

PATENT SPECIFICATION

DRAWINGS ATTACHED



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COMPLETE SPECIFICATION

Improvements in Independent Superheaters

WE NATIONAL STEEL CORPORATION, a Corporation of the State of Delaware, United States of America, of 2800, Grant Building, Pittsburgh 19, Pennsylvania, United States of America, (Assignee of William Newton McCoy and James Diamond Bell); do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of operating superheater and to independent superheater structure and control apparatus.

The present invention provides a method of operating an independent superheater to deliver fluid at a desired temperature, the independent superheater having a heating coil arrangement within a heat exchange chamber, fuel burner means for introducing fuel and combustion supporting gasing to the heat exchange chamber, and a flue arrangement for discharging the gases of combustion from the heat exchange chamber, in which method supply of combustion supporting gas to the fuel burner means is quantitatively controlled to maintain the amount of combustion supporting gas delivered to the heat exchange chamber at a predetermined and fixed value and flue discharge capacity from the heat exchange chamber is maintained at a fixed value, and in which method fuel input to the heat exchange chamber is controlled automatically in response to the temperature of fluid after heating in the heat exchange chamber to maintain the temperature of fluid delivered from the heat exchange chamber at a desired level.

The invention includes independent superheater structure and control apparatus comprising a longitudinally extended heat-

ing chamber, a helical heating coil in the chamber for carrying a fluid to be heated and having convolutions defining a longitudinally extended cylindrical configuration having its longitudinal axis substantially parallel to the longitudinal axis of the heating chamber, the helical coil having a fluid inlet at one longitudinal end of the heating chamber and a fluid outlet at the opposite longitudinal end of the heating chamber, fuel burner means at the longitudinal end of the heating chamber having the fluid inlet, the fuel burner being disposed to discharge gases of combustion along the longitudinal axis within the cylindrical configuration formed by the convolutions of the helical coil, fuel supply means connected to the fuel burner including fuel input control means for quantitatively controlling the fuel delivered to the fuel burner, combustion supporting gas supply means connected to the fuel burner and including means for supplying a constant volume of combustion supporting gas to the fuel burner, temperature sensing means located at the fluid outlet to measure fluid temperature and generate a signal in response to such temperature measurement, and means connecting the temperature sensing means to the fuel input control means to control fuel input in response to temperature measurement.

The invention will be further described by way of example, with reference to the accompanying drawings wherein:

Figure 1 is a schematic view, partially in section, of a superheater structure;

Figure 2 is a schematic view of the superheater structure with associated control apparatus;

Figure 3 is an enlarged view of a portion of the structure of Figures 1 and 2; and

Figure 4 is a schematic view of the

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superheater structure and control apparatus as applied to the control of coating weight of hot-dip coated steel strip.

In these drawings, like numerals have been used to designate like parts where appropriate in the various figures.

The longitudinally extended independent superheater of Figure 1 includes a heating chamber 12, a fuel burner 14, and flues 16 and 18. A helical coil 20 is disposed within the heating chamber 12 with convolutions of the coil 20 defining a cylindrical configuration having a longitudinal axis which is substantially coextensive with that of the heating chamber 12.

Fluid to be heated is introduced at a fluid inlet 22 of the coil 20 and delivered at a fluid outlet 24. Fuel and combustion supporting gas are fed to the burner 14 via a fuel line 23 and a combustion supporting gas line 25, respectively and are combined in the burner.

Gases of combustion discharged from the fuel burner 14 travel along the longitudinal axis within the cylinder formed by the convolutions of the coil 20. At the fluid outlet end of the heating chamber 12, the gases of combustion are directed radially outwardly, as indicated by the flow arrows, and then in substantially counterflow relationship. Gases of combustion are discharged from the heating chamber through the flues 16 and 18. It should be noted that the flue discharges are located at the fluid inlet end of the heating chamber 12 and that no damper control is provided. As will be seen from the description to follow, a constant volume of combustion supporting gas, such as air or oxygen-enriched air, is provided and, with control of fuel supply, plays an important role in producing a rapid-response to fluctuations in the rate of flow of fluid to be heated.

Temperature selection and rapid response are available with constant or varying flow demands. To accomplish this end, the superheater is operated on a fixed volume of air or other combustion supporting gas and the fuel supply is varied to meet temperature requirements and/or varying fluid flow requirements. With the superheater described above, fuel input affects both flame temperature and combustion product temperature. Therefore, both radiant heating and convection heating are affected. With the constant volume of air supplied and discharged, temperature response is almost instantaneous.

Referring to Figure 2, a constant volume of air is supplied to the fuel burner 14 by a compressed air blower 28. Quantitative control of fuel flow in the line 23 is maintained by a valve 30 which is controlled by a valve drive unit 32.

At the heated fluid discharge end of the

longitudinally extended heating chamber 12, a temperature sensor 34, connected to the line 24, measures the temperature of heated fluid. The sensor 34 generates a signal which is delivered over a line 36 to a temperature controller 38 and, in turn, a signal is delivered over a line 40 to the valve drive unit 32. The temperature desired for superheated fluid can be selected at the temperature controller 38 and differences between the measured temperature at the sensor 34 and the desired temperature input to the controller 38 generate responsive signals to raise or lower the fuel input to the fuel burner 14.

An excess air type of fuel burner as shown in Figure 3 is used. This type of burner may also be referred to as a tempered flame burner. A constant pilot is provided; operation of this type of burner will be obvious from Figure 3. In combination with other features of the invention, the burner helps to provide rapid temperature response. For example, when fuel is being added the hottest flame, at the burner 14, contacts steam in the coil 20 shortly after entering the heater when the steam is relatively low in temperature. This large temperature differential facilitates rapid heat exchange.

Combustion gases travel as shown in Figure 1; heat exchange along the internal surface of the cylindrical space defined by the convolutions of the coil 20 is primarily due to radiant heating. Along the external surface of the cylinder, heat transfer is due chiefly to convection heating. It can be readily seen that when fuel supply is diminished, the flame temperature and the temperature of the products of combustion will diminish. Fluid temperature change within the coil 20 will follow rapidly with heat exchange facilitated by the constant volume of air supplied by the compressed air blower 28. Whether heating up or cooling down, heat exchange takes place over the full surface area of the coil because of the coil's configuration. In effect, almost instantaneous temperature response is available by controlling fuel input. This rapid response is especially important when steam flow requirements vary since heating requirements would vary instantaneously with change in the flow rate demand.

Referring to Figure 2, fluid under pressure is supplied via the line 22. The pressure may be regulated by a pressure regulator valve 42. In operation, the pressure is sensed near the point of use of the superheated fluid by a pressure sensor 44 which generates a signal which is delivered over a line 45 to a pressure controller 46. Desired pressure is selected at the pressure controller 46. Any differential between measured and desired pressure controls the pressure regulator valve 42.

The present invention can be used for control of superheated steam used in a jet coating control process. Referring to Figure 4, galvanized strip 50 is travelling upwardly from a hot-dip coating pot (not shown) between superheated steam nozzles 52 and 54 which are used to control the coating weight of molten zinc on the strip. It is essential in this environment to maintain instantaneous control of the temperature and pressure of the steam in order to exercise proper coating control for the varying gauges of steel strip being coated. The speed of the line varies with variation in strip gauge and the temperature, pressure, and flow requirements may vary accordingly.

The control features described in relation to Figure 2 are employed in this environment as are various safety controls. For example, the nozzles 52 and 54 have regulator valves 56 and 58, respectively. These may be automatically controlled from a control panel 60. Pressure and temperature indicator gauges for the entire system may be included in the control panel 60. At the supply end of the heating chamber 12, a manually operated butterfly valve 62 is provided in the line 25. Pilot controls 64 are provided for the constant pilot of the burner 14 and a flame protection relay 66 is provided for safety reasons. A main gas pressure regulator is provided at 68 and a safety valve is provided at 70.

The above system functions to provide almost instantaneous control of superheated gas as required to provide temperature selectively and meet varying flow demands.

WHAT WE CLAIM IS:—

1. Method of operating an independent superheater to deliver fluid at a desired temperature, the independent superheater having a heating coil arrangement within a heat exchange chamber, fuel burner means for introducing fuel and combustion supporting gasing to the heat exchange chamber, and a flue arrangement for discharging the gases of combustion from the heat exchange chamber, in which method supply of combustion supporting gas to the fuel burner means is quantitatively controlled to maintain the amount of combustion supporting gas delivered to the heat exchange chamber at a predetermined and fixed value and flue discharge capacity from the heat exchange chamber is maintained at a fixed value, and in which method fuel input to the heat exchange chamber is controlled automatically in response to the temperature of fluid after heating in the heat exchange chamber to maintain the temperature of fluid delivered from the heat exchange chamber at a desired level.

2. Method as claimed in claim 1 in which the fuel and combustion supporting

gases are combined in the fuel burner means and gases of combustion are discharged thereby into the heat exchange chamber.

3. Method as claimed in claim 1 or 2 in which the pressure of fluid delivered to the heating coil arrangement to be heated by the chamber is controlled responsively to the pressure of fluid being delivered from the heat exchange chamber after heating to deliver the fluid at a preselected pressure.

4. Method as claimed in claim 1, 2 or 3 in which the fluid heated and delivered by the superheater is steam.

5. The utilization of superheated steam produced by the method claimed in claim 4 in which the superheated steam delivered by the superheater is directed on to hot-dip coated metal strip upon exit from a hot-dip coating bath to control the coating weight.

6. The utilization of superheated steam as claimed in claim 5 in which the strip is steel and the coating bath is a galvanizing bath.

7. Methods of superheating a fluid substantially as herein described with reference to the accompanying drawings.

8. A method of controlling the coating thickness in a galvanized strip producing process substantially as herein described with reference to Fig. 4 of the accompanying drawings.

9. Independent superheater structure and control apparatus comprising a longitudinally extended heating chamber, a helical heating coil in the chamber for carrying a fluid to be heated and having convolutions defining a longitudinally extended cylindrical configuration having its longitudinal axis substantially parallel to the longitudinal axis of the heating chamber, the helical coil having a fluid inlet at one longitudinal end of the heating chamber and a fluid outlet at the opposite longitudinal end of the heating chamber fuel burner means at the longitudinal end of the heating chamber having the fluid inlet, the fuel burner being disposed to discharge gases of combustion along the longitudinal axis within the cylindrical configuration formed by the convolutions of the helical coil, fuel supply means connected to the fuel burner including fuel input control means for quantitatively controlling the fuel delivered to the fuel burner, combustion supporting gas supply means connected to the fuel burner and including means for supplying a constant volume of combustion supporting gas to the fuel burner, temperature sensing means located at the fluid outlet to measure fluid temperature and generate a signal in response to such temperature measurement, and means connecting the temperature sensing means to the fuel input control



The present invention can be used for control of superheated steam used in a jet coating control process. Referring to Figure 4, galvanized strip 50 is travelling upwardly from a hot-dip coating pot (not shown) between superheated steam nozzles 52 and 54 which are used to control the coating weight of molten zinc on the strip. It is essential in this environment to maintain instantaneous control of the temperature and pressure of the steam in order to exercise proper coating control for the varying gauges of steel strip being coated. The speed of the line varies with variation in strip gauge and the temperature, pressure, and flow requirements may vary accordingly.

The control features described in relation to Figure 2 are employed in this environment as are various safety controls. For example, the nozzles 52 and 54 have regulator valves 56 and 58, respectively. These may be automatically controlled from a control panel 60. Pressure and temperature indicator gauges for the entire system may be included in the control panel 60. At the supply end of the heating chamber 12, a manually operated butterfly valve 62 is provided in the line 25. Pilot controls 64 are provided for the constant pilot of the burner 14 and a flame protection relay 66 is provided for safety reasons. A main gas pressure regulator is provided at 68 and a safety valve is provided at 70.

The above system functions to provide almost instantaneous control of superheated gas as required to provide temperature selectively and meet varying flow demands.

WHAT WE CLAIM IS:—

1. Method of operating an independent superheater to deliver fluid at a desired temperature, the independent superheater having a heating coil arrangement within a heat exchange chamber, fuel burner means for introducing fuel and combustion supporting gasing to the heat exchange chamber, and a flue arrangement for discharging the gases of combustion from the heat exchange chamber, in which method supply of combustion supporting gas to the fuel burner means is quantitatively controlled to maintain the amount of combustion supporting gas delivered to the heat exchange chamber at a predetermined and fixed value and flue discharge capacity from the heat exchange chamber is maintained at a fixed value, and in which method fuel input to the heat exchange chamber is controlled automatically in response to the temperature of fluid after heating in the heat exchange chamber to maintain the temperature of fluid delivered from the heat exchange chamber at a desired level.

2. Method as claimed in claim 1 in which the fuel and combustion supporting

gases are combined in the fuel burner means and gases of combustion are discharged thereby into the heat exchange chamber.

3. Method as claimed in claim 1 or 2 in which the pressure of fluid delivered to the heating coil arrangement to be heated by the chamber is controlled responsively to the pressure of fluid being delivered from the heat exchange chamber after heating to deliver the fluid at a preselected pressure.

4. Method as claimed in claim 1, 2 or 3 in which the fluid heated and delivered by the superheater is steam.

5. The utilization of superheated steam produced by the method claimed in claim 4 in which the superheated steam delivered by the superheater is directed on to hot-dip coated metal strip upon exit from a hot-dip coating bath to control the coating weight.

6. The utilization of superheated steam as claimed in claim 5 in which the strip is steel and the coating bath is a galvanizing bath.

7. Methods of superheating a fluid substantially as herein described with reference to the accompanying drawings.

8. A method of controlling the coating thickness in a galvanized strip producing process substantially as herein described with reference to Fig. 4 of the accompanying drawings.

9. Independent superheater structure and control apparatus comprising a longitudinally extended heating chamber, a helical heating coil in the chamber for carrying a fluid to be heated and having convolutions defining a longitudinally extended cylindrical configuration having its longitudinal axis substantially parallel to the longitudinal axis of the heating chamber, the helical coil having a fluid inlet at one longitudinal end of the heating chamber and a fluid outlet at the opposite longitudinal end of the heating chamber, the fuel burner means at the longitudinal end of the heating chamber having the fluid inlet, the fuel burner being disposed to discharge gases of combustion along the longitudinal axis within the cylindrical configuration formed by the convolutions of the helical coil, fuel supply means connected to the fuel burner including fuel input control means for quantitatively controlling the fuel delivered to the fuel burner, combustion supporting gas supply means connected to the fuel burner and including means for supplying a constant volume of combustion supporting gas to the fuel burner, temperature sensing means located at the fluid outlet to measure fluid temperature and generate a signal in response to such temperature measurement, and means connecting the temperature sensing means to the fuel input control



means to control fuel input in response to temperature measurement.

10. Independent superheater structure and control apparatus as claimed in claim 9 further including a selectively operable temperature controller connected between the temperature sensing means and the fuel input control means to coordinate the measure temperature with a selected temperature and regulate fuel input responsively thereto.

11. Independent superheater structure and control apparatus as claimed in claim 9 or 10 further including pressure sensing means located at the fluid outlet to measure fluid pressure within the helical coil and generate a signal in response to such pressure measurement, fluid supply pressure control means connected to said fluid inlet, and means connecting the pressure sensing means to the fluid supply pressure control means to control fluid supply to the helical coil responsive to pressure measurements by the pressure sensing means.

12. Independent superheater structure and control apparatus as claimed in claim 11 further including a selectively operable pressure regulator connecting the pressure sensing means to the fluid supply pressure control means to coordinate the measured

fluid pressure with a selected fluid pressure and regulate the fluid inlet pressure responsively thereto.

13. Apparatus for delivering superheated steam at selected temperature and pressure for controlling coating weight of hot-dip coated steel strip by directing the superheated steam onto the strip upon exit from a hot-dip coating bath, comprising a superheater structure and control apparatus as claimed in claims 10 and 12, steam supply means for delivering steam under pressure to the fluid inlet to the heating coil, and means for delivering superheated steam from the fluid outlet to the hot-dip coating operation at preselected temperature and pressure.

14. A superheater structure and control apparatus constructed substantially as herein described with reference to and as illustrated in Figs. 1, 2 and 3 of the accompanying drawings.

15. Hot-dip coating weight control apparatus constructed and adapted to operate substantially as herein described with reference to and as illustrated in Fig. 4 of the accompanying drawings.

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