A system for controlling the temperature of a natural gas processing unit. The system having a main burner and a pilot burner operatively associated with the main burner, and temperature control means for regulating the temperature of the natural gas processing unit. A pilot valve is interposed between a fuel supply and the pilot burner and is responsive to the temperature control means so as to allow fuel to flow through the pilot valve and to the pilot burner when the natural gas processing unit is below a selected temperature. An igniter wire is operatively associated with the pilot burner and responsive to temperature control means for generating a spark that ignites fuel being discharged from pilot burner. A main burner control valve is interposed between the fuel supply and the main burner and is responsive to the temperature control means so as to allow fuel to flow through the main burner control valve and the main burner upon ignition of the pilot burner.
BURNER IGNITION CONTROL SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims benefit of U.S. Provisional Application No. 61/020,277, filed Jan. 10, 2008, which is incorporated herein by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention generally relates to burners for combustion of fuels, and specifically, but not by way of limitation, to a system for controlling a burner assembly having a pilot burner and a main burner, for example, of the kind used in natural gas production facilities.

[0004] 2. Brief Description of Related Art

[0005] Numerous burners and burner assemblies are known in the art. Many such burner assemblies include a pilot burner and a main burner. Facilities for the production of natural gas, as well as those for the production of oil and/or other hydrocarbons and fuels, often include heaters and/or burners, e.g., regenerators and the like, that burn natural gas and/or waste gases to heat the facilities or portions of the facilities. Additionally, such heaters and/or burners may further provide a means for disposing of or destroying waste gases by way of combustion that minimizes the environmental impact of such disposal. To both ends, it is desirable to ensure complete and efficient combustion of fuel gases and/or waste gases.

[0006] A source of waste of natural gas and liquid petroleum gases has been the practice of having the pilot burner flame operate associated with the main burners to remain continuously ignited. The reason for this has generally been for safety purposes. In the event of a gas leak through a main burner or pilot burner valve, the presence of a pilot flame would insulate that the leaking gas would ignite and thus prevent the collection of a large volume of gas that could be unexpectedly ignited with the consequent danger of explosion.

[0007] Numerous systems have been proposed for an automatically igniting a pilot flame. While many of such systems have achieved varying degrees of success, such systems are often overly complex, thereby increasing the probability of failure.

[0008] To this end, a need exists for a simple burner ignition control system in which the pilot burner is initially ignited only upon demand so as to ignite the main burner associated therewith, and then the pilot burner is extinguished when the main burner goes off so as to conserve the fuel that would otherwise be burned while the pilot burner was uselessly "idling," and which includes features that insure the safe operation of the system. It is to such a system that the present invention is directed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a schematic view of a burner ignition control system constructed in accordance with the present invention.

[0010] FIG. 1A is an enlarged, partially-cutaway view of a pilot burner of the system of FIG. 1.

[0011] FIG. 1B is an end view of FIG. 1A.

[0012] FIG. 2 is a schematic view of another embodiment of a burner ignition control system constructed in accordance with the present invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0013] Referring now to the drawings, and more particularly to FIG. 1, shown therein and designated by the reference numeral 10 is a burner ignition control system constructed in accordance with the present invention shown in association with a natural gas processing unit 12, such as a heated separator or a dehydrator re-boiler. For brevity, the burner ignition control system 10 may be interchangeably referred to herein as the burner ignition control system 10, the control system 10, and/or the system 10.

[0014] Among other components, the system 10 includes a system supply gas line 18 ("system line 18") connected to a gas supply 20, a control gas line 22 ("control line 22"), a pilot burner supply gas line 26 ("pilot line 26"), and a main burner supply gas line 30 ("main line 30"). The system 10 further includes a pilot burner 34, a main burner 38, a temperature controller 42, a main burner control valve 46, and various valves, sensors, pressure regulators, and the like. Although the system 10 will be described using a gaseous fuel, such as natural gas, it will be understood that the system 10 is equally applicable to other types of fuel.

[0015] It will be appreciated that, although not depicted in FIG. 1, the temperature controller 42 will be mounted to the gas processing unit 12 so as to be responsive to changes to the temperature gas processing unit 12. The temperature controller 42 is preferably of a pneumatic variety, such that the pressure of gas permitted to pass through, or output from, the temperature controller 42 is preferably varied by the temperature controller 42 relative to the temperature sensed by the temperature controller 42. In other embodiments, the temperature controller 42 may be substituted and/or supplemented with any suitable temperature controller, such as, for example, an electric temperature controller, a mechanical temperature controller, or the like. Similarly, in other embodiments, the temperature controller 42 may be substituted and/or supplemented with any suitable sensor and/or control device that varies its respective output in response to any suitable property or signal. For example, the temperature controller 42 may be substituted and/or supplemented with a remotely-controlled and/or pre-programmed adjustable valve. By way of another example, the temperature controller 42 may be substituted and/or supplemented with a sensor and/or valve that responds to or varies with the pressure of gas in one of, or any combination of, the gas lines, e.g., 18, 22, 26, and 30.

[0016] The system 10 shown in FIG. 1 includes a pilot burner control valve 54, a pilot valve control line 58, an igniter controller 62, a sensor line 66, an igniter wire 70, an igniter tip 74, a main safety valve 78, and a pilot safety valve 82. The igniter controller 62 includes a power source 86, an output 90, a pressure sensor 94, and a computerized logic device 96. The power source 86 preferably includes a battery (not separately shown), such as a 12V battery, and a solar panel (not separately shown). As is known in the art, the solar panel functions to keep the battery charged and/or supplement the output of the battery to the igniter controller 62, such as at times of increased and/or peak power demand. As shown, the power supply 86 is preferably connected to the igniter controller 62 by one or more connectors 98, such as wires and/or any other...
suitable electrical connectors and/or connections 98. The output 90 may be a wired and/or wireless output, such as, for example, a telephone line, Internet connection, transmitter, transceiver, and/or any other suitable output 90 that permits the system 10 to function as described herein. The computerized logic device 96 may be, by way of example, a programmable logic controller, central processing unit, digital signal processor, or micro-controller.

The burner ignition control system 10 is applicable to new production equipment installations, or existing production facilities may be retrofitted to provide the system 10. The method and/or means of concurrent installation of the system 10 with a current production facility will be apparent from a description of a retrofit installation, and, as such, the retrofit installation will be described herein. The order of steps described herein are not necessarily indicative of a required order of performance. Rather, the steps described herein may be performed in any suitable order that permits creation of the system 10.

First, the main burner control valve 46 is modified and/or replaced such that the main burner control valve 46 has a delayed response to an increase in pressure in the control line 22. Such a delayed response may be accomplished in one of, or both of, two ways. More specifically, (2) the main burner control valve 46 may be set to have a relatively high threshold pressure such that the main burner control valve will not open until the higher threshold pressure is reached, and/or (2) the main burner control valve 46 may be set to have a varying response to the pressure in the control line 22, that is, to open relatively less at relatively lower pressures and to open relatively more at relatively higher pressures.

The pilot burner control valve 54 is installed in the pilot line 26, and the pilot valve control line 58 is installed between the pilot burner control valve 54 and the control line 22. The pilot burner control valve 54 is preferably adjustable such that the threshold pressure, i.e., the pressure at which the valve 54 opens or begins to open, may be set to a desired level. Additionally, the pilot burner control valve 54 may be provided with a variable response of the type described above with reference to the main burner control valve 46, that is, such that the pilot burner control valve 54 opens relatively less at relatively lower pressures and opens relatively more at relatively higher pressures. In this way, the pilot burner control valve 54 is in communication with the temperature controller 42 such that, in operation of the system 10, the pilot burner control valve 54 opens in response to an appropriate output for the temperature controller 42.

The igniter controller 62 is installed. In particular, the sensor line 66 is installed between the pilot line 26 and the pressure switch 94 and the igniter tip 74 is installed on the pilot burner 34 such that the igniter wire 70 extends from the igniter controller 62 to the igniter tip 74 on the pilot burner 34. As best shown in the FIGS. 1A and 1B, which depict an enlarged, partially-cutaway view and end view, respectively, of a portion of the pilot burner 34, the igniter wire 70 preferably extends to the operational end 102 of the pilot burner 34, such that the igniter tip 74 extends in the flame path of the pilot burner 34. To permit the igniter tip 74 to function as described herein, the igniter tip 74 is preferably spaced apart from the sidewall 106 of the pilot burner 34 and a grounding rod 107, as shown.

The main safety valve 78 is installed in the main line 30, and the pilot safety valve 82 is installed in the pilot line 26. The main safety valve 78 and pilot safety valve 82 are then preferably placed in electrical communication with the igniter controller 62, via connection 110. In the preferred embodiment, the connection 110 includes one or more wires and/or other suitable connections and/or connectors. In other embodiments, the igniter controller 62 may communicate with the safety valves 78 and 82 by any suitable means or in any suitable fashion. For example, the connection 110 may be wireless, pneumatic, mechanical, and/or any combination thereof. Finally, the system line 18 is preferably opened to permit gas to flow into the system.

In operation, the temperature controller 42 senses the need to increase or decrease the thermal energy produced by the main burner 38, and varies its pneumatic (or other) output in response to that need. For example, when a need for greater thermal energy or heat is sensed, the temperature controller 42 varies the output pressure and thereby varies the pressure in the control line 22. The pressure is thereby varied in the pilot valve control line 58. Once the pressure in the pilot valve control line 58 reaches the threshold pressure for the pilot burner control valve 54, the pilot burner control valve 54 begins to open, permitting gas to flow past the pilot burner control valve 54, to the pressure switch 94, via the sensor line 66, and to the pilot burner 34.

The pressure switch 94 is preferably adjusted and/or set to respond to a relatively low switch pressure. For example, the pressures switch 94 preferably responds to a switch pressure of as little as between about 3 and about 4 pounds of pressure in the sensor line 66. In other embodiments, however, the pressure switch 94 may be set to any suitably-functional switch pressure. Upon sensing the pre-set switch pressure, the pressure switch 94 sends an electric signal (or any other suitably-functional signal) to the computerized logic device 96 to cause the igniter controller 62 to begin an ignition process. By setting the pressure switch 94 to such a low switch pressure, it preferably helps to ensure that the igniter controller 62 will ignite the pilot burner 34 before the gas at the pilot burner 34 reaches full pressure and/or before a substantial amount of gas escapes the pilot burner 34. In other embodiments, the switch pressure of the pressure switch 94 may be adjusted to any suitably-functional level.

Upon receiving the signal from the pressure switch 94, the computerized logic device 96 sends a signal to the igniter wire 70 such that an electric current passes through the ignition wire 70 and causes electricity to arc between the igniter tip 74 and the sidewall 106, any other portion of the pilot burner 34, and/or any other metallic surface. The electric current may be passed through the igniter wire 70 continuously, or may be passed impulsively or cyclically, for example, to conserve energy. As will be appreciated by those skilled in the art, the arcing electricity preferably ignites the gas passing through the pilot burner 34 such that the pilot burner 34 begins to burn continuously as the pilot burner control valve 54 opens fully and the gas reaching the pilot burner 34 reaches full pressure.

As the pressure in the control line 22 increases, the main burner control valve 46 also begins to open. As mentioned above, the main burner control valve 46 is preferably adjusted and/or set to have a delayed response to the increasing pressure in the control line 22. More specifically, the main burner control valve 46 is preferably adjusted and/or set to have a higher threshold pressure than the pilot burner control valve 54 such that the main burner control valve 54 will open after the pilot burner control valve 46 to give the pilot burner 34 a period of time to ignite, as described above, before a
Substantial amount of gas is permitted to flow to the main burner 38. In this way, the main burner control valve 46 preferably does not reach a fully-open position until after the pilot burner 34 is ignited and burning continuously, such that the pilot burner 34 will ignite the main burner 38 before the main burner control valve 46 reaches a fully-open position.

The system 10 is also preferably provided with a safety mechanism to prevent gas from continuing to flow to the pilot and main burners 34 and 38 in the event that the pilot burner 34, and thereby the main burner 38, fails to ignite. More specifically, the igniter controller 62 senses whether the pilot burner 34 has successfully ignited. This is preferably facilitated by grounding the pilot burner 34 such that the igniter controller 62 can measure the voltage between the igniter tip 74 and the grounding rod 107. The detection of the pilot flame signal in this fashion is commonly referred to as flame ionization rectification. When there is gas flowing through the pilot burner 34 before the pilot burner 34 has been ignited, the igniter controller 62 will measure a baseline resistance. Once the pilot burner 34 ignites, the resistance between the igniter tip 74 and the pilot burner 34 changes. This change in resistance is preferably registered by the igniter controller 62 to indicate successful ignition of the pilot burner 34. Similarly, the resistance may be continuously monitored and/or periodically checked to monitor whether the pilot burner 34 has stopped burning.

The computerized logic device 96 is preferably programmed to continue the ignition sequence for a pre-determined amount of time, for example, 50 seconds. If the pilot burner 34 does not successfully ignite within the pre-determined period of time, the computerized logic device 96 sends a signal to the main safety valve 78 and the pilot safety valve 82 to shut off or close both of the pilot line 26 and the main line 30 so as to prevent any further gas from flowing to or out of the pilot and main burners 34 and 38. Once the main and pilot safety valves 78 and 82 are closed, the computerized logic device 96 preferably sends a signal to one or more users, such as technicians, engineers, managers, or the like, via the output 90, to inform the one or more users of the unsuccessful ignition sequence. In the preferred embodiment, the safety valves 78 and 82 then remain closed until manually reset (either locally or remotely) by a user. In other embodiments, the computerized logic device 96 may automatically reset and re-initiate the ignition sequence after a pre-determined period of time, such as if no reset signal or other input has been received from a user.

It should be appreciated that the default position of the safety valves 78 and 82 may be open, such that the safety valves 78 and 82 are only closed when the pilot burner 34 fails to light successfully; or the default position of the safety valves 34 and 38 may be closed, such that the safety valves 78 and 82 are only opened when the igniter controller 62 is signaled to begin the ignition process by the pressure switch 94 and the pilot burner 34 is successfully ignited.

Assuming successful ignition of the pilot and main burners 34 and 38, both burners 34 and 38 burn until the temperature controller 42 senses that sufficient heat or thermal energy has been generated and the main burner may therefore be shut down. The temperature controller 42 accordingly varies its output which adjusts the pressure in the control line 22 and the pilot burner control line 58. When the pressure in the control line 22 drops below the threshold pressure of the main burner control valve 46, the main burner control valve 46 closes and the main burner 38 is extinguished when it runs out of gas. The pressure in the control line 22 and the pilot burner control line 58 continues to fall. When the pressure in the pilot burner control line 58 drops below the threshold pressure of the pilot burner control valve 54, the pilot burner control valve 54 will close and the pilot burner 34 will be extinguished when it runs out of gas. In the preferred embodiment, the threshold pressure of the pilot burner control valve 54 is lower than the threshold pressure of the main burner control valve 46, such that the pilot burner 34 will continue to burn for a period of time after the main burner 38 has been extinguished, for example, to burn excess gas and reduce latent pressure in system 10.

The cycle described above will preferably repeat itself as the need for heat in the production unit and/or dehydrator is answered by the pneumatic temperature controller. In addition to lighting and extinguishing the pilot and main burners 34 and 38, the igniter controller 62 preferably monitors the pilot burner 34 and has the ability to re-light the pilot burner 34 if circumstances other than normal operations cause the pilot burner 34 to lose flame.

Referring now to FIG. 2, shown is another embodiment of a burner ignition control system 200 shown in association with a natural gas processing unit 201, such as a regenerator or a separator. Among other components, the system 200 includes a system supply gas line 202 (“system line 202”) connected to a gas supply 204, a control gas line 206 (“control line 206”), a pilot burner supply gas line 208 (“pilot line 208”), and a main burner supply gas line 210 (“main line 210”). The system 200 further includes a pilot burner 212, a main burner 214, a temperature controller 216, a main burner control valve 218 interposed in the main line 210, and various valves, sensors, pressure regulators, and the like. It will be appreciated that, although not depicted in FIG. 2, the temperature controller 216 will be mounted to the gas processing unit 201 so as to be responsive to changes to the temperature gas processing unit 201. The temperature controller 216 is preferably of a pneumatic variety, such that the pressure of gas permitted to pass through, or output from, the temperature controller 216 is preferably varied relative to the temperature sensed by the temperature controller 216.

The system 200 shown in FIG. 2 includes a pilot safety valve 220 interposed in the pilot line 208, a main safety valve 222 interposed in the control line 206 between the temperature controller 216 and a controller for the main burner control valve 218. The system 200 further includes an igniter controller 230, an igniter wire 232, and an igniter tip 234. The igniter controller 230 includes a power source 240, an output 242, pressure switches 244, 246, and 248, and a computerized logic device 250. The power source 240 preferably includes a battery (not separately shown), such as a 12V battery, and a solar panel (not separately shown). As is known in the art, the solar panel functions to keep the battery charged and/or supplement the output of the battery to the igniter controller 230, such as at times of increased and/or peak power demand. As shown, the power source 240 is preferably connected to the igniter controller 230 by one or more connectors 252, such as wires and/or any other suitable electrical connectors and/or connections 252. The output 242 may be a wired and/or wireless output, such as, for example, a telephone line, Internet connection, transmitter, transceiver, and/or any other suitable output 242 that permits the system 200 to function as described herein.

The pressure switch 244 is positioned between the downstream side of the temperature controller 216 and the
upstream of the main safety valve 222 and electrically connected to the computerized logic device 250, the pressure switch 246 is positioned on the downstream side of the pilot safety valve 220 and electrically connected to the computerized logic device 250, and the pressure switch 248 is positioned on the downstream side of the main burner control valve 218 and electrically connected to the computerized logic device 250. The computerized logic device 250 may be, by way of example, a programmable logic controller, central processing unit, digital signal processor, or micro-controller.

In operation, the temperature controller 216 senses the need to increase or decrease the thermal energy produced by the main burner, and varies its pneumatic (or other) output in response to that need. For example, when a need for greater thermal energy or heat is sensed, the temperature controller 216 varies the output pressure and thereby varies the pressure in the control line 206. Once the pressure in the control line reaches 3 to 4 psi, the pressure switch 244 will close sending an electronic signal (or any other suitably-functional signal) to the computerized logic device 250 to initiate an ignition process. By setting the pressure switch 244 to such a low switch pressure, it preferably helps to ensure that the pilot burner 212 is ignited before the gas at the pilot burner 212 reaches full pressure and/or before a substantial amount of gas escapes the pilot burner 212. In other embodiments, the switch pressure of the pressure switch 244 may be adjusted to any suitably-functional level.

Upon receiving the signal from the pressure switch 244, the computerized logic device 250 causes the pilot safety valve 220 to open allowing gas to flow through the pilot line 208 to the pilot burner 212. A signal is sent to the igniter wire 232 such that an electric current passes through the igniter wire 232 in a manner described above so as to ignite the gas passing through the pilot burner 212 such that the pilot burner 212 begins to burn continuously as monitored by the igniter controller 230. More specifically, the igniter controller 230 preferably senses whether the pilot burner 212 has successfully ignited. This is preferably facilitated by grounding the pilot burner 212 such that the igniter controller 230 can measure the voltage between the igniter tip 234 and the grounding rod (not shown). The detection of the pilot flame signal in this fashion is commonly referred to as flame ionization rectification.

The computerized logic device 250 is preferably programmed to continue the ignition sequence for a predetermined amount of time, for example, seven seconds. If the pilot burner 212 does not successfully ignite within the predetermined period of time, a signal is sent to the pilot safety valve 220 to shut off or close the pilot line 208 so as to prevent any further gas from flowing to or out of the pilot burner 212. Once the pilot safety valve 220 is closed, the igniter controller 230 shall automatically reset and re-try the ignition sequence after a designated purge time, e.g., 30 seconds. The automatic reset and re-try of the ignition sequence will be conducted a preset number of times, for example ten times. If the pilot burner 212 does not successfully ignite within the predetermined number of tries, a signal preferably is sent to one or more users, such as technicians, engineers, managers, or the like, via the output 242, to inform one or more users of the unsuccessful ignition. In the preferred embodiment, the igniter controller 230 will remain in a lock-out condition until manually reset (either locally or remotely) by a user. It should be appreciated that the default position of the safety valves 220 and 222 preferably shall be closed when the pilot burner 212 fails to light successfully.

Upon successful ignition of the pilot burner 212, the computerized logic device 250 sends a signal to the main safety valve 222 to open allowing gas to flow to the controller of the main burner valve 218 thereby causing the main burner control valve 218 to open allowing gas to flow to the main burner 214 thus lighting the main burner 214 with assistance from the already established pilot flame. Both burners 212 and 214 burn until the temperature controller 216 senses that sufficient heat or thermal energy has been generated and the main burner 214 may therefore be shut down. The temperature controller 216 accordingly varies its output which adjusts the pressure in the control line 206. When the pressure in the control line 206 drops below the threshold pressure as sensed by the pressure switch 244, the computerized logic device 250 sends a signal to safety valves 220 and 222 to close thus extinguishing the pilot burner 212 and main burner 214 when they run out of gas.

What is claimed is:

1. A system in combination with a natural gas processing unit for controlling the temperature of the natural gas processing unit, the system comprising:
   a main burner operatively associated with the natural gas processing unit, the main burner capable of burning a fuel from a fuel supply to generate thermal energy for the natural gas processing unit;
   a pilot burner operatively associated with the main burner to ignite the fuel discharged from the main burner;
   temperature control means for regulating the temperature of the natural gas processing unit, the temperature control means being operative to call for an ignition and maintenance of a flame at the main burner;
   a pilot valve interposed between the fuel supply and the pilot burner and being responsive to the temperature control means so as to allow fuel to flow through the pilot valve and to the pilot burner when the natural gas processing unit is below a selected temperature;
   an igniter operatively associated with the pilot burner and responsive to temperature control means for generating a spark that ignites fuel being discharged from pilot burner;
   and
   a main burner control valve interposed between the fuel supply and the main burner and being responsive to the temperature control means so as to allow fuel to flow through the main burner control valve and the main burner upon ignition of the pilot burner.

2. The combination of claim 1 wherein the pilot valve closes in response to the pilot burner failing to ignite in a predetermined time period.
3. The combination of claim 1 further comprising:
   a computerized logic device in electrical communication
   with pilot valve and the igniter; and
   a first pressure switch pneumatically connected to the tem-
   perature controller, the first pressure switch being in
   electrical communication with the computerized logic
   device.
4. The combination of claim 3 wherein the computerized
   logic device generates a signal to the igniter to re-try igniting
   the pilot burner after a predetermined period of time during
   which the pilot burner is purged of fuel.
5. The combination of claim 3 further comprising an output
   in electrical communication with the computerized logic
device in such a way that a signal is sent to one or more remote
users to inform the users that ignition of the pilot valve has
failed.
6. The combination of claim 1 wherein the main burner
   control valve is controlled by fuel flowing through the tem-
   perature controller.
7. The combination of claim 6 further comprising a main
   burner safety valve interposed between the temperature con-
   troller and the main burner control valve, the main burner
   safety valve being in electrical communication with the com-
   puterized logic device.

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