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EP 0 205 238 B1

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Description

This invention concerns a method for introducing fluid feeds to pressurized reactors. This invention also concerns an apparatus capable of effecting such introduction. In one of the more specific aspects, the method and apparatus of this invention concern the manufacture of H_2 and CO containing gaseous products, e.g., synthesis gas, reducing gas and fuel gas, by the high pressure partial oxidation of carbonaceous slurries.

Processes for and apparatuses used in the pressurized partial oxidation of carbonaceous slurries are both well known in the art. See, for example, U.S. Patents 4,113,445; 4,353,712; and 4,443,230. In most instances, the carbonaceous slurry and an oxygen-containing gas are fed to the reactor which is above the temperature, generally above 2500°F (1400°C) of the devolatilization products of the carbonaceous slurry in the presence of oxygen. Bringing the reactor up to the autoignition temperature can be achieved by at least two methods. In one of the methods, a simple pre-heat burner is affixed, in a non-airtight manner, to the reactor's burner port. This pre-heat burner introduces a fuel gas, e.g., methane, into the reactor to produce a flame sufficient to warm the reactor to a temperature of about 2000 to 2500°F (1100 to 1400°C) at a rate which does not do harm to the reactor refractory material. Generally, this rate is from about 40°F/hr to about 80°F/hr (4.5°C/hr to 27°C/hr). During this pre-heat stage, the reactor is kept at ambient pressure or slightly below. The less than ambient pressure is desirable as it causes air to enter the reactor through the non-airtight connection between the pre-heater and the reactor, which air is then available for use in combusting the fuel gas. After the desired preheat temperature is achived, the pre-heat burner is removed from the reactor and is replaced by the process burner. The replacement should occur as quickly as possible as the reactor will be cooling down during the replacement time. Cool downs to a temperature as low as 1800°F (980°C) are not uncommon. If the reactor temperature is still within the acceptable temperature range, the carbonaceous slurry and the oxygen-containing gas, with or without a temperature moderator, are fed through the process burner to achieve partial oxidation of the slurry. When the slurry is initially fed, the oxygen-containing gas feed has to be set to bring the reaction zone quickly to a temperature above the liquid temperature of the slag produced in the reaction zone. This quick heating causes thermal shock to the reactor refractory material.

If, however, the reactor temperature is too low, then the pre-heater must be replaced back into service. This replacement is not desirable as process time is lost and additional labor expense is realized with the replacement duplication.

The other of the two methods for bringing up the reactor temperature to within the desirable range entails the use of a process burner only; see, for example, the burner disclosed in U.S. Patent 4,353,712. This type of process burner provides conduits for selective and contemporaneous feeding of carbonaceous slurry, oxygen-containing gas, fuel gas and/or temperature moderators. When the process burner is used for pre-heating the reactor, the burner feeds the oxygen-containing gas and the fuel gas in the proper proportions to achieve complete combustion. After the reactor temperature is within the desired range, the fuel gas can either be replaced completely by the carbonaceous slurry or co-fed with the slurry. When the co-feeding mode is used, generally the fuel gas feed is reduced so that there will only be partial oxidation occurring. Co-feeding is usually used when initially introducing the carbonaceous slurry to the reactor and when maintaining reactor temperature until process conditions can be equilibrated for the carbonaceous slurry/oxygen-containing gas feed mode of operation.

While the process burner only method of operation does not suffer from the loss in process time and the additional labor expenses of the pre-heat burner/process burner method, it is not without its own drawbacks. When using the process burner only method, the maintenance of flame stability under both ambient pressure-complete oxidation and high pressure-partial oxidation conditions, which are, respectively, used in the pre-heat and the carbonaceous slurry partial oxidation steps of the process, is difficult and can result in lowering of process reliability.

Some in the synthesis gas industry have proposed using the combination of a pre-heat burner and a process burner in which the latter is capable of providing a selective contemporaneous feed of carbonaceous slurry, oxygen-containing gas, fuel gas and/or temperature moderators. While this combination may still entail the loss of process time and the realization of labor costs associated with the preheat burner replacement by the process burner, the selective contemporaneous feed feature of the process burner is used to reduce the before-discussed thermal shock to the reactor refractory material. The reduction in thermal shock is achieved by bringing the reactor temperature from its cooled-down temperature back up to the desired temperature with the fuel gas feed and then feeding the carbonaceous slurry contemporaneously with the fuel gas. The carbonaceous slurry feed is started off at a low level and is increased while the fuel gas feed is gradually decreased to 0 in accordance with the need by the reactor for heat to maintain its desired temperature. By initially feeding the carbonaceous slurry at a low rate, there is less of the slurry liquid to heat and vaporize and thus a minimization of reactor temperature dip. Further, during the initial period of carbonaceous slurry feed, the continued feeding of the fuel gas results in the addition of heat to the reactor. The fuel gas is combusted under partial oxidation conditions so that there is little contamination by, for example, CO_2 of the gas product.

For a process burner to be useful in the just-described procedure, it must be capable of providing to the reactor, in an efficient manner, both the carbonaceous slurry and the fuel gas feeds in conjunction with their respective oxygen-containing gas

feeds. Efficiency demands that the carbonaceous slurry be evenly dispersed in the oxygen-containing gas and be in a highly atomized state, e.g., having a maximum droplet size less than about 100 micrometres. Both uniform dispersion and atomization help ensure proper burn and the avoidance of hot spots in the reaction zone.

This invention provides a process burner which is capable of providing selective and contemporaneous feed of three or more fluid feed streams to a reaction zone while at the same time providing atomization of an uniform dispersion of the carbonaceous slurry in the oxygen-containing gas.

This invention provides a novel process burner for use in the manufacture of synthesis gas, fuel gas, or reducing gas by the partial oxidation of a carbonaceous slurry in a vessel which provides a reaction zone normally maintained at a pressure in the range of from about 15 to about 3500 psig (0.2 to 24 MPa), more preferably from about 30 to about 3500 psig (0.3 MPa to 24 MPa), most preferrably from 1500 to 2500 psig (10 to 17 MPa) and at a temperature within the range of from about 1700 to about 3500°F (900 to 1900°C). The burner is affixed to the vessel whereby the carbonaceous slurry, and oxygen-containing gas and, optionally, a temperature moderator are fed through the burner into the reaction zone. The burner additionally provides for feeding, into the reaction zone, a fuel gas such as methane. The burner is capable of selectively and contemporaneously handling all of these streams.

Due to its unique configuration, the process burner of this invention is capable of providing to the reaction zone the carbonaceous slurry in a highly atomized form, i.e., the carbonaceous slurry has a volume median droplet size in the range of from about 100 to about 600 micrometres. Not only is the carbonaceous slurry highly atomized it is also substantially uniformly dispersed in the oxygen-containing gas at the time that the slurry and gas are introduced into the reaction zone. By being able to provide such atomization and uniformity of dispersion, improved and highly uniform combustion is achieved in the reaction zone. Prior art process burners which do not provide the degree of atomization or dispersion of the carbonaceous slurry and the oxygen-containing gas can experience uneven burning, hot spots, and the production of unwanted by-products, such as carbon or CO_2. It is also an important feature of this invention that the uniform dispersion and atomization occur interiorly of the nozzle. Having the dispersion and atomization substantially completed within the nozzle, allows for more exact control of the degree of atomization of the carbonaceous slurry before it is combusted in the reaction zone. The prior art nozzles which attempt to effect most, if not all, of the atomization within the reaction zone have less control over particle size as further atomization is forced to occur in an area, i.e., the reaction zone, which is by atomization standards unconfined. Also, the atomization process in the reaction zone has to compete time-wise with the combustion of the carbonaceous slurry and the oxygen-containing gas.

Another feature of the process burner of this invention is that it provides for the introduction of fuel gas to the reaction zone, which introduction is exterior of the process burner. One of the benefits realized by the exterior introduction of the fuel gas is that the fuel gas flame is maintained at a distance from the burner face. If the fuel gas flame is adjacent the burner face, then burner damage can occur. When the oxygen-containing gas is high in O_2 content, say 50 percent, then the introduction of fuel gas from the interior of the process burner is most undesirable as the flame propagation of most fuel gases in a high O_2 atmosphere is very rapid. Thus, there is always the danger that the flame could propagate up into the burner causing severe damage to the burner.

When the burner is used for manufacture of H_2 and CO, an improved process results. In a process for the manufacture of a gas comprising H_2 and CO by the partial oxidation of a carbonaceous slurry in a vessel which provides a reaction zone normally maintained at a pressure in the range of from about 15 to about 3500 psig (0.2 to 24 MPa) and at a temperature of from about 1700 to about 3500°F (900 to 1900°C), the improvement comprises:

(a) introducing, as reactants, a carbonaceous slurry and an oxygen-containing gas to said reaction zone, said carbonaceous slurry being substantially uniformly dispersed within said oxygen-containing gas and being atomized prior to said reactants entering said reaction zone;

(b) introducing into said reaction zone that amount of fuel gas needed to maintain said reaction zone at said temperature, said fuel gas being introduced by directing it into the reactants of (a) after their entry into said reaction zone to effect mixing of said fuel gas and the entering reactants;

(c) reacting, by partial oxidation, the introduced reactants of (a) within said reaction zone to produce said gas comprising H_2 and CO; and,

(d) reacting, by partial oxidation, said amount of introduced fuel gas of (b) with at least a portion of said introduced oxygen-containing gas reactant of (a).

In one embodiment of this invention, as shown in Figure 1, the process burner has structure to provide a center cylindrical oxygen-containing gas stream, an annular carbonaceous slurry stream and a frusto-conical oxygen-containing gas stream. These streams are concentric with and radially displaced from another so that the center gas stream is within the annular carbonaceous slurry stream and so that the annular carbonaceous slurry stream will intersect the frusto-conical oxygen-containing gas stream at an angle within the range of from about 15° to about 75°. The velocities of the oxygen-containing gas streams are within the range of from about 75 ft/sec (23 m/s) to about sonic velocity and are greater than the slurry stream which has a minimum velocity of about 1 ft/sec (0.3 m/s). Substantially uniform dispersion of the carbonaceous slurry in the oxygen-containing gas is achieved by the arrangement of streams and their velocity disparity.

The frusto-conical and the center cylindrical oxygen-containing gas streams both provide shearing of the annular slurry stream to effect the dispersion and initial atomization of the slurry stream. Subsequent to the dispersion and initial atomization, the dispersion of slurry and gas is passed through an acceleration zone. The acceleration zone can be provided by a downstream hollow right cylindrical conduit located adjacent the apex of the frusto-conical stream. For the present embodiment, the hollow cylindrical conduit has a cross-sectional area which is less than the combined cross-sectional areas of the annular carbonaceous slurry stream and the center cylindrical and frusto-conical oxygen-containing streams. The operation and dimensioning criteria of this hollow cylindrical conduit are the same as that for the hollow cylindrical conduit of the subsequently described second proces burner embodiment.

This process burner provides for feed of a fuel gas to the reaction zone for dispersion within the carbonaceous slurry/oxygen-containing gas dispersion in the reaction zone. This fuel gas dispersion occurs exteriorly of the process burner.

Thus a first embodiment of the invention provides a burner which comprises:

(a) a hollow cylindrical central conduit having fluid feed means at its distal end and an opening at its proximate end;

(b) a first annular conduit coaxial with and circumscribing at least a portion of the length of said central conduit, said first annular conduit having fluid feed means at its distal end and an opening at its proximate end;

(c) a second annular conduit coaxial with and circumscribing at least a portion of the length of said first annular conduit, said second annular conduit having fluid feed means at its distal end and an opening at its proximate end;

(d) a hollow cylindrical acceleration conduit having a cross-sectional area less than the combined cross-sectional areas of said central conduit, said first annular conduit and said second annular conduit, and having at its proximate end, an opening located on the outside face of said burner;

(e) a frusto-conical surface connecting, at its apex, the distal end of said acceleration conduit and, at its base, the proximate end outside diameter of said second annular conduit; and

(f) at least one gas conduit which is in fluid communication with a port located on the outside face of said burner.

To achieve the uniform dispersion of the carbonaceous slurry within the oxygen-containing gas, another embodiment of this invention features a process burner which provides structure to yield a frusto-conical stream of the oxygen-containing gas which is at a first velocity, as shown in Figure 2. Other burner structure provides a carbonaceous slurry stream which is cylindrical in shape and which is at a second velocity. The cylindrical stream is located so that it intersects the inside surface of the frusto-conical stream of the oxygen-containing gas. The angle of intersection is preferably within the range of from about 15° to about 75°. The frusto-conical stream preferably has a velocity of from about 75 ft/sec (23 m/s) to sonic velocity and should be greater than the preferred velocity of the carbonaceous slurry stream which is within the range of from about 1 to about 50 ft/sec (0.3 to 15 m/s).

By providing the intersection of the cylindrical carbonaceous slurry stream with the frusto-conical oxygen-containing gas stream and by having the disparity between the two streams's velocities, the substantially uniform dispersion provided by the process nozzle of this invention is achieved. It is believed, but the process burner of this invention is not limited to this theory, that the frusto-conical stream shears and at least atomizes a portion the cylindrical slurry stream.

After the desired uniform dispersion is achieved, the carbonaceous slurry is further atomized within the process burner. This further atomization is preferably achieved by providing an acceleration zone through which the dispersed slurry and gas are passed. Such a zone is preferably provided adjacent the apex of the frusto-conical stream and comprises a downstream hollow cylindrical conduit which has a cross-sectional area less than the combined cross-sectional area of the cylindrical carbonaceous slurry stream and the frusto-conical oxygen-containing gas stream. A pressure P_1 measured at the juncture of the frusto-conical apex and the distal end of the acceleration conduit is maintained to be greater than the pressure P_2, measured just exteriorly of the proximate end of the acceleration zone. The P_1-P_2 pressure difference is preferably maintained between 10 and 1500 psi (0.2 and 1.5 MPa). In accordance with the laws of fluid dynamics and with the assumption of a constant stream throughput, the two streams will be accelerated as they pass through the cylindrical conduit. The gas portion of the dispersed streams will accelerate quicker than the slurry component thereby causing further shearing of the slurry particles to yield more atomization of the slurry. The length and diameter of the cylindrical acceleration conduit is determinative, at least in part, to the degree of atomization that occurs. The diameter and length of the acceleration conduit depends on the P_1-P_2 difference, slurry viscosity, temperature of the slurry and gas, the presence of a temperature moderator, relative amounts of the slurry and gas, and the like. With so many interrelated variables, empirical determination of the diameter and length of the acceleration conduit is required.

This second embodiment of the present invention provides a burner which comprises:

(a) a hollow cylindrical central conduit having fluid feed means at its distal end and an opening at its proximate end;

(b) a first annular conduit coaxial with and circumscribing at least a portion of the length of said central conduit, said first annular conduit having fluid feed means at its distal end and an opening at its proximate end;

(c) a hollow cylindrical acceleration conduit hav-

ing a uniform cross-sectional area less than combined cross-section areas of said central conduit and said first annular conduit and having at its proximate end, an opening located on the outside face of said burner;

(d) a frusto-conical surface connecting, at its apex, the distal end of said acceleration conduit and, at its base, the proximate end outside diameter of said first annular conduit; and

(e) at least one gas conduit which is in fluid communication with a port located on the outside face of said burner.

The non-catalytic partial oxidation process for which the process burners of this invention are especially useful produces a raw gas stream in a reaction zone which is provided by a refractory-lined vessel. The process burner can be either temporarily or permanently mounted to the vessel's burner port. Permanent mounting can be used when there is additionally permanently mounted to the vessel a pre-heat burner. In this case, the pre-heat burner is turned on to achieve the initial reaction zone temperature and then turned off. After the pre-heat burner is turned off, the process burner of this invention is then operated. Temporary mounting of the process burner is used in those cases where the pre-heat burner is removed after the initial heating and replaced by the process burner.

As mentioned previously, for the manufacture of synthesis gas, fuel gas or reducing gas, by the partial oxidation of a carbonaceous slurry, generally takes place in a reaction zone having a temperature within the range of from about 1700 to about 3500°F (900 to 1900°C) and a pressure within the range of from about 15 to about 3500 psig (0.2 to 24 MPa). A typical partial oxidation gas generating vessel is described in U.S. Patent No. 2,809,104. The produced gas stream contains, for the most part, hydrogen and carbon monoxide and may contain one or more of the following CO_2, H_2O, N_2, Ar, CH_4, H_2S and COS. The raw gas stream may also contain, depending upon the fuel available and the operating conditions used, entrained matter such as particulate carbon soot, flash or slag. Slag which is produced by the partial oxidation process and which is not entrained in the raw gas stream will be directed to the bottom of the vessel and continuously removed thereform.

The term "carbonaceous slurries" as used herein refers to slurries of solid carbonaceous fuels which are pumpable and which generally have a solids content within the range of from about 40 to about 80 percent and which are passable through the hereinafter described conduits of the process nozzles of this invention. These slurries are generally comprised of a liquid carrier and the solid carbonaceous fuel. The liquid carrier may be either water, liquid hydrocarbonaceous materials, or mixtures thereof. Water is the preferred carrier. Liquid hydrocarbonaceous materials which are useful as carriers are exemplified by the following materials: liquified petroleum gas, petroleum distillates and residues, gasoline, naptha, kerosene, crude petroleum, asphalt, gas oil, residual oil, tar, sand oil, shale oil, coal-derived oil, coal tar, cycle gas oil from fluid catalytic cracking operations, fufural extract of coke or gas oil, methanol, ethanol, other alcohols, by-product oxygen-containing liquid hydrocarbons from oxo and oxyl synthesis and mixtures thereof, and aromatic hydrocarbons such as benzene, toluene and xylene. Another liquid carrier is liquid carbon dioxide. To ensure that the carbon dioxide is in liquid form, it should be introduced into the process burner at a temperature within the range of from about -67°F to about 100°F (-55 to 40°C) depending upon the pressure. It is reported to be most advantageous to have the liquid slurry comprise from about 40 to about 70 weight percent solid carbonaceous fuel when liquid CO_2 is utilized.

The solid carbonaceous fuels are generally coal, coke from coal, char from coal, coal liquification residues, petroleum coke, particulate carbon soot in solids derived from oil shale, tar sands or pitch. The type of coal utilized is not generally critical as anthracite, bituminous, sub-bituminous and lignite coals are useful. Other solid carbonaceous fuels are, for example: bits of garbage, dewatered sanitary sewage, and semi-solid organic materials such as asphalt, rubber and rubber-like materials including rubber automobile tyres. As mentioned previously, the carbonaceous slurry used in the process burner of this invention is pumpable and is passable through the process burner conduits designated. To this end, the solid carbonaceous fuel component of the slurry should be finely ground so that substantially all of the material passes through the ASTM E 11-70C Sieve Designation Standard 140mm (Alternative Number 14) and at least 80 percent passes through an ASTM E 11-70C Sieve Designation Standard 425mm (Alternative Number 40). The sieve passage being measured with the solid carbonaceous fuel having a moisture content in the range of from about 0 to about 40 weight percent.

The oxygen-containing gas utilized in the process burner of this invention can be either air, oxygen-enriched air, i.e., air that contains greater than 20 mole percent oxygen, and substantially pure oxygen.

As mentioned previously, temperature moderators may be utilized with the subject process burner. These temperature moderators are usually used in admixture with the carbonaceous slurry stream and/or the oxygen-containing gas stream. Exemplary of suitable temperature moderators are water, steam, CO_2, N_2 and a recycled portion of the gas produced by the partial oxidation process described herein.

The fuel gas which is discharged exteriorly of the subject process burner includes such gases as methane, ethane, propane, butane, synthesis gas, hydrogen and natural gas.

The high dispersion and atomization features of the process burners of this invention and other features which contribute to satisfaction in use and economy in manufacture for the process burner will be more fully understood from the following description of preferred embodiments of the invention when taken in connection with the accompanying drawings in which identical numbers refer to identical parts and in which:

Figure 1 is a vertical cross-sectional view showing a process burner of this invention;

Figure 2 is a vertical cross-sectional view showing another process burner of this invention;

Figure 3 is a sectional view taken through section lines 3-3 in Figure 1; and

Figure 4 is a sectional view taken through section lines 4-4 in Figure 2.

Referring now to Figures 1 and 3, there can be seen a process burner of this invention, generally designated by the numeral 10. Process burner 10 is installed with the downstream end passing downwardly through a port made available in a partial oxidation synthesis gas reactor. Location of process burner 10, be it at the top or at the side of the reactor, is dependent upon reactor configuration. Process burner 10 may be installed either permanently or temporarily depending upon whether or not it is to be used with a permanently installed pre-heat burner or is to be utilized as a replacement for a pre-heat burner, all in the manner as previously described. Mounting of process burner 10 is accomplished by the use of annular flange 48.

Process burner 10 has a centrally disposed tube 22 which is closed off at its upper end by plate 21 and which has at its lower end a converging frusto-conical wall 26. At the apex of the frusto-conical wall 26 is opening 35 which is in fluid communication with acceleration zone 33. Acceleration zone 33, at its lower end, terminates into opening 30. For the embodiment shown in the drawings, acceleration zone 33 is a hollow right cylindrically shaped zone.

Passing through and in gas-tight relationship with an aperture in plate 21 is carbonaceous slurry feed line 14. Carbonaceous slurry feed line 14, at its lowermost end, is connected to a port in an annular plate 17 which closes off the upper end of a distributor 16. Distributor 16 has a converging frusto-conical lower wall 19. At the apex of frusto-conical wall 19 is a downwardly depending tube 28 which defines with a coaxial tube 23 an annular slurry conduit 25. The inside diameter of tube 28 is substantially less than the inside diameter, at its greatest extent, of distributor 16. It has been found that by utilising distributor 16 the flow of carbonaceous slurry from the opening found at the bottom of conduit 25 will be substantially uniform throughout its annular extent. Determination of the inside diameter of the distributor 16 and the inside diameter of tube 28 is made so that the pressure drop that the carbonaceous slurry experiences as it passes through annular conduit 25, defined by the inside wall of tube 28 and the outside wall of tube 23, is much greater than the difference between the highest and lowest pressures present in the slurry measured across any annular horizontal cross-sectional plane inside of distributor 16. If this pressure relationship is not maintained, it has been found that uneven annular flow will occur from annular conduit 25 resulting in the loss of dispersion efficiency when the carbonaceous slurry contacts the frusto-conical oxygen-containing gas streams as hereinafter described.

The difference in the inside and outside diameters of annular conduit 25 is at least partially dependent upon the fineness of the carbonaceous material found in the slurry. The diameter difference of annular conduit 25 should be sufficiently large to prevent plugging with the particular size of the carbonaceous material found in the slurry utilized. The difference in inside and outside diameters of annular conduit 25 will, in many applications, be within the range of from about 0.1 to about 1.0 inches (0.2 to 2.5 cm).

Coaxial with both the longitudinal axis of distributor 16 and downwardly depending tube 28 is tube 23 which has, throughout its extent, a substantially uniform diameter. The tube 23 provides a conduit 27 for the passage of an oxygen-containing gas and is open at both its upstream and downstream ends with the downstream opening being substantially coplanar with the opening of the downstream end of tube 28.

The oxygen-containing gas is fed to process burner 10 through feed line 24. A portion of the oxygen-containing gas will pass into the open end of tube 23 and through conduit 27. The remainder of the oxygen-containing gas flows through annular conduit 31 defined by the inside wall of tube 22 and the outside wall of tube 28. The gas passing through conduit 31 will be accelerated as it is forced through the frusto-conical conduit 29 defined by frusto-conical surface 26 and a frusto-condical outer end surface 20 of the tube 28. The distance between frusto-conical surfaces 20 and 26 can be such to provide the oxygen-containing gas velocity required to effectively disperse the carbonaceous slurry flowing out of carbonaceous slurry conduit 25. For example, it has been found that when the oxygen-containing gas passes through conduit 27 at a calculated velocity of about 200 ft/sec (60m/s) and the carbonaceous slurry passes through annular conduit 25 at a velocity of about 8 ft/sec (2.5 m/s) and has an inside, outside diameter difference of about 0.3 inches (7.6 cm), the oxygen-containing gas should pass through the frusto-conical conduit at a calculated velocity of about 200 ft/sec (60 m/s). Generally speaking, for the flows just and hereinafter discussed, the distance between the two frusto-conical surfaces is within the range of from about 0.05 to about 0.94 inches (0.13 to 2.4 cm). With these flows and relative velocities, it has also been found that the height and diameter of acceleration zone 33 should be about 7 inches (18 cm) and about 1.4 inches (3.6 cm), respectively.

Frusto-conical surface 26 converges to the extended longitudinal axis of tube 28 along an angle within the range of from about 15° to about 75°. If the angle is too shallow, say 10°, then the oxygen-containing gas expends much of its energy impacting the surface. However, if the angle is too deep, then the shear achieved is minimized.

Concentrically located with respect to tube 22 is tubular water jacket 32. Water jacket 32 is closed off at its uppermost end by annular plate 58. At the lowermost end of water jacket 32 is annular plate 42 which extends inwardly but which provides an annular water passageway 43. Located within the annular space 39 found between the outside wall of tube

22 and the inside wall of water jacket 32 are three fuel gas conduits, 36, 40 and 41. The fuel gas conduits 36, 40 and 41 are provided by tubes 36a and 40a and 41a, respectively. Tubes 36a, 40a and 41a pass through apertures in flange 42 as seen in Figure 1. Fuel gas is fed through tubes 40a and 36a by way of feed lines 52 and 50 respectively. The feed line for tube 41a is not shown but is the same type utilized for the other tubes.

As can be seen in Figure 1, fuel gas conduits 40 and 36 (and likewise for fuel gas conduit 41), are angled towards the extended longitudinal axis of tube 28. The conduits are also equiangularly and equidistantly radially spaced about this same axis. This angling and spacing is beneficial as it uniformly directs the fuel gas into the carbonaceous slurry/oxygen-containing gas dispersion subsequent to its flow through opening 30. The choice of angularity for the fuel gas conduits should be such that the fuel gas is introduced sufficiently far away from the burner face but not so far as to impede quick mixing or dispersion of the fuel gas into the carbonaceous slurry/oxygen-containing gas stream. Generally speaking, the angles a_1 and a_2 as seen in Figure 1 should be within the range of from about 30° to about 70°.

Concentrically mounted and radially displaced outwardly from the outside wall of water jacket 32 is burner shell 44. The radial outward displacement of burner shell 44 provides for an annular water conduit 45. At the upper end of burner shell 44 is water discharge line 56. As is seen in Figure 1, water which enters through water feed line 54,flows to and through water passageway 43 and thence through annular water conduit 45 and out water discharge line 56. This flow of water is utilized to keep process burner 10 at a desired and substantially constant temperature.

Burner shell 44 is closed off at its upper end in a water-tight manner by annular flange 60. Burner shell 44 is terminated at its lowermost end by burner face 46.

In operation, the process burner 10 is brought on line subsequent to the reaction zone completing its pre-heat phase which brings the zone to a temperature within the preferred range of from about 1500 to about 2500°F (800 to 1400°C). The relative proportions of the feed streams and the optional temperature moderator that are introduced into the reaction zone through process burner 10, are carefully regulated so that a substantial portion of the carbon in the carbonaceous slurry and the fuel gas is converted to the desirable CO and H_2 components of the product gas and so that the proper reaction zone temperature is maintained.

The dwell time in the reactor for the feed streams subsequent to their leaving process burner 10 will be about 1 to about 10 seconds.

The oxygen-containing gas will be fed to process burner 10 at a temperature dependent upon its O_2 content. For air, the temperature will be from about ambient to about 1200°F (650°C), while for pure O_2, the temperature will be in the range of from about ambient to about 800°F (425°C). The oxygen-containing gas will be fed under a pressure of from about 30 to about 3500 psig (0.3 to 24 MPa). The carbonaceous slurry will be fed at a temperature of from about ambient to about the saturation temperature of the liquid carrier and at a pressure of from about 30 to about 3500 psig (0.3 to 24 MPa). The fuel gas, which is utilized to maintain the reaction zone at the desired temperature range, is preferably methane and is fed at a temperature of from about ambient to about 1200°F (650°C) and under a pressure of from about 30 to about 3500 psig (0.3 to 24 MPa). Quantitatively, the carbonaceous slurry, fuel gas and oxygen-containing gas will be fed in amounts to provide a weight ratio of free oxygen to carbon which is within the range of from about 0.9 to about 2.27.

The carbonaceous slurry is fed via feed line 14 to the interior of distributor 16 at a preferred flow rate of from about 0.1 to about 5 ft/sec (0.03 to 1.5 m/s). Due to the smaller diameter of carbonaceous slurry conduit 25, the velocity of the carbonaceous slurry will increase to be within the range of from about 1 to about 50 ft/sec (0.3 to 15 m/s).

The oxygen-containing gas is fed through feed line 24 and is made into two streams, one stream passing through gas conduit 27 and the other passing to form a frusto-conical stream in conduit 29. The oxygen-containing gas streams can have different velocities, for example, the velocity through gas conduit 27 can be 200 ft/sec (60 m/s) and the velocity through the frusto-conical conduit 29 can be 300 ft/sec (90 m/s). As mentioned previously, the annular carbonaceous stream exits carbonaceous slurry conduit 25 and is intersected by a frusto-conical stream of oxygen-containing gas just beneath the lowermost extent of tube 28 and tube 23. The resultant shearing of the annular carbonaceous slurry stream by the frusto-conical oxygen-containing gas stream from conduit 27 results in substantially uniform dispersion of the carbonaceous slurry within the oxygen-containing gas.

The resultant dispersion is then passed through acceleration zone 33 which is dimensioned and configured to accelerate the oxygen-containing gas to a sufficient velocity to further atomize the carbonaceous slurry to a volume median droplet size within the range of from about 100 to about 600 micrometres.

When burner nozzle 10 is initially placed into operation the rate of fuel gas feed will be predominant over the rate of carbonaceous slurry feed. As the carbonaceous slurry feed is increased, however, the rate of fuel gas feed is decreased. This contemporaneous slow conversion from fuel gas feed to carbonaceous slurry feed will continue until fuel gas feed is completely stopped. Should a reaction zone upset occur and the carbonaceous slurry feed have to be reduced, then the fuel gas feed will be brought back on line in an amount sufficient to keep the reaction zone within the desired temperature range.

Referring now to Figures 2 and 4, there can be seen another embodiment of this invention which is generally designated by the numeral 110. Process burner 110 has a central tube 112 which is closed off at its upper end by plate 114. Also located at the upper end of tube 112 is carbonaceous slurry feed line

122. Tube 112 defines within its interior a carbonaceous slurry conduit 113 which has at its lowermost portion an area of reduced diameter 116. By reducing the diameter of the lowermost portion, the carbonaceous slurry feed is accelerated to a velocity of from about 1 to about 50 ft/sec (0.3 to 15 m/s). By having the larger diameter for tube 112 above the area of reduced diameter less plugging of tube 112 is experienced.

A tube 124 is concentric to and has an inside diameter greater than the outside diameter of tube 112. Tube 124 is closed off at its upper end by annular plate 120 which has an aperture therein for the mounting of tube 112 as is seen in Figure 2. Oxygen-containing gas feed line 144 is provided near the upper extent of tube 124. Tube 124, at its lower end, has a converging frusto-conical surface 126. This surface extends to a point beneath the inside surface which defines reduced diameter 116 as is shown in Figure 2. Frusto-conical surface 126, in conjunction with a frusto-conical outer end surface 118 of tube 112, provides a frusto-conical conduit 127 for the passage of the oxygen-containing gas. The distance between frusto-conical surfaces 118 and 126 is determined by the desired velocity for the oxygen-containing gas as it passes through the frusto-conical conduit 127. Generally speaking, for flows hereinafter discussed, the distance between the two frusto-conical surfaces is within the range of from about 0.05 to about 0.95 inches (0.13 to 2.4 cm). The desired velocity of the oxygen-containing gas as it passes through frusto-conical conduit 127 will affect the shearing of the carbonaceous slurry as it exits conduit 113. This shearing results in substantially uniform dispersion of the carbonaceous slurry in the oxygen-containing gas.

The frusto-conical surface converges to the extended longitudinal axis of tube 112 along an angle within the range of from about 15° to about 75°. If the angle is too shallow, say 10°, then the oxygen-containing gas expends much of its energy impacting the surface. However, if the angle is too deep, then the shear achieved is minimized.

Located at the apex of frusto-conical surface 126 is acceleration zone 130. For the embodiment shown in Figures 2 and 4, this acceleration zone is a hollow right cylinder having an opening at its upper end 131 and an opening 133 at its lower end. The dimensions of acceleration zone 130 can be the same as those for acceleration zone 33 used for the embodiment of Figures 1 and 3, assuming comparable stream flows. It may be beneficial to provide the acceleration zone with a wear resistant lining such as one made of tungsten carbide.

Concentrically mounted and radially displaced outward from the outside wall of tube 124 is water jacket 146. Water jacket 146 is closed off at its upper end by annular plate 148 which has an aperture therein for the passing and mounting of tube 124 as can be seen in Figure 2. Plate 148 also has three further apertures which are used for the passing and mounting of fuel gas feed lines 136 and 138 and the not shown feed line which is associated with fuel gas tube 143. Water jacket 146 provides an annular space 145 defined by its inside wall and the outside wall of tube 124. Within annular space 145, there are located three fuel gas tubes 142, 143 and 152. These tubes define respectively fuel gas conduits 142a, 143a and 152a. As can be seen Figure 2 and 4, fuel gas tubes 142, 143 and 152 are equiangularly and equiradially spaced from and angled downwardly towards the extended longitudinal axis of tube 112. The purpose of such angling and spacing for the embodiments shown in Figures 2 and 4 is the same for the angling of the fuel gas tubes described hereinabove for the embodiments shown in Figures 1 and 3.

Not only does annular space 145 contain the fuel gas tubes, but also it is utilized to provide a conduit for the passage of cooling water which is fed through cooling water feed line 150 which is located at the upper end of water jacket 146. Water jacket 146 has at its lower end an annular plate 140 which provides for water passageway 147 as shown in Figure 2. Also note that the fuel gas tubes pass through apertures in annular flange 140 for mounting purposes.

Also provided by process burner 110 is concentric outer burner shell 154 having a bottom face 158. Outer burner shell 154 is radially displaced outwardly so that its inside wall and the outside wall of tube 146 provide for cooling water conduit 151. Water conduit 151 is in liquid communication with annular space 145 by way of water passageway 147. Thus, water entering water feed line 150 passes through annular space 145, to passageway 147 and thence upward in conduit 151 so that it can be discharged through discharge line 160. Water conduit 151 is closed off at its top by annular flange 156.

Process burner 110 is mounted to the gas generator by way of flange 162 so that process burner 110 discharges directly into the reaction zone. The mounting of process burner 110 can be either in a temporary or permanent fashion depending upon whether or not it is to be utilized as a replacement for the pre-heat burner or is to be utilized in conjunction with a permanently mounted pre-heat burner. The temporary mounting is used when the pre-heat burner is to be replaced by process burner 110 after the reaction zone has been brought to the desired temperature range. Permanent mounting is used when the pre-heat burner is permanently affixed to the vessel.

In operation, process burner 110 is brought on line subsequent to the reaction zone completing its preheat phase to bring it to a temperature of from about in the reactor for the feed streams, subsequent to 1500 to 2500°F (800 to 1400°C). The dwell time in the reactor for the feed streams, subsequent to their leaving the process burner is from about 1 to about 10 seconds. The oxygen-containing gas fed to process burner 110 is at a temperature within the range of from about ambient to about 1200°F (650°C) while the carbonaceous slurry will be fed at a temperature of from about ambient to saturation temperature of the carrier liquid. The fuel gas is supplied to process burner 110 at a temperature of from about ambient to about 1200°F (650°C). Pressure-wise, the oxygen-containing gas is fed to the burner at a pressure of from about 30 to about 3500 psig, (0.3 to 24 MPa) while the car-

bonaceous slurry is fed under a pressure of from about 30 to about 3500 psig (0.3 to 24 MPa). The pressure under which the fuel gas is fed is advantageously from about 30 to about 3500 psig (0.3 to 24 MPa). Carbonaceous slurry, fuel gas and oxygen-containing gas are supplied to the burner in amounts sufficient to provide a weight ratio of free oxygen to carbon within the range of from about 0.9 to about 2.27.

When burner nozzle 110 is initially placed into operation, the rate of fuel gas feed will be predominant over the rate of carbonaceous slurry feed. The carbonaceous slurry feed increases as the fuel gas feed is decreased until there is no fuel gas feed and the carbonaceous slurry feed is at its maximum rate. Should there be reason to interrupt the carbonaceous feed slurry totally or in part the fuel gas feed can be brought on line to aid in the maintenance of the reaction zone temperature.

The carbonaceous slurry is fed through feed line 112 at the rate of from about 0.1 to about 5 ft/sec (0.03 to 1.5 m/s). As the carbonaceous slurry moves through conduit 113, it encounters the reduced diameter portion 116 of tube 112. The velocity of the carbonaceous slurry is thereby increased to be within the range of from about 1 to about 50 ft/sec (0.3 to 15 m/s). Carbonaceous slurry exits tube 112 and encounters a frusto-conical stream of oxygen-containing gas which is provided through frusto-conical conduit 127. This frusto-conical stream has a velocity within the range of from about 75 ft/sec (23 m/s) to about sonic. The resultant shearing of the carbonaceous slurry stream results in its being substantially uniformly dispersed within the oxygen-containing gas. The dispersed mix then passes through acceleration zone 130 which has a cross-sectional area less than that of conduit 113 together with frusto-conical conduit 127. As is the case for the acceleration zone previously described for the embodiment of Figures 1 and 3, acceleration zone 130 has a lower pressure at its lower opening 133 than it does at its upper opening 131. This difference in pressure accelerates the oxygen-containing gas so that it causes atomization of the dispersed carbonaceous slurry as the dispersion mix passes through the acceleration zone. Atomization within the range of from about 100 to about 600 micrometres is achieved.

The fuel gas, when fed to the process burner, is fed through fuel gas feed lines 136, 138 and a like line which is not shown.

Claims

1. A process for the manufacture of a gas comprising H_2 and CO by the partial oxidation of a carbonaceous slurry in a vessel which provides a reaction zone normally maintained at a pressure in the range of from 0.2 to 24 MPa (15 to 3500 psig) and at a temperature of from 900 to 1900°C (1700 to 3500°F), characterised in that

(a) a carbonaceous slurry and an oxygen-containing gas are introduced, as reactants, to said reaction zone, said carbonaceous slurry being substantially uniformly dispersed within said oxygen-containing gas and being atomized prior to said reactants entering said reaction zone;

(b) that amount of fuel gas needed to maintain said reaction zone at said temperature is introduced into said reaction zone by directing it into the reactants of (a) after their entry into said reaction zone to effect mixing of said fuel gas and the entering reactants;

(c) the introduced reactants of (a) are reacted, by partial oxidation, within said reaction zone to produce said gas comprising H_2 and CO; and

(d) said amount of introduced fuel gas of (b) is reacted, by partial oxidation, with at least a portion of said introduced oxygen-containing gas reactants of (a).

2. A process as claimed in Claim 1, wherein said substantially uniform dispersion of said carbonaceous slurry in said oxygen-containing gas is effected by providing a frusto-conical stream of said oxygen-containing gas at a first velocity and a concurrent cylindrical stream of said carbonaceous slurry at a second velocity, said cylindrical stream of said carbonaceous slurry intersecting the inside surface of said frusto-conical stream of said oxygen-containing gas at an angle within the range of from 15° to 75° and wherein said first velocity is within the range of from 23 m/s (75 ft/sec) to sonic velocity and said second velocity is within the range of from 0.3 to 15 m/s (1 to 50 ft/sec).

3. A process as claimed in Claim 1 or Claim 2, wherein said substantially uniform dispersion of said carbonaceous slurry and said oxygen-containing gas is effected by providing:

(i) cylindrical stream of said oxygen-containing gas having a first velocity;

(ii) an annular stream of said carbonaceous slurry having a second velocity; and

(iii) a frusto-conical stream of said oxygen-containing gas having a third velocity, said streams being substantially concentric and radially displaced so that said cylindrical stream is within said annular stream and said annular stream intersects the inside surface of said frusto-conical stream at an angle within the range of from 15° to 75° and wherein said second velocity is within the range of from 0.3 to 15 m/s (1 to 50 ft/sec) and said first and third velocities are within the range of from 23 m/s (75 ft/sec) to sonic velocity.

4. A process as claimed in any one of the preceding claims, wherein atomization of said carbonaceous slurry is effected by passing the said substantially uniform dispersion of reactants through a zone in which the substantially uniformly dispersed reactants are accelerated, said oxygen-containing gas component being accelerated at a faster rate than said carbonaceous slurry component of the substantially uniform dispersion.

5. A process as claimed in Claim 4, wherein said acceleration is accomplished providing a pressure drop across said zone.

6. A process as claimed in any one of the preceding claims, wherein said fuel gas is introduced into said reaction zone as at least two streams.

7. A process as claimed in any one of the preceding claims, wherein the pressure is in the range of from 10 to 17 MPa (1500 to 2500 psig).

8. A burner which comprises:
(a) a hollow cylindrical central conduit having fluid feed means at its distal end and an opening at its proximate end;
(b) a first annular conduit coaxial with and circumscribing at least a portion of the length of said central conduit, said first annular conduit having fluid feed means at its distal end and an opening at its proximate end;
(c) a second annular conduit coaxial with and circumscribing at least a portion of the length of said first annular conduit, said second annular conduit having fluid feed means at its distal end and an opening at its proximate end;
(d) a hollow cylindrical acceleration conduit having a cross-sectional area less than the combined cross-sectional area of said central conduit, said first annular conduit and said second annular conduit, and having at its proximate end, an opening located on the outside face of said burner;
(e) a frusto-conical surface connecting, at its apex, the distal end of said acceleration conduit and, at its base, the proximate end outside diameter of said second annular conduit; and
(f) at least one gas conduit which is in fluid communication with a port located on the outside face of said burner.

9. A burner which comprises:
(a) a hollow cylindrical central conduit having fluid feed means at its distal end and an opening at its proximate end;
(b) a first annular conduit coaxial with and circumscribing at least a portion of the length of said central conduit, said first annular conduit having fluid feed means at its distal end and an opening at its proximate end;
(c) a hollow cylindrical acceleration conduit having a uniform cross-sectional area less than the combined cross-sectional areas of said central conduit and said first annular conduit and having at its proximate end, an opening located on the outside face of said burner;
(d) a frusto-conical surface connecting, at its apex, the distal end of said acceleration conduit and, at its base, the proximate end outside diameter of said first annular conduit; and
(e) at least one gas conduit which is in fluid communication with a port located on the outside face of said burner.

10. A burner as claimed in Claim 9, wherein the proximate end of said central conduit is located between the plane in which the base of said frusto-conical lies and the plane in which the apex of said frusto-conical lies.

11. A burner as claimed in Claim 8, wherein the proximate end of said first annular conduit is located between the plane in which the base of said frusto-conical lies and the plane in which the apex of said frusto-conical lies.

12. A burner as claimed in any one of Claims 8 to 11, wherein there are at least two of said ports equiradially displaced from and equiangularly located around said opening on the outside face of said burner.

Patentansprüche

1. Verfahren zur Erzeugung eines Gases, das H_2 und CO enthält, durch partielle Oxidation einer kohlenstoffhaltigen Schlämme in einem Behälter mit einer Reaktionszone, in der gewöhnlich ein Druck im Bereich von 0,2 bis 24 MPa (15 bis 3500 psig) und eine Temperatur von 900 bis 1900°C (1700 bis 3500°F), herrscht, dadurch gekennzeichnet, daß
(a) eine kohlenstoffhaltige Schlämme und ein Sauerstoff enthaltendes Gas als Reaktanden in die Reaktionszone eingebracht werden und die kohlenstoffhaltige Schlämme im wesentlichen gleichförmig im Sauerstoff enthaltenden Gas dispergiert und zerstäubt wird, bevor die Reaktanden in die Reaktionszone eingebracht werden,
(b) die Menge an Brennstoffgas, die benötigt wird, um die Temperatur in der Reaktionszone aufrechtzuerhalten, in die Reaktionszone eingebracht wird, indem man sie in die Reaktanden aus (a) nach deren Eintritt in die Reaktionszone einleitet, um ein Vermischen des Brennstoffgases und der eintretenden Reaktanden zu bewirken,
(c) die eingebrachten Reaktanden aus (a) in der Reaktionszone durch partielle Oxidation umgesetzt werden, um ein Gas zu erzeugen, das H_2 und CO enthält, und
(d) die eingebrachte Menge an Brennstoffgas aus (b) durch partielle Oxidation mit mindestens einem Teil der eingebrachten, Sauerstoff enthaltenden gasförmigen Reaktanden aus (a) umgesetzt wird.

2. Verfahren nach Anspruch 1, worin man die im wesentlichen gleichförmige Dispersion der kohlenstoffhaltigen Schlämme im Sauerstoff enthaltenden Gas durch einen abgestumpft konischen Strom des Sauerstoff enthaltenden Gases mit einer ersten Geschwindigkeit und einem zusammenlaufenden zylindrischen Strom der kohlenstoffhaltigen Schlämme mit einer zweiten Geschwindigkeit bewirkt, wobei der zylindrische Strom der kohlenstoffhaltigen Schlämme die innere Oberfläche des abgestumpft konischen Stroms des Sauerstoff enthaltenden Gases in einem Winkel zwischen 15° und 75° schneidet und die erste Geschwindigkeit von 23 m/s (75 ft/sec) bis Schallgeschwindigkeit und die zweite Geschwindigkeit von 0,3 bis 15 m/s (1 bis 50 ft/sec) beträgt.

3. Verfahren nach Anspruch 1 oder 2, worin man die im wesentlichen gleichförmige Dispersion der kohlenstoffhaltigen Schlämme im sauerstoffhaltigen Gas bewirkt durch:
(i) einen zylindrischen Strom des Sauerstoff enthaltenden Gases mit einer ersten Geschwindigkeit,
(ii) einen ringförmigen Strom der kohlenstoffhaltigen Schlämme mit einer zweiten Geschwindigkeit und
(iii) einen abgestumpft konischen Strom des Sauerstoff enthaltenden Gases mit einer dritten Geschwindigkeit, wobei die Ströme im wesentlichen

konzentrisch und radial angeordnet sind, so daß sich der zylindrische Strom innerhalb des ringförmigen Stroms befindet und der ringförmige Strom die innere Oberfläche des abgestumpft konischen Stroms in einem Winkel von 15° bis 75° schneidet und worin die zweite Geschwindigkeit von 0,3 bis 15 m/s (1 bis 50 ft/sec) und die erste und die dritte Geschwindigkeit von 23 m/s (75 ft/sec) bis Schallgeschwindigkeit betragen.

4. Verfahren nach einem der vorhergehenden Ansprüche, worin man die Zerstäubung der kohlenstoffhaltigen Schlämme bewirkt, indem man die im wesentlichen gleichförmige Dispersion der Reaktanden durch eine Zone leitet, in der die im wesentlichen gleichförmig dispergierten Reaktanden beschleunigt werden, wobei der aus Sauerstoff enthaltendem Gas bestehende Anteil mit einer höheren Rate als der aus kohlenstoffhaltiger Schlämme bestehende Anteil der im wesentlichen gleichförmigen Dispersion beschleunigt wird.

5. Verfahren nach Anspruch 4, worin die Beschleunigung durch einen Druckabfall über besagte Zone bewirkt wird.

6. Verfahren nach einem der vorhergehenden Ansprüche, worin das Brennstoffgas in mindestens zwei Strömen in die Reaktionszone eingebracht wird.

7. Verfahren nach einem der vorhergehenden Ansprüche, worin der Druck in einem Bereich von 10 bis 17 MPa (1500 bis 2500 psig) liegt.

8. Brenner, enthaltend:

(a) ein hohlzylindrisches Zentralrohr mit einer Zufuhreinrichtung für Flüssigkeiten an seinem entfernten Ende und einer Öffnung an seinem nahegelegenen Ende,

(b) ein erstes ringförmiges Rohr, das mindestens einen Teil der Länge des Zentralrohres konzentrisch umschließt, wobei das erste ringförmige Rohr eine Zufuhreinrichtung für Flüssigkeiten an seinem entfernten Ende und eine Öffnung an seinem nahegelegenen Ende besitzt,

(c) ein zweites ringförmiges Rohr, das mindestens einen Teil der Länge des ersten ringförmigen Rohres konzentrisch umschließt, wobei das zweite ringförmige Rohr eine Zufuhreinrichtung für Flüssigkeiten an seinem entfernten Ende und eine Öffnung an seinem nahegelegenen Ende besitzt,

(d) ein hohlzylindrisches Beschleunigungsrohr mit einer geringeren Querschnittsfläche als die vereinigte Querschnittsfläche von Zentralrohr, erstem und zweitem ringförmigem Rohr mit einer Öffnung an seinem nahegelegenen Ende, die sich in der Außenwand des Brenners befindet,

(e) eine abgestumpft konische Außenwand, die von ihrem Scheitelpunkt, dem entfernten Ende des Beschleunigungsrohres, bis zu ihrer Basis, dem Außendurchmesser am nahegelegenen Ende des zweiten ringförmigen Rohres reicht,

(f) mindestens ein Gasrohr, das in Flüssigkeits-Kommunikation mit einem Eingang steht, der sich in der Außenwand des Brenners befindet.

9. Brenner, enthaltend:

(a) ein hohlzylindrisches Zentralrohr mit einer Zufuhreinrichtung für Flüssigkeiten an seinem entfernten Ende und einer Öffnung an seinem nahegelegenen Ende,

(b) ein erstes ringförmiges Rohr, das mindestens einen Teil der Länge des Zentralrohres konzentrisch umschließt, wobei das erste ringförmige Rohr eine Zufuhreinrichtung für Flüssigkeiten an seinem entfernten Ende und eine Öffnung an seinem nahegelegenen Ende besitzt,

(c) ein hohlzylindrisches Beschleunigungsrohr mit einer geringeren einheitlichen Querschnittsfläche als die vereinigte Querschnittsfläche von Zentralrohr und erstem ringförmigem Rohr mit einer Öffnung an seinem nahegelegenen Ende, die sich in der Außenwand des Brenners befindet,

(d) eine abgestumpft konische Außenwand, die von ihrem Scheitelpunkt, dem entfernten Ende des Beschleunigungsrohres, bis zu ihrer Basis, dem Außendurchmesser am nahegelegenen Ende des ersten ringförmigen Rohres reicht, und

(e) mindestens ein Gasrohr, das in Flüssigkeits-Kommunikation mit einem Eingang steht, der sich in der Außenwand des Brenners befindet.

10. Brenner nach Anspruch 9, worin sich das nahegelegene Ende des Zentralrohres zwischen der Ebene, in der die Basis des Konus liegt, und der Ebene, in der der Scheitelpunkt des Konus liegt, befindet.

11. Brenner nach Anspruch 8, worin sich das nahegelegene Ende des ersten ringförmigen Rohres zwischen der Ebene, in der die Basis des Konus liegt, und der Ebene, in der der Scheitelpunkt des Konus liegt, befindet.

12. Brenner nach einem der Ansprüche 8 bis 11, worin es mindestens zwei Eingänge gibt, die in gleichem Abstand und gleichem Winkel um die Öffnung in der Außenwand des Brenners angeordnet sind.

Revendications

1. Procédé pour la fabrication d'un gaz comprenant H_2 et CO, par l'oxydation partielle d'une suspension carbonée dans un récipient qui présente une zone de réaction normalement maintenue à une pression comprise entre 0,2 et 24 MPa (15 et 3 500 psig) et à une température comprise entre 900 et 1 900°C (1 700 et 3 500°F), caractérisé en ce que

(a) une suspension carbonée et un gaz contenant de l'oxygène sont introduits, en tant que réactifs, dans ladite zone de réaction, ladite suspension carbonée étant dispersée de façon sensiblement uniforme dans ledit gaz contenant de l'oxygène et étant atomisée avant l'entrée desdits réactifs dans ladite zone de réaction;

(b) la quantité de gaz combustible nécessaire pour maintenir ladite zone de réaction à ladite température est introduite dans ladite zone de réaction en l'envoyant dans les réactifs de (a) après leur entrée dans ladite zone de réaction afin de réaliser un mélange dudit gaz combustible et des réactifs introduits;

(c) les réactifs introduits de (a) sont amenés à réagir, par oxydation partielle, dans ladite zone de réaction pour produire ledit gaz comprenant H_2 et CO; et

(d) ladite quantité de gaz combustible introduite

de (b) est amenée à réagir, par oxydation partielle, avec au moins une partie desdits réactifs gazeux introduits de (a) contenant de l'oxygène.

2. Procédé selon la revendication 1, dans lequel ladite dispersion sensiblement uniforme de ladite suspension carbonée dans ledit gaz contenant de l'oxygène est effectuée en réalisant un courant tronconique dudit gaz contenant de l'oxygène à une première vitesse et un courant cylindrique simultané de ladite suspension carbonée à une seconde vitesse, ledit courant cylindrique de ladite suspension carbonée rencontrant la surface inférieure dudit courant tronconique dudit gaz contenant de l'oxygène selon un angle compris entre 15° et 75°, et dans lequel ladite première vitesse est comprise entre 23 m/s (75 pieds/s) et la vitesse du son, et ladite seconde vitesse est comprise entre 0,3 et 15 m/s (1 à 50 pieds/s).

3. Procédé selon la revendication 1 ou la revendication 2, dans lequel ladite dispersion sensiblement uniforme de ladite suspension carbonée et dudit gaz contenant de l'oxygène est effectuée en réalisant:

(i) un courant cylindrique dudit gaz contenant de l'oxygène ayant une première vitesse;

(ii) un courant annulaire de ladite suspension carbonée ayant une seconde vitesse; et

(iii) un courant tronconique dudit gaz contenant de l'oxygène ayant une troisième vitesse, lesdits courants étant sensiblement concentriques et radialement décalés de façon que ledit courant cylindrique soit à l'intérieur dudit courant annulaire et que ledit courant annulaire rencontre la surface intérieure dudit courant tronconique selon un angle compris entre 15° et 75°, et dans lequel ladite seconde vitesse est comprise entre 0,3 et 15 m/s (1 et 50 pieds/s) et lesdites première et troisième vitesses sont comprises entre 23 m/s (75 pieds/s) et la vitesse du son.

4. Procédé selon l'une quelconque des revendications précédentes, dans lequel l'atomisation de ladite suspension carbonée est effectuée en faisant passer ladite dispersion sensiblement uniforme de réactifs à travers une zone dans laquelle les réactifs dispersés de façon sensiblement uniforme subissent une accélération, ledit constituant formé par un gaz contenant de l'oxygène subissant une accélération plus rapide que ladite suspension carbonée entrant dans la composition de la dispersion sensiblement uniforme.

5. Procédé selon la revendication 4, dans lequel ladite accélération est accomplie en réalisant une chute de pression à travers ladite zone.

6. Procédé selon l'une quelconque des revendications précédentes, dans lequel ledit gaz combustible est introduit dans ladite zone de réaction sous la forme d'au moins deux courants.

7. Procédé selon l'une quelconque des revendications précédentes, dans lequel la pression est comprise entre 10 et 17 MPa (1 500 et 2 500 psig).

8. Brûleur qui comporte:

(a) un conduit central cylindrique creux ayant à son extrémité distale un moyen d'alimentation en fluide et à son extrémité proximale une ouverture;

(b) un premier conduit annulaire coaxial avec ledit conduit central et englobant au moins une partie de la longueur de celui-ci, ledit premier conduit annulaire ayant à son extrémité distale un moyen d'alimentation en fluide et à son extrémité proximale une ouverture;

(c) un second conduit annulaire coaxial avec ledit premier conduit annulaire et englobant au moins une partie de la longueur de celui-ci, ledit second conduit annulaire ayant à son extrémité distale un moyen d'alimentation en fluide et à son extrémité proximale une ouverture;

(d) un conduit cylindrique creux d'accélération ayant une surface de section transversale plus petite que la surface de section transversale combinée dudit conduit central, dudit premier conduit annulaire et dudit second conduit annulaire, et ayant à son extrémité proximale une ouverture située sur la face extérieure dudit brûleur;

(e) une surface tronconique reliant, à son sommet, l'extrémité distale dudit conduit d'accélération et, à sa base, le diamètre extérieur de l'extrémité proximale dudit second conduit annulaire; et

(f) au moins un conduit de gaz qui fait communiquer un fluide avec un orifice situé sur la face extérieure dudit brûleur.

9. Brûleur qui comporte:

(a) un conduit central cylindrique creux ayant à son extrémité distale un moyen d'alimentation en fluide et à son extrémité proximale une ouverture;

(b) un premier conduit annulaire coaxial avec ledit conduit central et englobant au moins une partie de la longueur de celui-ci, ledit premier conduit annulaire ayant à son extrémité distale un moyen d'alimentation en fluide et à son extrémité proximale une ouverture;

(c) un conduit cylindrique creux d'accélération ayant une surface de section transversale inférieure aux surfaces de section transversale combinées dudit conduit central et dudit premier conduit annulaire et ayant, à son extrémité proximale, une ouverture située sur la face extérieure dudit brûleur;

(d) une surface tronconique reliant, à son sommet, l'extrémité distale dudit conduit d'accélération et, à sa base, le diamètre extérieur de l'extrémité proximale dudit premier conduit annulaire; et

(e) au moins un conduit de gaz qui fait communiquer un fluide avec un orifice situé sur la face extérieure dudit brûleur.

10. Brûleur selon la revendication 9, dans lequel l'extrémité proximale dudit conduit central se trouve entre le plan dans lequel est située la base de ladite surface tronconique et le plan dans lequel est situé le sommet de ladite surface tronconique.

11. Brûleur selon la revendication 8, dans lequel l'extrémité proximale dudit premier conduit annulaire se trouve entre le plan dans lequel est située la base de la surface tronconique et le plan dans lequel est situé le sommet de ladite surface tronconique.

12. Brûleur selon l'une quelconque des revendications 8 à 11, dans lequel au moins deux desdits orifices sont décalés équiradialement par rapport à ladite ouverture située sur la face extérieure dudit brûleur et sont situés selon des angles égaux autour de ladite ouverture.

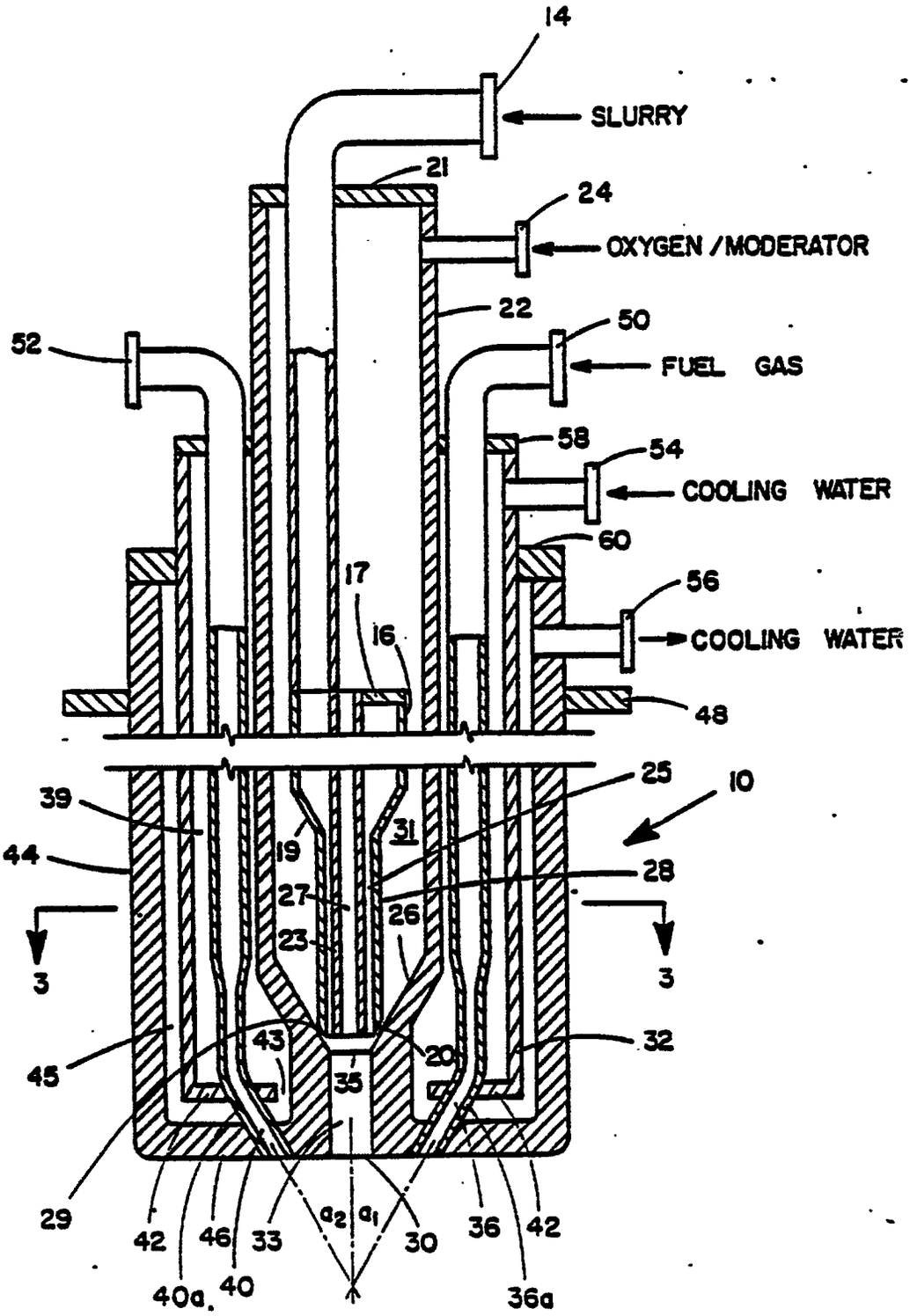

14
SLURRY
21
24
OXYGEN /MODERATOR
22
50
52
FUEL GAS
58
54
COOLING WATER
60
17
56
16
COOLING WATER
48
39
25
10
31
44
19
28
27
26
23
3
3
43
20
32
45
35
29
42
46
33
a_2
a_1
30
36
42
40a
40
36a

FIGURE 1

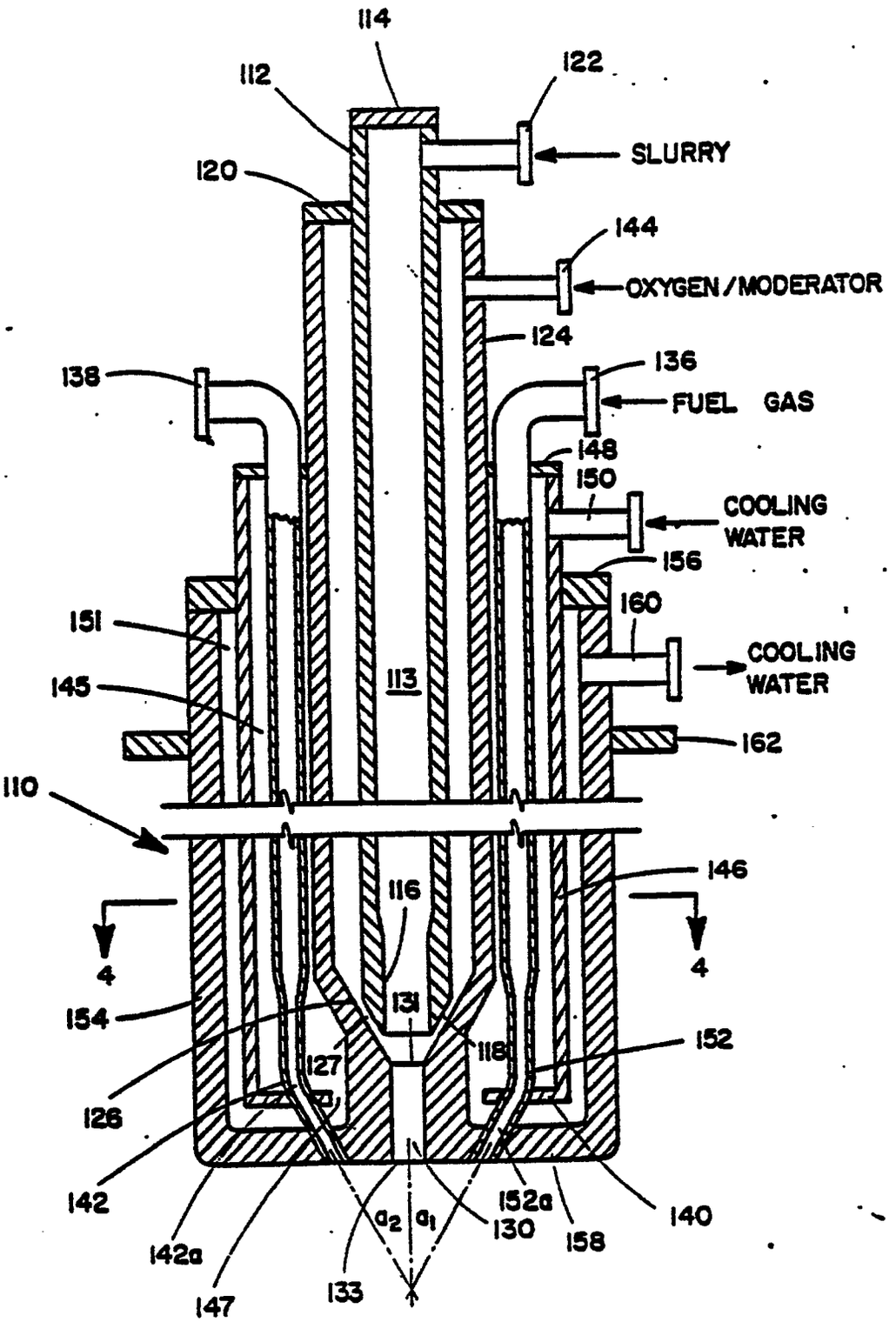

114
112
122
SLURRY
120
144
OXYGEN/MODERATOR
124
138
136
FUEL GAS
148
150
COOLING WATER
156
160
151
113
COOLING WATER
145
162
110
146
116
4
4
154
131
118
152
127
126
142
140
152a
130
158
142a
147
133
a_2
a_1

FIGURE 2

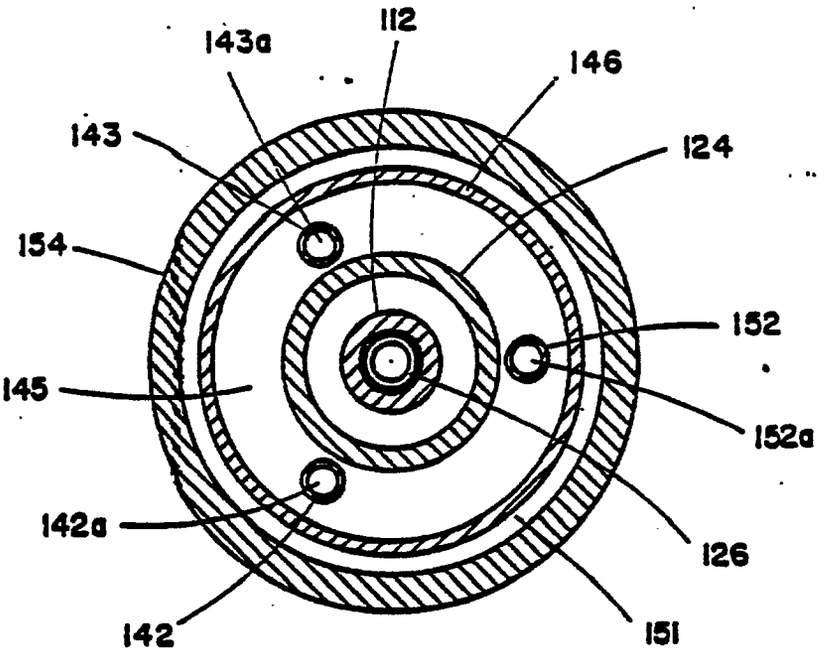


FIGURE 4

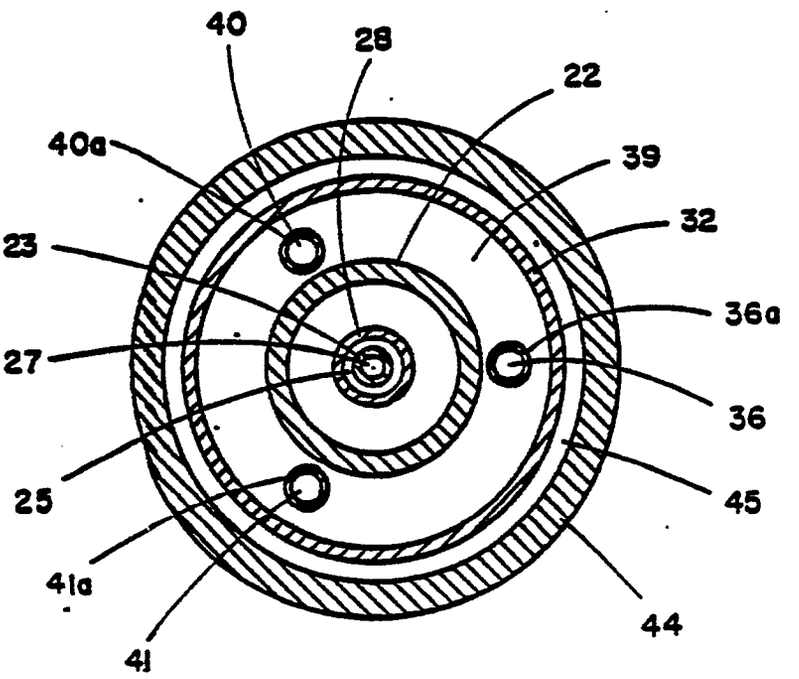


FIGURE 3