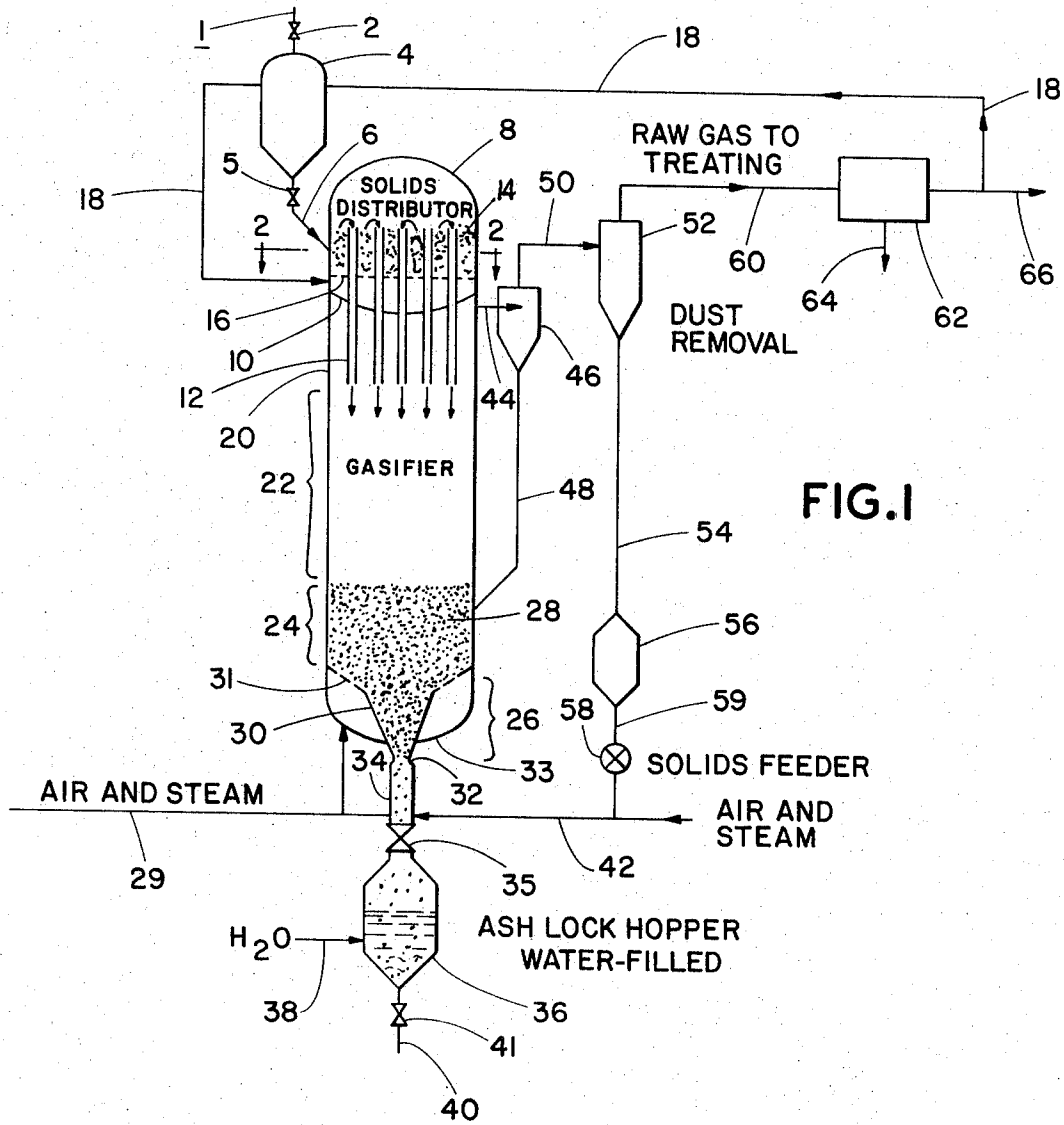
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[57] ABSTRACT

An improved process for the pretreatment of coal, prior to gasification, to remove volatile matter and lower the propensity of the coal to cake during the gasification reaction which comprises contacting finely divided feed coal with the hot product gases from the coal gasification reaction. Preferably, the product gas from the gasification step is used to fluidize finely divided coal particles in a solids distribution chamber superjacent to a fluidized gasification reaction zone and the resulting product gas-coal feed mixture is passed downward through a plurality of spaced apart conduits positioned a substantial distance above the fluidized bed. The coal particles pass, at a slow uniform rate, due to hindered settling through the product gases rising from the gasification reaction and are effectively pretreated prior to contact with the fluidized gasification bed.

4 Claims, 2 Drawing Figures





METHOD OF COAL PRETREATMENT

BACKGROUND OF THE INVENTION

This invention relates to the pretreatment of a solid carbonaceous material such as caking bituminous coal particles to remove volatile matter therefrom and to eliminate the propensity for the coal to cake in a subsequent gasification reaction.

It has been recognized in the art that certain coals, such as bituminous coal, have a tendency to become plastic and sticky when they are heated. It is also known in the art that an efficient method of gasifying coal is to treat the coal with oxygen (or air) and steam at elevated temperatures in a fluidized bed. As a consequence, if a fluidized bed gasification reaction is to be successful, caking or agglomeration of the coal particles in the fluidized bed must be reduced or eliminated.

One method used by the art to eliminate the caking or agglomeration properties of the coal is to mildly oxidize the surface of the coal particles with an oxygen containing gas such as air. This method, as illustrated in U.S. Pat. No. 2,805,189, has the disadvantage of generating large amounts of heat that are difficult to recover and of converting a portion of the carbon value of the coal to CO₂ which obviously cannot be used as a fuel. In addition, the gaseous products from the pretreatment step contain valuable hydrocarbon liquids that may be lost if the gaseous product is separately treated from the product gases thereby increasing the capital expenditure required.

Another method of pretreating coal is illustrated in U.S. Pat. No. 2,582,712. In this patent, a single volume of raw pulverized feed coal is admixed with 15-30 volumes of hot circulating residue recovered from the gasification reaction to rapidly preheat the coal to gasification temperatures to avoid coal agglomeration. The circulation of high volumes of abrasive solid particulate matter has the obvious disadvantages of equipment wear and expense.

SUMMARY OF THE INVENTION

It is an object of this invention to provide an efficient, facile method to pretreat solid carbonaceous particles such as caking coal before gasification without the need for the application of external heat.

It is another object of this invention to provide a method to uniformly pretreat finely divided, caking solid carbonaceous particles such as coal and to uniformly distribute the resultant heated particles in the fluid bed of a fluidized gasification zone at the temperature of the fluid bed.

It is a specific object of this invention to provide an efficient method for pretreating finely divided caking solid carbonaceous particles with the hot gaseous products from a fluidized gasification reaction.

The present invention provides an improvement in a process for the gasification of a solid carbonaceous material such as bituminous coal, tar sands, oil shale, lignite, etc. to provide a hot gaseous reaction product by a gasification reaction in a conventional gasification reaction zone wherein the solid feed material must be pretreated to prevent caking problems in the gasification reaction. This improved process comprises contacting the solid carbonaceous feed material, in a finely divided state, with the hot gaseous reaction products produced in the gasification reaction. These hot gaseous products are not subject to intervening cooling or

treatment prior to contact with the solids and are contacted with the finely divided solids as the gases are produced and emanate from the gasification reaction for a time sufficient to devolatilize the coal and destroy its caking properties. The thus treated solid particles are then passed directly to the gasification reaction for conversion into gaseous products. Preferably the gasification reaction zone comprises a conventional dense phase fluidized bed reaction zone maintained at a temperature below the plastic or agglomerating temperature of the ash of the coal and typically in the range of about 1200°-2000°F. with a preferred range of 1600°-1900°F.. The hot gaseous products as they emanate from the fluidized bed will have a temperature substantially the same as the fluid bed. However, some cooling will occur when the gases start to contact the fresh feed coal. Typically, a contact time of about 2 to 30 seconds of the hot gases with the feed coal is sufficient to devolatilize the coal and destroy its caking properties.

In a particularly preferred embodiment, the present invention provides an improved process of contacting finely divided carbonaceous solids such as a caking bituminous coal with the hot gaseous products from the fluidized gasification reaction zone. According to this embodiment, the finely divided coal, in a size range of about 8 to 100 mesh, is passed to a solids distribution chamber superjacent to the gasification chamber or zone. This solid distribution chamber has a solids inlet, a fluidizing gas inlet, and a plurality of spaced apart vertical conduits passing through the bottom of the distribution chamber. The upper or inlet ends of these conduits terminate within the distribution chamber at a point above the solids and gas inlet. The opposite, discharge end of the conduits terminates a substantial distance above the fluidized gasification zone. The finely divided coal solids and fluidizing gas are passed to the lower portion of the distribution chamber wherein the finely divided solids are fluidized. Thereafter, the top of the resultant gas-solid mixture is passed downwardly through the spaced apart conduits and are uniformly discharged a substantial distance above the fluidized gasification reaction bed. As a result, the particles as discharged from the distribution chamber, contact the hot product gases as they are produced and emanate from the fluidized reaction bed and the feed coal is devolatilized and carbonized in situ to a sufficient degree to destroy the tendency for the coal to agglomerate when it reaches the fluidized gasification reaction bed. Preferably, the fluidized gas used to initially fluidize the finely divided solids is a portion of the gaseous products removed from the gasification chamber. Preferably, any solids and/or normally liquid hydrocarbons present in this gas stream are removed prior to recycling a portion of the gas back to the solids distributor as the fluidized medium.

Other objects and embodiments will become apparent by reference to the following detailed description of the present invention.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 schematically illustrates the pretreatment of finely divided coal particles by contacting these particles with the hot gaseous products from a fluid gasification reaction accordingly to a preferred embodiment of the present invention; and

FIG. 2 is a top sectional view of the solids distributor taken along section 2—2 of FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

Previously pulverized particulate coal reduced to a particle size of about 8 mesh to 100 mesh enters the process of the present invention by a line 1 and is passed to coal feed lock hopper 4. When lock hopper 4 is filled, inlet valve 2 in line 1 is closed, and outlet valve 5 in discharge line 6 is opened and the coal is passed to solid distribution chamber 8. Within the solid distribution chamber 8 the finely divided particulate coal is fluidized by product gas (source of which to be described hereinafter) entering via line 18. Solid distribution chamber 8 comprises a chamber having a bottom wall 10 to isolate the bottom of chamber 8 from gasification chamber 20 positioned directly below the solids distribution chamber 8. A plurality of vertically positioned conduits or pipes 12 pass through bottom wall 10 of solid distributor chamber 8 in the manner illustrated in FIG. 2 to equally distribute the fluidized solids across the top cross sectional area of chamber 20. The top end of pipes 12 are positioned above the inlet of coal feed line 6 and fluidized gas line 18 as they enter chamber 8. A grate 16 is horizontally positioned across chamber 8 above the entry point 4 for gas line 18. Grate 16 has a plurality of closely spaced small openings 16a which allow the fluidizing gas entering via line 18 to be uniformly distributed across the cross sectional area of chamber 18 and to provide a uniform fluidized bed with uniform solids flow down into each of the several pipes 12.

In any event, sufficient gas is passed via line 18 to solid distributor chamber 8 to fluidize the coal therein and the top of the resultant coal-gas fluidized mixture 14 overflows and is allowed to pass down through pipes 12 and is ultimately discharged into pretreatment section 22 in the top portion of gasification reactor 20. Pipes 12 discharge the coal into gasification chamber 20 a substantial distance above a conventional fluid dense phase fluidized gasification reaction bed 28 positioned in the bottom of the gasification chamber 20 in gasification section 24. This fluid bed 28 is maintained at conventional gasification conditions such as a temperature below the plastic point of the ash in the coal. The pressure within chamber 20 can range from atmospheric to superatmospheric with superatmospheric preferred for the production of higher BTU value gas. The bed temperature is an important variable since fluid bed temperatures in the plastic range of the ash can cause agglomeration of the ash in the fluidized bed proper thereby interfering with removal of ash from the fluidized reaction bed. Preferred reaction conditions for fluidized bed 28 are a temperature in the range of about 1500°-2000°F. and a holding time sufficient to gasify all of the carbon in the coal such as in the range of about 20 to 60 minutes.

The bottom portion of gasification chamber 20 contains a sloping grate 31 and a cone 30 as illustrated in Jéquier et al. U.S. Pat. No. 2,006,608, the teachings of which are incorporated by reference herein. This particular cone design is directed to selectively agglomerate the ash particles in the coal and withdrawing the agglomerated ash particles from fluid bed 28 without withdrawing any appreciable amounts of the unreacted coal from the bed. According to this known design, the majority of the air and steam necessary for the gasifica-

tion reaction enters free space 33 via line 29 and is distributed across the cross-sectional area of the fluidized bed by the openings in grate 31, and maintains bed 28 in a fluid state. Additional air and steam (about one-third of the total required for the gasification reaction) enters withdrawal pipe 34 and passes through constriction 32 and reacts with the coal present within cone 30 thereby causing locally higher temperatures than present in fluid bed 28. This locally higher temperature is above the plastic temperature of the ash and causes the individual ash particles to become sticky and agglomerate with each other. The flow rate of the air steam mixture is adjusted to insure that minute coal and ash particles do not pass through constriction 32. However, as the individual ash particles agglomerate within cone 30, they will eventually reach a sufficient size and weight so that they can pass freely through constriction 32 and be selectively withdrawn from the fluidized bed. The resultant agglomerated ash particles are then passed by withdrawal pipe 34 to waterfilled ash lock hopper 36 wherein the hot ash is quenched by water entering via line 38. Periodically, lock hopper 36 is emptied by closing valve 35, opening valve 41 and withdrawing a water ash slurry via discharge line 40.

Returning now to the description of pretreatment section 22, the hot gasification gases emanating from fluidized bed 28 strike the untreated finely divided coal particles discharged from the bottom of distribution pipes 12 in a counter current fashion. The distance between the discharge end of pipes 12, the top of dense phase fluidized bed 28 and the gas flow rate are adjusted to give a residence time sufficient to devolatilize the finely divided coal particles and char the particles to a sufficient degree so that they do not agglomerate when they reach fluidized bed 28. In particular, a residence time of about 2-30 seconds is preferred. The gas flow rate is adjusted to give a gas velocity through zone 22 of about one-half to 4 feet per second so that there is a hindered settling of the finely divided coal particles as they pass through pretreatment section 22. Preferably the gas velocity is adjusted in accordance with particle size, to allow the coal particles to settle in pretreatment zone 22 at a rate of about 15 to 500 feet per minute.

The hot gaseous products from the fluidized bed 28 within gasification zone 24 comprise a mixture of CO, CO₂, nitrogen, hydrogen, methane and water and, as they emanate from dense phase fluidized bed 24, have the same temperature as the bed. Solids distributor chamber 8, however, is preferably maintained at a temperature below about 500°F. and preferably at 80° to 300°F. to avoid any caking of the coal in the solids distributor. As a consequence, as the cooler coal particles strike the counter-current flowing hot gaseous products, the temperature of the product gases are lowered to a certain degree. For example, when the temperature of the reaction bed is about 1900°F., the temperature of the hot gaseous product that strikes the finely divided coal immediately upon discharge from pipe 12 is at a temperature of about 1500°F.. The temperature drop is due to the heating of the cooler coal particles. In any event, the average temperature of the hot gaseous product in pretreatment section 22 is generally within the range of 1500°-1900°F. and is sufficient to substantially instantaneously heat the finely divided coal particles to a temperature high enough to char the coal particles. This substantially instantaneous heating

removes the volatile matter on the coke and chars the surface of the coal particles thereby rendering them resistant to agglomeration when the particles reach dense phase fluidized bed 28.

The resultant product gases after contact with the fresh feed coal in pretreatment section 22 contain oils and tars as removed from the feed coal and as produced in the gasification reactor as well as finely divided solids. This gas-solids mixture is removed via gas outlet line 44 positioned above the bottom discharge end of pipes 12 and passed to first cyclone 46 wherein the coarse solid particles are removed from the gases. These solids in turn, are then passed via line 48 to fluidized bed 28 to recover their carbon value. The gases containing fine particulate matter are removed via line 50 from cyclone 46 and passed to second cyclone 52 for removal of the remaining fine solid particles via line 54. These fine particles are then accumulated in vessel 56 and removed via line 59 by solids feeder 58 and admixed with the air steam mixture passed via line 42 to nozzle cone 30. The carbon value in these fine particles reacts with the air steam mixture and helps develop the higher temperature present in agglomeration section 26. The resultant, essentially solids free, gas is then passed from second cyclone 52 via line 60 to purification zone 62 wherein the normally liquid hydrocarbons present in the hot gaseous effluent are condensed and removed via line 64 for further processing. The resultant product gas is then passed via line 66 to subsequent treating steps such as a Stretford process for removal of hydrogen sulphide from the product gas. A portion of product gas stream 66 is removed via line 18 and passed to solids distributor chamber 8 to serve as the fluidizing gaseous medium for the finely divided coal particles to be pretreated and then gasified.

Accordingly, it is seen that the present invention evenly distributes a finely divided coal mixture across the cross-sectional area of a gasification chamber, and this finely divided coal is contacted with hot product gases. This rapid heating of the finely divided fluid coal to a high temperature with the product gases devolatilizes the coal and chars the surface of the coal particle thereby destroying the caking properties of the coal before it enters a gasification fluidized bed. This method of pretreatment utilizes the heat generated during the coal gasification and does not require the application of heat from an external source. Further, the gaseous products of the devolatilization step are admixed with the product gases and become part of the net coal gasifier gases and are not lost from the system. Thus, the waste products from the pretreatment step can be removed from the system together with the waste products from the gasification reaction thereby consolidating the waste treatment problems to a single gaseous stream. Further, the pretreated coal enters the coal gasification bed at substantially the same temperature as the bed itself thereby increasing the efficiency of the

gasification reaction.

We claim as our invention:

1. In a process for the gasification of a finely divided solid carbonaceous feed material to produce a hot gaseous product by a gasification reaction in a fluidized gasification reaction bed wherein the carbonaceous feed material must be pretreated before passage to the fluidized reaction bed, to prevent caking of the feed material during the gasification reaction the improvement which comprises
 - i. passing the finely divided feed material and a fluidizing gas into a solid distribution zone maintained at a temperature below about 500°F to produce a fluidized bed of feed material;
 - ii. said distribution zone positioned superjacent to the fluidized reaction bed said zone comprising a chamber having a solids inlet, a fluidizing gas inlet and a plurality of spaced apart distribution conduits passing through the bottom of said chamber and terminating within said chamber at a point above the solids inlet and fluidizing gas inlet;
 - iii. withdrawing a fluidized mixture of feed material and fluidizing gas from the fluidized bed of feed material;
 - iv. passing the withdrawn fluidized mixture of feed material and fluidizing gas down through the distribution conduits;
 - v. discharging the fluidized mixture of feed material and fluidizing gas from each conduit a substantial distance above the fluidized gasification bed and into a pretreatment zone positioned above said gasification bed wherein the feed material from each conduit, as it is discharged, is permitted to settle downward together to the fluidized gasification bed;
 - vi. heating the settling feed material with the hot gaseous product emanating from the gasification reaction zone, in the pretreatment zone, to substantially instantaneously heat the feed material to a temperature sufficient to char the feed material; and
 - vii. maintaining the settling feed material within said pretreatment zone for a time sufficient to devolatilize the coal and destroy its caking properties before it reaches the fluidized gasification bed.
2. An improved process as in claim 1 wherein said hot gaseous product is recovered after contacting said finely divided solids and a portion of said product is passed to said solids distribution zone as said fluidizing gas.
3. An improved process as in claim 2 wherein said gaseous product contains solids, said solids being removed from said gaseous product prior to being passed to said solids distribution zone.
4. An improved process as in claim 1 wherein said solid carbonaceous feed material is bituminous coal.

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