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Knudsen et al.

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[54] **COAL INJECTION SYSTEM**

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[51] **Int. Cl.**[2] **C10J 3/06**

[58] **Field of Search** .... 48/197 R, 202, 203, 206, 48/210; 201/9, 38, 31

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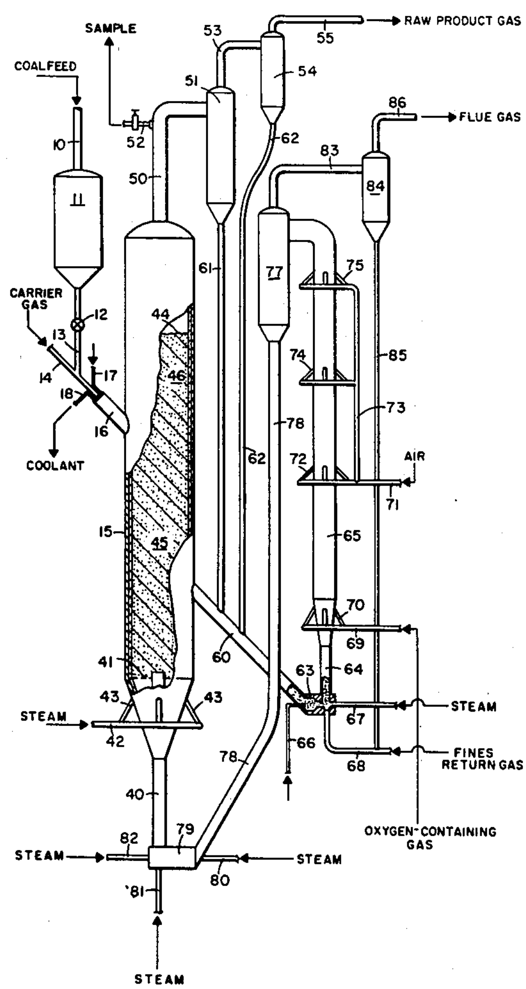
[57] **ABSTRACT**

A caking coal or similar carbonaceous solid is introduced into a fluidized bed containing char particles at a temperature in excess of the coal resolidification point by entraining coal particles less than about 8 mesh on the Tyler Screen Scale in a gas stream preheated to a temperature in excess of about 300° F. but below the initial softening point of the coal, injecting the hot gas and entrained coal particles through a fluid-cooled nozzle maintained at a temperature below the initial softening point of the coal into the fluidized bed at a superficial gas velocity between about 15 and about 1,000 feet per second, monitoring the fines carried overhead by gas from the fluidized bed, and regulating the velocity at which the hot gas and entrained coal particles are injected into the bed through the nozzle in response to changes in the fines content of the gas to produce controlled attrition of agglomerated particles in the bed.

10 Claims, 3 Drawing Figures



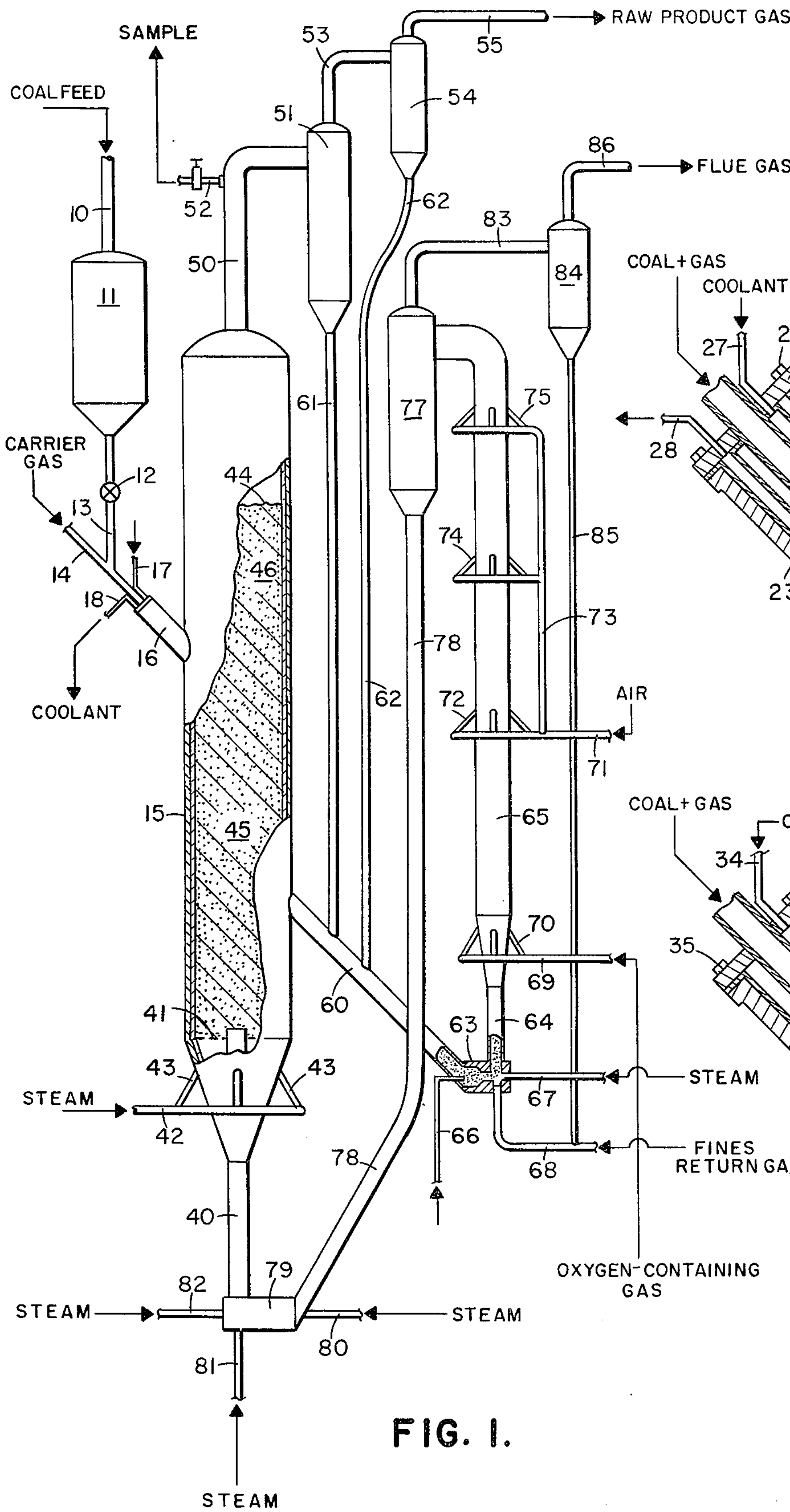


FIG. 1.

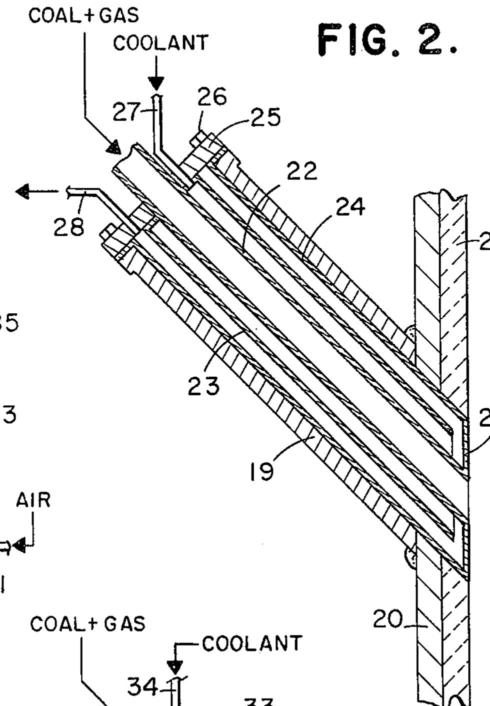


FIG. 2.

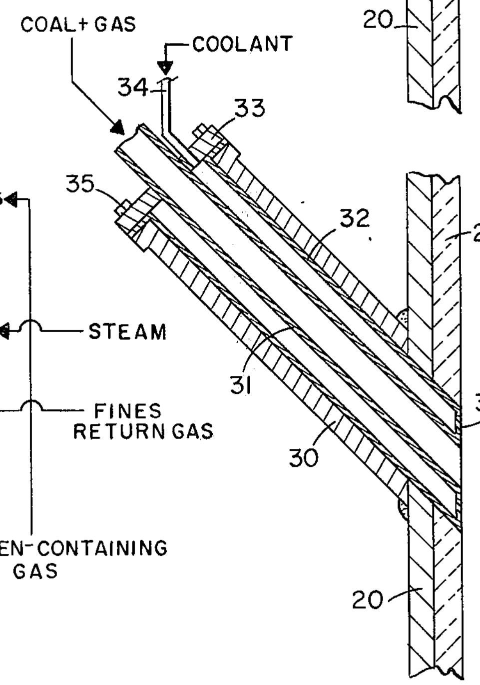


FIG. 3.

COAL INJECTION SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to coal gasification and similar processes and is particularly concerned with the injection of caking coals into high temperature fluidized beds containing coke particles.

2. Description of the Prior Art

Coal gasification and similar processes carried out in high temperature fluidized beds normally require the entrainment of finely divided coal particles in a stream of gas and the injection of this stream into the fluidized bed through a suitable nozzle. Although such processes work satisfactorily with noncaking coals, they frequently pose problems where highly caking coals are used. Coals of this latter type are generally characterized by oxygen contents of 15 weight percent or less, hydrogen contents of 5 weight percent or more, and Free Swelling Index values in the upper part of the 1 to 10 range. Experience has shown that such coals tend to devolatilize rapidly and begin to soften at temperatures in excess of about 600°F. The temperature at which softening starts, generally referred to as the initial softening point, depends upon the coal composition and is therefore higher in some coals than in others. Above this initial softening point, a coal particle begins to undergo deformation and tends to become rounded, rather than angular, in shape. The outer surface of the particle becomes plastic and small bubbles begin to appear in the coal. As the temperature is increased, deformation becomes more intense, the particle swells, the bubbles enlarge, and the walls surrounding the bubbles may rupture. At a still higher temperature, referred to as the resolidification point, the particle becomes a hard, porous mass and undergoes no further change in appearance. The resolidification point also depends upon the composition of the particular coal but generally occurs at a temperature of about 800°F. or higher.

When a highly caking coal is introduced through a nozzle into a fluidized bed containing coke particles at a temperature above the resolidification point, the coal particles quickly reach temperatures above the initial softening point, become plastic, and begin to swell. Individual particles contacting one another in the vicinity of the nozzle tend to adhere and form agglomerates. These agglomerates become larger due to devolatilization and swelling of the coal and brittle fragments may be produced. Attrition within the fluidized bed as the particles move upwardly results in the degradation of these fragments into very fine particles. The large agglomerates and fines thus produced make it difficult to control the fluidized bed, may have an adverse effect upon heat transfer within the bed, and often result in the loss of substantial quantities of carbon which would otherwise be available for reaction within the bed. They may also lead to the plugging of nozzles, the formation of deposits, and other difficulties.

It has been suggested that difficulties of the type outlined above might be avoided by mild oxidation of the coal at relatively low temperature until sufficient carbonization to prevent agglomeration has taken place, by using a series of fluidized beds in which the coal is carbonized at progressively higher temperatures, by injecting the raw coal at relatively low rates into a rapidly moving stream of char which is subsequently introduced into the fluidized bed gasification zone, by introducing the coal as a very fine powder under conditions which will result in almost instantaneous devolatilization and absorption of the sticky constituents on coke particles, or by passing the raw coal through a free-fall pretreatment zone in the presence of steam and oxygen before it reaches the fluidized bed. Although these techniques may be useful under certain conditions, they are all expensive, result in the loss of valuable volatile constituents from the coal, require the use of very complex equipment, or have other pronounced disadvantages. This has inhibited the development of fluidized bed processes using highly caking coals.

SUMMARY OF THE INVENTION

This invention provides an improved process for the introduction of caking coals and similar carbonaceous solids into high temperature fluidized beds which alleviates the difficulties outlined above and permits the use of highly caking coals and similar materials in fluidized bed gasification operations and similar processes without the severe problems that have characterized earlier efforts to use such materials. In accordance with the invention, it has now been found that caking coals and related materials can readily be injected into fluidized beds containing char particles at temperatures above the coal resolidification point by entraining finely divided coal particles less than about 8 mesh on the Tyler Screen Scale in size in a preheated gas stream having a temperature in excess of about 300+°F. but below the initial softening point of the coal; injecting the hot gas and entrained coal particles contained therein through a fluid-cooled nozzle maintained at a temperature below the initial softening point of the coal into the fluidized bed at a superficial gas velocity between about 15 and about 1,000 feet per second, preferably between about 50 and about 500 feet per second; monitoring the fines carried overhead by gas from the fluidized bed; and regulating the velocity at which the hot gas and entrained coal particles are injected through the nozzle into the bed in response to changes in the fines content of the overhead gas to produce controlled attrition of agglomerated particles within the bed. This process avoids the necessity for pretreatment of the coal to reduce its agglomerating tendency, permits the carrying out of gasification and similar reactions with apparatus less complex than that required in many of the earlier processes, is less expensive than processes suggested heretofore, and has other advantages over prior art processes. As a result of these advantages, the process of the invention has many potential applications.

DESCRIPTION OF THE DRAWING

FIG. 1 in the drawing is a schematic diagram of a coal gasification process in which the process of the invention is employed for the introduction of a highly caking coal into a high temperature fluidized bed gasifier;

FIG. 2 is an enlarged sectional view through a coal injection nozzle suitable for purposes of the invention; and

FIG. 3 is an enlarged sectional view through an alternate type of nozzle which may be employed for purposes of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The process depicted in FIG. 1 of the drawing is a process for the production of a methane-containing gas from bituminous coal, subbituminous coal, lignite or similar carbonaceous solids which contain volatilizable hydrocarbon constituents and may tend to agglomerate at elevated temperatures. The solid feed material employed in the process, preferably a bituminous or lower rank coal, is introduced into the system through line **10** from a preparation plant, not shown, in which the coal or other material may be crushed, dried and screened or from a storage facility which does not appear in the drawing. To facilitate handling of the solid feed material in a fluidized state, the coal or other carbonaceous solid is introduced into the system in a finely divided state, normally less than about 8 mesh on the Tyler Screen Scale.

The particular system depicted in the drawing is operated at elevated pressures and hence the coal or other feed material introduced through line **10** is fed into vessel **11**, from which it is discharged through star wheel feeder or similar device **12** into line **13** at the system operating pressure or a slightly higher pressure. In lieu of or in addition to this type of an arrangement, parallel lock hoppers, pressurized hoppers, aerated standpipes operating in series, or other apparatus may be employed to raise the input coal stream to the required pressure level. The use of such equipment for handling coal and other finely-divided solids at elevated pressures has been described in the patent literature and will therefore be familiar to those skilled in the art.

A carrier gas stream is introduced into the system through line **14** to permit the entrainment of solid particles from line **13** and introduction of the solids into gasifier **15**. High pressure steam or product gas may be employed as the feed gas stream. The use of recycled product gas tends to avoid significant reductions in the hydrogen concentration in the gasifier and improve methane yields and is therefore normally preferred. The carrier gas stream is introduced into the system at a pressure between about 100 and about 1,500 psig, depending upon the pressure at which gasifier **15** is operated and the solid feed material employed, and at a temperature in excess of about 300°F. but below the initial softening point of the coal or other carbonaceous feed material. For the gasification of bituminous coals, the use of carrier gas input temperatures in the range of from about 400° to about 550°F. is generally preferable. The coal particles introduced through line **13**, preferably less than about 20 mesh in size on the Tyler Screen Scale, are suspended in hot input carrier gas fed through line **14** in a ratio between about 0.2 and about 2.0 pounds of coal per pound of carrier gas. The optimum ratio for a particular system will depend in part upon the coal particle size and density, the molecular weight of the gas employed, the temperature of the coal and input gas stream, and other factors. In general, ratios between about 0.5 and about 1.5 pounds of coal per pound of carrier gas are preferred. The resultant stream of carrier gas and entrained coal particles is then fed through a fluid-cooled nozzle **16** into the gasifier. The cooling fluid, which will normally be low pressure steam but may also be water or other fluid, may be introduced into the nozzle through line **17** and recovered by means of line **18**. Suitable nozzles are shown in greater detail in FIGS. **2** and **3** of the drawing.

The nozzle structure shown in FIG. 2 includes an outer nozzle housing **19** which is welded in place to the outer shell **20** of the gasifier and extends downwardly at an acute angle to the longitudinal axis of the gasifier. Mounted within the nozzle housing and extending through the refractory lining **21** of the gasifier is a removable nozzle assembly including an inner injection tube **22**, an intermediate cylindrical baffle **23** and an outer coolant tube **24**. These members are welded or otherwise connected near the upper end of the nozzle assembly to a cap or flange **25** which is held in place by means of bolts **26**. Inlet and outlet tubes **27** and **28** extend through the cap to permit the introduction and withdrawal of coolant. The injection and coolant tubes **22** and **24** are connected at their lower ends by member **29**. Baffle **23** stops short of the end connection. Coolant introduced into the assembly thus flows downwardly between the baffle and the injection tube and then flows upwardly through the annular space between the outer coolant tube and the intermediate baffle. This permits control of the temperature of the gas and entrained coal injected into the gasifier and avoids temperatures above the initial softening point of the coal due to heat transfer from the gasifier before the coal reaches the fluidized bed.

FIG. **3** in the drawing depicts an alternate type of nozzle which may be employed if desired. This nozzle includes an outer nozzle housing **30** which is welded to the outer shell **20** of the gasifier and extends downwardly at an angle to the longitudinal axis of the gasifier. An inner ejection tube **31** and an outer coolant tube **32**, which extend downwardly through the housing and the ceramic lining **21** of the gasifier, are welded or otherwise connected to flange **33** which contains coolant inlet tube **34** and is held in place by bolts **35**. The injection and coolant tubes are interconnected at their lower ends by a perforated member **36** containing orifices through which the coolant fluid may pass into the gasifier. Carrier gas and entrained particles and cooltant may thus be injected concurrently into the gasifier through this nozzle assembly. The injected coolant fluid aids in maintaining the coal particles below the initial softening point and is advantageous in that it moderates the rate at which the particles are heated up within the fluidized bed. It will be understood that the process of the invention is not restricted to use of the particular nozzles shown in the drawing and that other nozzle assemblies which will permit control of the particle temperature can also be used. Although FIG. **1** shows only one nozzle, large diameter gasifiers will normally be provided with a plurality of nozzles.

The gasifier **15** which is employed in the system shown in the drawing comprises a refractory-lined vessel containing a fluidized bed of char particles introduced into the lower part of the vessel through inlet line **40**. The inlet line extends upwardly through the bottom of the vessel to a point above grid or similar distribution device **41**. Steam for maintaining char particles in a fluidized state and reacting with the char to produce a synthesis gas containing substantial quantitites of hydrogen and carbon monoxide is introduced into the gasifier below the grid through manifold **42** and injection nozzles **43**. The installation shown utilizes four nozzles spaced at 90° intervals about the periphery of the gasifier but a greater or lesser number may be employed if desired. The steam introduced through the nozzles will normally be fed into the system at a rate within the range between about 0.5 and about 2 pounds per pound of coal feed and at a pressure between about 100 and about 1,500 psig, depending upon the gasifier operating pressure and the solid feed material used. The upflowing stream and suspended char particles form a fluidized bed which extends upwardly in the gasifier to a level above the point at which the coal particles are introduced by means of nozzle **16.** The upper surface of this bed is indicated in the drawing by reference numeral **44.**

The lower portion of the fluidized bed in gasifier **15** between grid **41** and the level at which the coal particles are introduced through the nozzle, indicated generally by reference numeral **45,** serves as a steam gasification reaction zone. Here the steam introduced through the manifold and steam injection nozzles reacts with carbon in the hot char particles to form synthesis gas in accordance with the reaction: $H_2O + C$ $H_2 + CO$. At the point of steam injection near the lower end of the gasifier, the hydrogen concentration in the gaseous phase of the fluidized bed is substantially zero. As the steam moves upwardly through the fluidized char particles, it reacts with the hot carbon to produce synthesis gas and the hydrogen concentration in the gaseous phase thus increases. The temperature in the steam gasification zone will generally range between about 1,450° and about 1,950°F. Depending upon the particular feed material and particle sizes employed, the gas velocities in the fluidized bed will normally range between about 0.2 and about 4.0 feet per second, preferably between about 0.5 and about 2.0 feet per second.

The upper part of the fluidized bed in reactor vessel **15,** indicated generally by reference numeral **46,** serves as a hydrogasification zone where the feed coal is devolatilized and a portion of the volatile matter thus liberated reacts with hydrogen generated in the steam gasification zone below to produce methane as one of the significant constituents of the product gas. The point at which the coal feed stream is introduced into the gasifier through nozzle **16** and hence the location of the steam gasification and hydrogasification zones depends primarily upon the properties of the particular coal or carbonaceous solid which is employed as the feed material for the process. It is generally preferred to select the nozzle location so that the methane yield from the gasifier will be maximized and the tar yield minimized. In general, the amount of methane produced increases as the coal feed injection point is moved toward the top of the vessel. The tar formed from the input coal, which has a tendency to foul downstream processing equipment, normally increases in amount as the coal injection point is moved upwardly and decreases as the coal injection point is moved toward the bottom of the reaction vessel, other operating conditions being the same. The coal feed stream should therefore generally be introduced into the gasifier at a point where the hydrogen concentration in the gas phase is in excess of about 20% by volume, preferably between 30 and about 50% by volume. To secure acceptable methane concentrations in the product gas stream, the upper surface **44** of the fluidized bed should normally be located at a level sufficiently above the nozzle **16** to provide at least about 4 seconds of residence time for the gas phase in contact with the fluidized solids in the hydrogasification zone. A residence time for the gas in contact with the solid phase above the coal injection point of between 10 and about 20 seconds is normally preferred. It will be understood, of course, that the optimum hydrogen concentration at the coal injection point and the gas residence time above that point will vary with different types and grades of feed coal and will also change with variations in the gasifier temperature, pressure, steam rate, and other process variables. Higher rank coals normally require somewhat more severe reaction conditions and longer residence times to obtain high methane yields than do coals of lower rank. Similarly, high reaction temperatures and steam rates generally tend to increase the hydrogen concentration in the gas phase and thus reduce the solids residence time needed to secure acceptable methane yields from a particular feed coal.

As pointed out above, the temperature in gasifier **15** is normally maintained within the range between about 1,450° and about 1,950°F. This is above both the initial softening point and the resolidification point of the coal fed into the gasifier through nozzle **16.** The entrained coal particles emerging from the nozzle into the fluidized bed therefore tend to heat up rapidly and quickly reach the initial softening point. In order to avoid excessive agglomeration in the vicinity of the nozzle, the carrier gas in which the particles are entrained is injected into the fluidized bed at a superficial gas velocity sufficient to move the particles a significant distance into the bed before they soften, become sticky and begin to swell. The turbulence within the fluidized bed and the presence of a carrier gas injected with the particles tend to keep the particles separate from one another and thus reduce the amount of agglomeration which occurs. Some agglomeration due to contact between the hot sticky particles undergoing devolatilization and contact with hot char particles suspended in the bed will take place, however, and will tend to increase the average size of the particles within the fluidized bed. Swelling of the injected particles as they are heated from the initial softening point to the resolidification point also tends to increase the average particle size. The amount of swelling which takes place depends upon the composition of the particular coal being gasified and the particle size. The small surface-to-volume ratios of relatively large particles may lead to excessive swelling and the production of large brittle fragments which quickly degrade to fines in the turbulent fluidized bed and hence an average feed particle size of about 20 mesh or smaller is normally preferred.

In order to offset the effects of agglomeration and swelling and avoid the production of excessive fines which tend to be carried from the fluidized bed with the product gas, the velocity of the carrier gas stream containing the entrained feed coal particles is regulated to produce controlled attrition of the feed particles. Studies have shown that varying the input carrier gas velocity produces significant changes in the amount of attrition which takes place within the bed and that this can be used to regulate the bed particle size. By monitoring the amount of fines carried overhead from the fluidized bed by the product gas and adjusting the carrier gas velocity to obtain an acceptably low fines content, difficulties due to the agglomeration and swelling of caking coal can thus be largely avoided.

Gases from the fluidized bed move upwardly from the upper surface **44** of the bed, carrying entrained solids with them. These gases are withdrawn from gasifier **15** through line **50** and passed to cyclone separator or similar device **51** where the larger particles are separated from the gas stream. The solids content of this overhead gas can be monitored by withdrawing gas samples through line **52** and determining their solids contents, by means of optical monitoring equipment based on the transmisssion of light through the flowing gas stream, by the periodic insertion of filters into the gas stream, by means of radioactive monitoring equipment including a source and detector mounted on the gas line, or by other methods familiar to those skilled in the art. Equipment which may be employed for such monitoring is available commercially and may be used if desired. As indicated earlier, the amount of solids entrained in the gas stream will depend upon the particular operating conditions employed, the composition of the feed coal, the coal particle size and other factors. Assuming that the coal feed rate and other conditions are held constant, an increase in the carrier gas velocity through nozzle **16** will normally produce an increase in particle attrition within the bed. If excess agglomeration is occuring, such an increase will tend to reduce the average particle size without producing excessive fines. An overly high carrier gas velocity, on the other hand, may tend to produce a marked increase in the fines content of the overhead gas. By monitoring the solids content of the gas stream and adjusting the carrier gas velocity as necessary, an optimum gas velocity for a particular coal and a particular set of operating conditions can thus be determined.

The gas stream taken overhead from separation unit **51** through line **53** will normally contain entrained fines too small to be taken out by separation unit **51.** This gas stream may therefore be passed to a second centrifugal separator or similar unit **54** for the removal of additional fine particles. The raw product gas is withdrawn overhead from this second separation unit through line **55** and may be passed to conventional downstream facilities for cooling, the removal of water and any additional entrained solids, treatment to take out carbon dioxide and sulfur compounds, and the like. If desired, the treated gas can then be passed through a catalytic shift conversion unit to adjust the hydrogen-to-carbon monoxide ratio and then introduced into a methanation unit to increase the amount of methane and raise the B.t.u. content of the gas. All of these downstream gas treating and processing steps may be carried out in a conventional manner and will be familiar to those skilleld in the art.

The heat required to sustain the overall endothermic reaction taking place in gasifier **15** and maintain the operating temperature of from about 1,450° to about 1,950°F. is provided by withdrawing a portion of the char solids from the fluidized bed in the gasifier through line **60** and passing these solids, together with solid particles recovered from separation units **51** and **53** through diplegs **61** and **62,** through connector **63,** and into vertical riser **64** at the lower end of transfer line burner **65.** Steam may be introduced into the system through line **66,** and through line **67** if desired, to promote smooth flow of the dense phase solids stream and avoid clogging problems. A fines return gas, normally recycled flue gas containing suspended solids recovered from the overhead flue gas stream as described hereafter, may be injected into the lower end of connector **63** through line **68** and used to aid in lifting the solid particles withdrawn from the gasifier upwardly through line **64** into the burner. An oxygen-containing gas, preferably a mixture of air and sufficient recycle flue gas to give a molecular oxygen content less than about 10% by volume, is introduced into the lower end of the burner through line **69** and peripherally spaced nozzles **70** in a quantity sufficient to establish dilute phase flow of the solids and initiate combustion of the char particles. This use of a gas of relatively low oxygen content at the lower end of the burner aids in avoiding the establishment of hot spots which may result in localized temperatures that exceed the ash fusion temperature and may lead to the formation of deposits and fouling of the burner. Oxygen-containing gas having a higher molecular oxygen content than that introduced at the lower end of the burner is supplied to the burner through line **71** and peripherally spaced nozzles **72.** It is generally preferred to introduce this additional oxygen-containing gas at two or more vertically-spaced levels along the burner in order to achieve better control of the combustion process and again avoid localized overheating and the problems that may accompany it. In the system shown in the drawing, air or other oxygen-containing gas is introduced at two additional levels by means of line **73** and peripherally spaced nozzles **74** and **75.** The levels at which the oxygen-containing gas is introduced into the burner are generally spaced sufficiently far apart so that substantially all of the oxygen introduced at one level is consumed before the gas and entrained solids reach the next level. This generally provides better control of the temperatures within the burner, results in more efficient combustion, and reduced the carbon monoxide content of the gas stream. The total amount of oxygen introduced in this manner should be sufficient to raise the temperature of the solids passing upwardly through the burner by about 50° to about 300° F. and thus provide sufficient heat upon return of the solids to the gasifier to maintain the gasification reactions.

The gases and entrained solids leaving the upper end of burner **65** are passed into a cyclone separator or similar separation unit **77** where the larger solids are removed from the gas stream and returned through dipleg **78** and connector **79** to the gasifier bottom intake line **40.** Steam may be introduced into the solids return system through lines **80** and **81,** and through line **82,** if desired, to promote proper flow of the solids stream and avoid clogging difficulties. The hot solid char particles thus returned to the gasifier provide the heat required to sustain the steam gasification reaction taking place in steam gasification zone **45** and that necessary for the hydrogasification reactions taking place in hydrogasification zone **46.** As indicated earlier, these hot char particles will normally be at a temperature well in excess of the coal resolidification point.

The overhead gas from the transfer line burner, following the removal of entrained solids in separation unit **77,** is passed through line **83** to a second cyclone separator **84** where finer solid particles not removed in separator **77** are taken out of the gas stream. These finer particles are withdrawn from the separator through dipleg **85** and entrained in the fines return gas introduced through line **68.** The fines thus returned to the burner are preferentially consumed and supply much of the fuel for the combustion process taking place in the transfer line burner. The flue gas is taken overhead from separator **84** through line **86.** Depending upon the solids content of this stream, the flue gas may be passed to still another cyclone separator for the elimination of very fine entrained solids consisting primarily of ash or may be scrubbed for the removal of such solids. The flue gas stream can then be treated as necessary to comply with applicable pollution regulations and then discharged into the atomsphere. As indicated earlier, a portion of the flue gas stream may be recycled for use as a fines return gas and as a diluent gas in the burner. Conventional procedures can be used for treatment of the flue gas to remove pollutants before its discharge.

It will be apparent from the foregoing that the process of the invention provides an improved method for the introduction of coal and similar materials into high temperature fluidized beds and that this method has advantages over methods employed in the past. Although the method has been described primarily in terms of coal gasification, it will be understood that it is not restricted to gasification operations and may instead be used in other fluidized bed operations in which agglomeration and related difficulties are apt to be encountered. In coal pyrolysis and hydrogen manufacturing processes carried out in fluidized beds, for example, use of the method of the invention permits the injection of highly caking coals without severe deposit formation, excessive fines production and other difficulties which have generally precluded the use of such coals heretofore. In such processes, the feed solids will normally be injected into the fluidized bed at locations different from that at which the solids are injected into a fluidized bed used for gasification purposes. Materials other than coal which contain volatilizable hydrocarbon constituents, have an initial softening point and a somewhat higher resolidification point, and often behave in much the same manner as caking coals in high temperature fluidized beds, lignite for example, can also be employed. These and other modifications will be apparent to those skilled in the art.

We claim:

1. In a process wherein finely divided carbonaceous solids which contain volatilizable hydrocarbon constituents and have an initial softening point and a resolidification point higher than said initial softening point are introduced into a fluidized bed of char particles maintained at a temperature above said resolidification point for devolatilization and wherein gases containing entrained fines are withdrawn overhead from said fluidized bed, the improvement which comprises entraining said carbonaceous solids in a preheated stream of carrier gas having a temperature in excess of about 300° F. but below said initial softening point, injecting said stream of carrier gas containing the entrained solids into said fluidized bed through a fluid-cooled nozzle at a superficial gas velocity between about 15 and 1,000 feet per second, monitoring the entrained fines content of said gases withdrawn overhead from said fluidized bed, and regulating the velocity at which said carrier gas and entrained carbonaceous solids are injected into the bed through said nozzle in response to changes in said entrained fines content of said gases to produce controlled attrition of agglomerated particles in said bed.

2. A process as defined by claim **1** wherein said carbonaceous solids are caking coal particles.

3. A process as defined by claim **1** wherein said carrier gas comprises a methane-containing gas produced by coal gasification.

4. A process as defined by claim **1** wherein said gas containing said entrained solids is injected through said nozzle at a superficial gas velocity between about 50 and about 500 feet per second.

5. A process as defined by claim **1** wherein said carbonaceous solids have an average particle size less than about 20 mesh on the Tyler Screen Scale.

6. A process as defined by claim **1** wherein said fluidized bed is a bed of char particles fluidized by steam.

7. A process as defined by claim **1** wherein said nozzle is cooled by steam.

8. A process as defined by claim **1** wherein said preheated stream of carrier gas has a temperature between about 400° and about 550° F.

9. A process as defined by claim **1** wherein said stream of carrier gas contains from about 0.5 to about 1.5 pounds of carbonaceous solids per pound of carrier gas.

10. A process as defined by claim **1** wherein said stream of carrier gas and entrained solids is injected through said nozzle into said fluidized bed at a pressure between about 50 and about 1,500 psig.

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