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(54) **Slag zone mapping**

(57) Solutions for mapping slag zones (152) in a boiler (100) are disclosed. In one embodiment, the system includes an obtainer (40) for obtaining data about a location of a slag zone (152) within a boiler (100), the slag zone (152) being one of a plurality of slag zones (152) in a slag plane (150); a determinater (50) for determining a flow distribution of a working fluid (120) within the boiler (100), the flow distribution originating at a plurality of

burners (110) and intersecting the slag zone (152) and a sensor grid (130) including a plurality of grid sensors; an identifier (60) for identifying at least one grid sensor in the plurality of grid sensors that is intersected by the flow distribution of the working fluid (120); and a user interface module (70) for displaying the flow distribution of the working fluid (120) from the plurality of burners (110) to the at least one grid sensor.

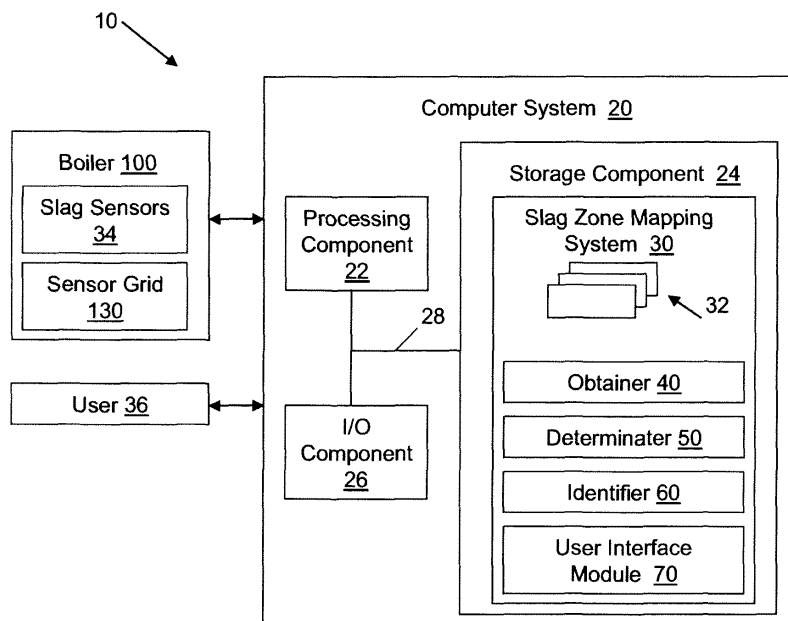


FIG. 1

Description

[0001] The subject matter disclosed herein relates to solutions for mapping slag zones in a boiler. Specifically, the subject matter disclosed herein relates to mapping slag zones in fossil-fuel fired boiler systems.

[0002] Fossil-fuel fired boiler systems are commonly used to generate electricity. One type of fossil-fuel fired boiler system combusts an air/coal mixture to generate heat energy. This heat energy is used to increase a temperature of water to produce steam. This steam is then used to drive a turbine generator that outputs electrical power.

[0003] These fossil-fuel fired boiler systems may have regions in which slag or unburned hydrocarbons adhere to walls of the boiler system and accumulate to form large masses. If this slag formation is not controlled, the accumulation may affect run-time efficiency of the boiler system, as well as the maintenance cycle.

[0004] Solutions for mapping slag zones in a boiler are disclosed. In one embodiment, the slag zone mapping system includes: an obtainer for obtaining data about a location of a slag zone within a boiler, the slag zone being one of a plurality of slag zones in a slag plane; a determinater for determining a flow distribution of a working fluid within the boiler, the flow distribution originating at a plurality of burners and intersecting the slag zone and a sensor grid including a plurality of grid sensors; an identifier for identifying at least one grid sensor in the plurality of grid sensors that is intersected by the flow distribution of the working fluid; and a user interface module for displaying the flow distribution of the working fluid from the plurality of burners to the at least one grid sensor.

[0005] A first aspect of the invention provides a slag zone mapping system comprising: an obtainer for obtaining data about a location of a slag zone within a boiler, the slag zone being one of a plurality of slag zones in a slag plane; a determinater for determining a flow distribution of a working fluid within the boiler, the flow distribution originating at a plurality of burners and intersecting the slag zone and a sensor grid including a plurality of grid sensors; an identifier for identifying at least one grid sensor in the plurality of grid sensors that is intersected by the flow distribution of the working fluid; and a user interface module for displaying the flow distribution of the working fluid from the plurality of burners to the at least one grid sensor.

[0006] A second aspect of the invention provides a boiler comprising: a plurality of burners; a working fluid heated by the plurality of burners; a sensor grid in contact with the working fluid; and a slag zone mapping system connected to the sensor grid and the plurality of burners, the slag zone mapping system including: an obtainer for obtaining data about a location of a slag zone within a boiler, the slag zone being one of a plurality of slag zones in a slag plane; a determinater for determining a flow distribution of a working fluid within the boiler, the flow distribution originating at a plurality of burners and inter-

secting the slag zone and a sensor grid including a plurality of grid sensors; an identifier for identifying at least one grid sensor in the plurality of grid sensors that is intersected by the flow distribution of the working fluid; and a user interface module for displaying the flow distribution of the working fluid from the plurality of burners to the at least one grid sensor.

[0007] A third aspect of the invention provides a program product stored on a computer readable medium, which when executed, performs the following: obtaining data about a location of a slag zone within a boiler, the slag zone being one of a plurality of slag zones in a slag plane; determining a flow distribution of a working fluid within the boiler, the flow distribution originating at a plurality of burners and intersecting the slag zone and a sensor grid including a plurality of grid sensors; identifying at least one grid sensor in the plurality of sensors that is intersected by the flow distribution of the working fluid; and displaying, on a user interface, the flow distribution of the working fluid from the plurality of burners to the at least one grid sensor.

[0008] A fourth aspect of the invention provides a method of generating a system for mapping slag zones in a boiler, the method comprising: providing a computer system operable to: obtain data about a location of a slag zone within the boiler, the slag zone being one of a plurality of slag zones in a slag plane; determine a flow distribution of a working fluid within the boiler, the flow distribution originating at a plurality of burners and intersecting the slag zone and a sensor grid including a plurality of grid sensors; identify at least one grid sensor in the plurality of grid sensors that is intersected by the flow distribution of the working fluid; and display, on a user interface, the flow distribution of the working fluid from the plurality of burners to the at least one grid sensor.

[0009] A fifth aspect of the invention provides a method comprising: at least one of providing or receiving a copy of a computer program that is embodied in a set of data signals, wherein the computer program enables a computer system to implement a method of mapping slag zones in a boiler, the method comprising: obtaining data about a location of a slag zone within the boiler, the slag zone being one of a plurality of slag zones in a slag plane; determining a flow distribution of a working fluid within the boiler, the flow distribution originating at a plurality of burners and intersecting the slag zone and a sensor grid including a plurality of grid sensors; identifying at least one grid sensor in the plurality of grid sensors that is intersected by the flow distribution of the working fluid; and displaying, on a user interface, the flow distribution of the working fluid from the plurality of burners to the at least one grid sensor.

[0010] A sixth aspect of the invention provides a method of mapping slag zones in a boiler, the method comprising: obtaining data about a location of a slag zone within the boiler, the slag zone being one of a plurality of slag zones in a slag plane; determining a flow distribution of a working fluid within the boiler, the flow distribution

originating at a plurality of burners and intersecting the slag zone and a sensor grid including a plurality of grid sensors; identifying at least one grid sensor in the plurality of grid sensors that is intersected by the flow distribution of the working fluid; and displaying, on a user interface, the flow distribution of the working fluid from the plurality of burners to the at least one grid sensor.

[0011] Various features of this invention will be more readily understood from the following detailed description of the various aspects of the invention taken in conjunction with the accompanying drawings that depict various embodiments of the invention, in which:

FIG. 1 shows a block diagram of an illustrative environment and computer infrastructure for implementing one embodiment of the invention.

FIG. 2A shows a side cross-sectional view of a working fluid flow through a boiler according to one embodiment of the invention.

FIG. 2B shows a front view of a slag plane including a plurality of slag zones according to one embodiment of the invention.

FIG. 3 shows a flow diagram of embodiments of mapping slag zones in a boiler.

FIG. 4 shows a screenshot of a graphical user interface according to one embodiment of the invention.

FIG. 5 shows a screenshot of a three-dimensional slag map according to one embodiment of the invention.

[0012] It is noted that the drawings of the invention are not to scale. The drawings are intended to depict only typical aspects of the invention, and therefore should not be considered as limiting the scope of the invention. In the drawings, like numbering represents like elements between the drawings.

[0013] As indicated above, aspects of the invention provide solutions for mapping slag zones in a boiler. As used herein, unless otherwise noted, the term "set" means one or more (i.e., at least one) and the phrase "any solution" means any now known or later developed solution.

[0014] Turning to the drawings, FIG. 1 shows an illustrative environment 10 for mapping a slag zone in a boiler. To this extent, environment 10 includes a computer system 20 that can perform a process described herein in order to map a slag zone in a boiler. In particular, computer system 20 is shown including a slag zone mapping system 30, which makes computer system 20 operable to map slag in a boiler by performing a process described herein.

[0015] Computer system 20 is shown in communication with boiler 100, which may include slag sensors 34

and sensor grid 130. Further, computer system 20 is shown in communication with user 36. A user may, for example, be a programmer or operator. Interactions between these components and computer system 20 will be discussed in subsequent portions of this application. Computer system 20 is shown including a processing component 22 (e.g., one or more processors), a storage component 24 (e.g., a storage hierarchy), an input/output (I/O) component 26 (e.g., one or more I/O interfaces and/or devices), and a communications pathway 28. In one embodiment, processing component 22 executes program code, such as slag zone mapping system 30, which is at least partially embodied in storage component 24. While executing program code, processing component 22 can process data, which can result in reading and/or writing the data to/from storage component 24 and/or I/O component 26 for further processing. Pathway 28 provides a communications link between each of the components in computer system 20. I/O component 26 can comprise one or more human I/O devices or storage devices, which enable user 36 to interact with computer system 20 and/or one or more communications devices to enable user 36 to communicate with computer system 20 using any type of communications link. To this extent, slag zone mapping system 30 can manage a set of interfaces (e.g., graphical user interface(s), application program interface, and/or the like) that enable human and/or system interaction with slag zone mapping system 30.

[0016] In any event, computer system 20 can comprise one or more general purpose computing articles of manufacture (e.g., computing devices) capable of executing program code installed thereon. As used herein, it is understood that "program code" means any collection of instructions, in any language, code or notation, that cause a computing device having an information processing capability to perform a particular function either directly or after any combination of the following: (a) conversion to another language, code or notation; (b) reproduction in a different material form; and/or (c) decompression. To this extent, slag zone mapping system 30 can be embodied as any combination of system software and/or application software. In any event, the technical effect of computer system 20 is to provide processing instructions for mapping slag zones in a boiler.

[0017] Further, slag zone mapping system 30 can be implemented using a set of modules 32. In this case, a module 32 can enable computer system 20 to perform a set of tasks used by slag zone mapping system 30, and can be separately developed and/or implemented apart from other portions of slag zone mapping system 30. Slag zone mapping system 30 may include modules 32 which comprise a specific use machine/hardware and/or software. Regardless, it is understood that two or more modules, and/or systems may share some/all of their respective hardware and/or software. Further, it is understood that some of the functionality discussed herein may not be implemented or additional functionality may be included.

ed as part of computer system 20.

[0018] When computer system 20 comprises multiple computing devices, each computing device may have only a portion of slag zone mapping system 30 embodied thereon (e.g., one or more modules 32). However, it is understood that computer system 20 and slag zone mapping system 30 are only representative of various possible equivalent computer systems that may perform a process described herein. To this extent, in other embodiments, the functionality provided by computer system 20 and slag zone mapping system 30 can be at least partially implemented by one or more computing devices that include any combination of general and/or specific purpose hardware with or without program code. In each embodiment, the hardware and program code, if included, can be created using standard engineering and programming techniques, respectively.

[0019] Regardless, when computer system 20 includes multiple computing devices, the computing devices can communicate over any type of communications link. Further, while performing a process described herein, computer system 20 can communicate with one or more other computer systems using any type of communications link. In either case, the communications link can comprise any combination of various types of wired and/or wireless links; comprise any combination of one or more types of networks; and/or utilize any combination of various types of transmission techniques and protocols.

[0020] As discussed herein, slag zone mapping system 30 enables computer system 20 to provide processing instructions for mapping slag zones in a boiler. Slag zone mapping system 30 may include logic, which may include the following functions: an obtainer 30, a determiner 50, an identifier 60 and a user interface 70 (FIG. 2). In one embodiment, slag zone mapping system 30 may include logic to perform the above-stated functions. Structurally, the logic may take any of a variety of forms such as a field programmable gate array (FPGA), a microprocessor, a digital signal processor, an application specific integrated circuit (ASIC) or any other specific use machine structure capable of carrying out the functions described herein. Logic may take any of a variety of forms, such as software and/or hardware. However, for illustrative purposes, slag zone mapping system 30 and logic included therein will be described herein as a specific use machine. As will be understood from the description, while logic is illustrated as including each of the above-stated functions, not all of the functions are necessary according to the teachings of the invention as recited in the appended claims.

[0021] Turning to FIGS. 2A-2B, a cross-sectional view of a portion of a boiler 100 and a front view of a slag plane 150 are shown, respectively. As used herein, boiler 100 refers to a portion of a fossil-fuel fired boiler, with portions omitted for clarity. It is understood that boiler 100 may not include all of the components present in a fossil-fuel fired boiler. FIG. 2A shows boiler 100 including a plurality

of burners 110. Plurality of burners 110 combust an air/coal mixture which generates heat energy. This heat energy may be used, for example, in increasing a temperature of water to produce steam, which may drive a steam turbine. Boiler 100 including plurality of burners 110 may be a part of a power generation system including, for example, a steam turbine and an electric generator (both omitted). In any event, boiler 100 may combust the air/coal mixture producing a working fluid 120. Working fluid 120 travels upward through boiler 100 due to its high temperature caused by combustion. Working fluid 120 may travel on a particular flow distribution upward through boiler 100 due to conditions such as temperature, oxygen concentration, carbon monoxide concentration, flow rate, etc. Certain flow distributions, compositions of working fluid 120, and temperature conditions within boiler 100 may cause the build up of molten ash (slag) inside boiler 100. Slag may build up in a plurality of slag zones 152 (FIG. 2B) within a slag plane 150. Slag plane 150 including plurality of slag zones 152 are areas in which slag has begun to accumulate through the flow of working fluid 120. Slag may accumulate, for example through build-up on a boiler wall 160. Molten ash (slag) particles may adhere to a portion of boiler wall 160, thereby causing a partial obstruction within boiler 100. Additional slag particles may adhere to the obstruction, causing a larger obstruction within boiler 100. Consequently, over time, the accumulation of slag may adversely affect performance of boiler 100.

[0022] The build-up of slag may be categorized by slag zones 152 within a slag plane 150. Slag zones 152 may include locations within boiler 100 where slag has accumulated or where evaluation of slag is desired. Slag plane 150 may include observation locations in one or more areas of boiler 100. In one embodiment, slag plane 150 may be a vantage point for physical observation of a location of slag zone 152. For example, slag plane 150 may be located adjacent a door or opening on side 160 of boiler 100. In this case, user 36 (FIG. 1) may look into an opening on wall 160 of boiler 100 and physically observe a location of a slag zone 152. In another embodiment, slag plane 150 may be set by the location of one or more slag sensors 34 (FIG. 1) capable of measuring slag. Slag sensor(s) 34 may measure a flow rate of working fluid 120 at different portions of boiler 100. Further, slag sensor(s) 34 may determine a temperature of working fluid 120 at different portions of boiler 100. Slag sensor(s) 34 may also determine fluid concentrations (e.g., carbon monoxide) and/or other characteristics of working fluid 120 which may indicate the presence of slag.

[0023] Also shown in FIG. 2A is a sensor grid 130, which may measure conditions of working fluid 120 downstream (farther from plurality of burners 110) from slag zone 152. Sensor grid 130 may include a plurality of sensors (not shown). The plurality of sensors may measure carbon monoxide (CO) concentrations, mass/volume flow rates, and/or temperatures of working fluid 120. Further, this plurality of sensors may measure any

parameter known to indicate formation of slag within working fluid 120.

[0024] Turning to FIG. 3, a flow diagram of embodiments of mapping slag zones in a boiler is shown. In step S1, obtainer 40 obtains data about a location of a slag zone 152 within the boiler. Slag zone 152 may be one of a plurality of slag zones 152 in slag plane 150. Obtaining data may include observing the location of slag zone 152 through physical observation. As described with reference to FIG. 3, user 36 may view a slag zone 152 through an opening, a door, or another vantage point in a boiler 100. User 36 may enter data about a location of a slag zone 152 within a boiler 100 into computer system 20 via a user interface (FIG. 4). The user interface of one embodiment of this invention will be discussed in further detail with reference to FIG. 4. Alternatively, obtaining data about a location of a slag zone 152 may be based on a location of slag sensor(s) 34. Obtaining data using slag sensor(s) 34 is described in greater detail with reference to FIGS. 2A-2B. Slag sensor(s) 34 may be linked to computer system 20 in any conventional manner, and may provide data about a location of a slag zone 152 within a boiler 100 in any conventional manner.

[0025] In step S2, determinater 50 determines a flow distribution of working fluid 120 within boiler 100. The flow distribution originates at plurality of burners 110 and intersects slag zone 150 and sensor grid 130 including a plurality of grid sensors. Determining the flow distribution may be based on sensor grid data versus burner conditions data correspondence. This data correspondence may include data about conditions at plurality of burners 110 and at sensor grid 130. These conditions may include: air to fuel ratios, CO concentrations, temperature, flow rates, etc.

[0026] Using the data correspondence and the data about a location of slag zone 152 within boiler 100, identifier 60 may identify at least one grid sensor in the plurality of grid sensors in sensor grid 130 that is intersected by the flow distribution of working fluid 120 in step S3. Each grid sensor within sensor grid 130 may have a data correspondence with one or more specific burners 110 under predetermined conditions. For example, plurality of burners 110 may produce a working fluid 120 that intersects sensor grid 130. Data correspondence between plurality of burners 110 and sensor grid 130 may indicate expected grid sensor readings (e.g., temperature, CO concentration, etc.) for particular burner 110 conditions (e.g., temperature, CO concentration, etc.). However, slag zones 152 may interfere with the flow of working fluid 120 such that actual grid sensor readings at sensor grid 130 differ from the expected grid sensor readings. This discrepancy in grid sensor readings at sensor grid 130 indicates a flow distribution of working fluid 120 which differs from an expected flow distribution. This different flow distribution can be traced to at least one grid sensor within sensor grid 130, and that at least one grid sensor can be identified. Based upon the location of slag zone 152, readings at sensor grid 130, known conditions at

plurality of burners 110 and sensor grid data versus burner conditions data correspondence, a flow distribution of working fluid 120 can be determined.

[0027] In step S4, the method includes displaying the flow distribution of working fluid 120 from plurality of burners 110 to the at least one sensor grid 130, for example, on a user interface 70. Turning to FIG. 4, user interface 70 is shown according to one embodiment of the invention. As illustrated, user interface 70 includes a graphical user interface. It is understood, however, that it may be embodied in many different forms, e.g., a numerical representation without graphics. In one embodiment, user 36 may provide data about a location of a slag zone 152 within boiler 100 by entering data into user interface 70. User 36 may enter data into fields 72 representing slag zones 152 within slag plane 150 of boiler 100. For example, fields 72 may include a plurality of settings, each indicative of an amount of slag present in a slag zone 152. In the illustrative example of FIG. 4, "L" indicates a default, or "no slag" setting, while "H" indicates the presence of slag. If user 36 determines slag plane 150 includes one or more slag zones 152, user 36 may indicate as much through fields 72 of user interface 70. Alternatively, slag sensors 34 may provide data about a location of a slag zone 152 to slag zone mapping system 30. Slag zone mapping system 30 may then provide that data to user interface 70, which may indicate the presence of slag. User interface 70 may indicate the presence of slag, for example, by indicating an "H" in one or more of fields 72.

[0028] User interface 70 may also include sensor grid readings 74 that indicate readings at plurality of grid sensors on sensor grid 130. User interface may also include boiler readings 76 as well as historical boiler data 78. Additionally, user interface 70 may also include a "Calculate Slag Map" (CSM) button 80. User 36 may request calculation of a slag map by triggering CSM button 80. Upon triggering of CSM button 80, a boiler map 200 (FIG. 5) may be displayed in user interface 70, or a different user interface.

[0029] Turning to FIG. 5, a portion of an illustrative boiler map 200 is shown. Boiler map 200 is a graphical representation of a flow distribution of working fluid 120 as described with reference to FIGS. 1-3. Boiler map 200 may include a depiction of boiler 100, working fluid 120, and plurality of burners 110. In an alternative embodiment, boiler map 200 may depict a slag plane 150, slag zones 152 and a sensor grid 130 as described with reference to boiler 100 in FIG. 2. Boiler map 200 may indicate varying flow rates of working fluid 120 through different line weights, styles, or other emphasis/de-emphasis. Further, boiler map 200 may indicate varying temperatures of working fluid 120 through line color, background/foreground color, labels, and/or segmenting. Boiler map 200 may also indicate differences in conditions within boiler 100 via any conventional means such as shading, highlighting, animation, etc.. Boiler map 200 may indicate laminar flow conditions using straight or

substantially straight lines. Additionally, boiler map 200 may indicate various turbulent flow conditions such as recirculation, eddies and apparent randomness through substantially curved lines and/or loops. Boiler map 200 may also indicate flow conditions by other conventional means, for example, labeling with text, highlighting, shading, etc.

[0030] While shown and described herein as a slag zone mapping system, it is understood that aspects of the invention further provide various alternative embodiments. For example, in one embodiment, the invention provides a computer program embodied in at least one computer-readable medium, which when executed, enables a computer system to map slag zones in a boiler. To this extent, the computer-readable medium includes program code, such as slag zone mapping system 30 (FIG. 1), which implements some or all of a process described herein. It is understood that the term "computer-readable medium" comprises one or more of any type of tangible medium of expression capable of embodying a copy of the program code (e.g., a physical embodiment). For example, the computer-readable medium can comprise: one or more portable storage articles of manufacture; one or more memory/storage components of a computing device; paper; and/or the like.

[0031] In another embodiment, the invention provides a method of providing a copy of program code, such as slag zone mapping system 30 (FIG. 1), which implements some or all of a process described herein. In this case, a computer system can generate and transmit, for reception at a second, distinct location, a set of data signals that has one or more of its characteristics set and/or changed in such a manner as to encode a copy of the program code in the set of data signals. Similarly, an embodiment of the invention provides a method of acquiring a copy of program code that implements some or all of a process described herein, which includes a computer system receiving the set of data signals described herein, and translating the set of data signals into a copy of the computer program embodied in at least one computer-readable medium. In either case, the set of data signals can be transmitted/received using any type of communications link.

[0032] In still another embodiment, the invention provides a method of generating a system for mapping slag zones in a boiler. In this case, a computer system, such as computer system 20 (FIG. 1), can be obtained (e.g., created, maintained, made available, etc.) and one or more modules for performing a process described herein can be obtained (e.g., created, purchased, used, modified, etc.) and deployed to the computer system. To this extent, the deployment can comprise one or more of: (1) installing program code on a computing device from a computer-readable medium; (2) adding one or more computing and/or I/O devices to the computer system; and (3) incorporating and/or modifying the computer system to enable it to perform a process described herein.

[0033] It is understood that aspects of the invention

can be implemented as part of a method that performs a process described herein on a subscription, advertising, and/or fee basis. That is, a service provider could offer to provide processing instructions for mapping slag zones in a boiler as described herein. In this case, the service provider can manage (e.g., create, maintain, support, etc.) a computer system, such as computer system 20 (FIG. 1), that performs a process described herein for one or more customers. In return, the service provider can receive payment from the customer(s) under a subscription and/or fee agreement, receive payment from the sale of advertising to one or more third parties, and/or the like.

[0034] This written description uses examples to disclose the invention, including the preferred mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they have structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal languages of the claims.

[0035] Various aspects and embodiments of the present invention are defined by the following numbered clauses:

1. A slag zone mapping system comprising:

an obtainer for obtaining data about a location of a slag zone within a boiler, the slag zone being one of a plurality of slag zones in a slag plane;

a determinater for determining a flow distribution of a working fluid within the boiler, the flow distribution originating at a plurality of burners and intersecting the slag zone and a sensor grid including a plurality of grid sensors;

an identifier for identifying at least one grid sensor in the plurality of grid sensors that is intersected by the flow distribution of the working fluid; and

a user interface module for displaying the flow distribution of the working fluid from the plurality of burners to the at least one grid sensor.

2. The slag zone mapping system of clause 1, wherein the user interface module generates a graphical user interface (GUI).

3. The slag zone mapping system of any preceding clause, wherein the obtainer obtains data about a location of a slag zone via a user input at the user

interface.

4. The slag zone mapping system of any preceding clause, wherein the determinater determines the flow distribution based on a sensor grid data versus burner conditions data correspondence. 5

5. The slag zone mapping system of any preceding clause, wherein the user interface module generates a graphical display for displaying a graphical representation of the flow distribution of the working fluid. 10

6. The slag zone mapping system of any preceding clause, wherein the obtainer uses a slag sensor to gather data about a location of the slag zone within the boiler. 15

7. The slag zone mapping system of any preceding clause, further including: 20

the boiler having:

the plurality of burners;
the working fluid heated by the plurality of burners; and
the sensor grid in contact with the working fluid. 25

8. A boiler comprising: 30

a plurality of burners;
a working fluid heated by the plurality of burners;
a sensor grid in contact with the working fluid;
and
a slag zone mapping system connected to the sensor grid and the plurality of burners, the slag zone mapping system including: 35

an obtainer for obtaining data about a location of a slag zone within a boiler, the slag zone being one of a plurality of slag zones in a slag plane;
a determinater for determining a flow distribution of a working fluid within the boiler, the flow distribution originating at a plurality of burners and intersecting the slag zone and a sensor grid including a plurality of grid sensors;
an identifier for identifying at least one grid sensor in the plurality of grid sensors that is intersected by the flow distribution of the working fluid; and
a user interface module for displaying the flow distribution of the working fluid from the plurality of burners to the at least grid one sensor. 50 55

9. The boiler of any preceding clause, wherein the

user interface module generates a graphical user interface (GUI).

10. The boiler of any preceding clause, wherein the obtainer obtains data about a location of a slag zone via a user input at the user interface.

11. The boiler of any preceding clause, wherein the determinater determines the flow distribution based on a sensor grid data versus burner conditions data correspondence.

12. The boiler of any preceding clause, wherein the user interface module generates a graphical display for displaying a graphical representation of the flow distribution of the working fluid.

13. The boiler of any preceding clause, wherein the obtainer uses a slag sensor to gather data about a location of the slag zone within the boiler.

14. A program product stored on a computer readable medium, which when executed, performs the following:

obtaining data about a location of a slag zone within a boiler, the slag zone being one of a plurality of slag zones in a slag plane;
determining a flow distribution of a working fluid within the boiler, the flow distribution originating at a plurality of burners and intersecting the slag zone and a sensor grid including a plurality of grid sensors;
identifying at least one grid sensor in the plurality of sensors that is intersected by the flow distribution of the working fluid; and
displaying, on a user interface, the flow distribution of the working fluid from the plurality of burners to the at least one grid sensor.

15. The program product of any preceding clause, wherein the user interface includes a graphical user interface (GUI).

16. The program product of any preceding clause, wherein the obtaining includes observing the location of the slag zone through physical observation and entering the data about the location of the slag zone into the user interface.

17. The program product of any preceding clause, wherein the determinater determines the flow distribution based on a sensor grid data versus burner conditions data correspondence.

18. The program product of any preceding clause, wherein the displaying includes mapping a graphical representation of the flow distribution of the working

fluid.

19. The program product of any preceding clause, wherein the graphical representation is a three-dimensional representation.

20. The program product of any preceding clause, wherein the obtaining includes using a slag sensor to gather data about a location of the slag zone within the boiler.

Claims

1. A slag zone mapping system (30) comprising:

an obtainer for (40) obtaining data about a location of a slag zone (152) within a boiler (100), the slag zone (152) being one of a plurality of slag zones (152) in a slag plane (150);

a determinater (50) for determining a flow distribution of a working fluid (120) within the boiler (100), the flow distribution originating at a plurality of burners (110) and intersecting the slag zone (152) and a sensor grid (130) including a plurality of grid sensors;

an identifier (60) for identifying at least one grid sensor in the plurality of grid sensors that is intersected by the flow distribution of the working fluid (120); and

a user interface module (70) for displaying the flow distribution of the working fluid (120) from the plurality of burners (110) to the at least one grid sensor.

2. The slag zone mapping system (30) of claim 1, wherein the obtainer (40) uses a slag sensor (34) to gather data about a location of the slag zone (152) within the boiler (100).

3. The slag zone mapping system (30) of any preceding claim, further including:

the boiler (100) having:

the plurality of burners (110);
the working fluid (120) heated by the plurality of burners (110); and
the sensor grid (130) in contact with the working fluid (120).

4. A boiler (100) comprising:

a plurality of burners (110);
a working fluid (120) heated by the plurality of burners (110);
a sensor grid (130) in contact with the working fluid (120); and

a slag zone mapping system (30) connected to the sensor grid (130) and the plurality of burners (110), the slag zone mapping system (30) including:

an obtainer (40) for obtaining data about a location of a slag zone (152) within a boiler (100), the slag zone (152) being one of a plurality of slag zones (152) in a slag plane (150);

a determinater (50) for determining a flow distribution of a working fluid (120) within the boiler (100), the flow distribution originating at a plurality of burners (110) and intersecting the slag zone (152) and a sensor grid (130) including a plurality of grid sensors;

an identifier (60) for identifying at least one grid sensor in the plurality of grid sensors that is intersected by the flow distribution of the working fluid (120); and

a user interface module (70) for displaying the flow distribution of the working fluid (120) from the plurality of burners (110) to the at least one grid sensor.

5. The boiler (100) of claim 4, wherein the user interface module (70) generates a graphical display for displaying a graphical representation of the flow distribution of the working fluid (120).

6. A program product stored on a computer readable medium, which when executed, performs the following:

obtaining data about a location of a slag zone (152) within a boiler (100), the slag zone (152) being one of a plurality of slag zones (152) in a slag plane (150);

determining a flow distribution of a working fluid (120) within the boiler (100), the flow distribution originating at a plurality of burners (110) and intersecting the slag zone (152) and a sensor grid (130) including a plurality of grid sensors;

identifying at least one grid sensor in the plurality of grid sensors that is intersected by the flow distribution of the working fluid (120); and
displaying, on a user interface (70), the flow distribution of the working fluid (120) from the plurality of burners (110) to the at least one grid sensor.

7. The program product of claim 6, wherein the user interface (70) includes a graphical user interface (GUI).

8. The program product of claim 6 or claim 7, wherein the obtaining includes observing the location of the

slag zone (152) through physical observation and entering the data about the location of the slag zone (152) into the user interface (70).

9. The program product of any of claims 6 to 8, wherein the displaying includes mapping a graphical representation of the flow distribution of the working fluid (120). 5
10. The program product of claim 9, wherein the graphical representation is a three-dimensional representation. 10

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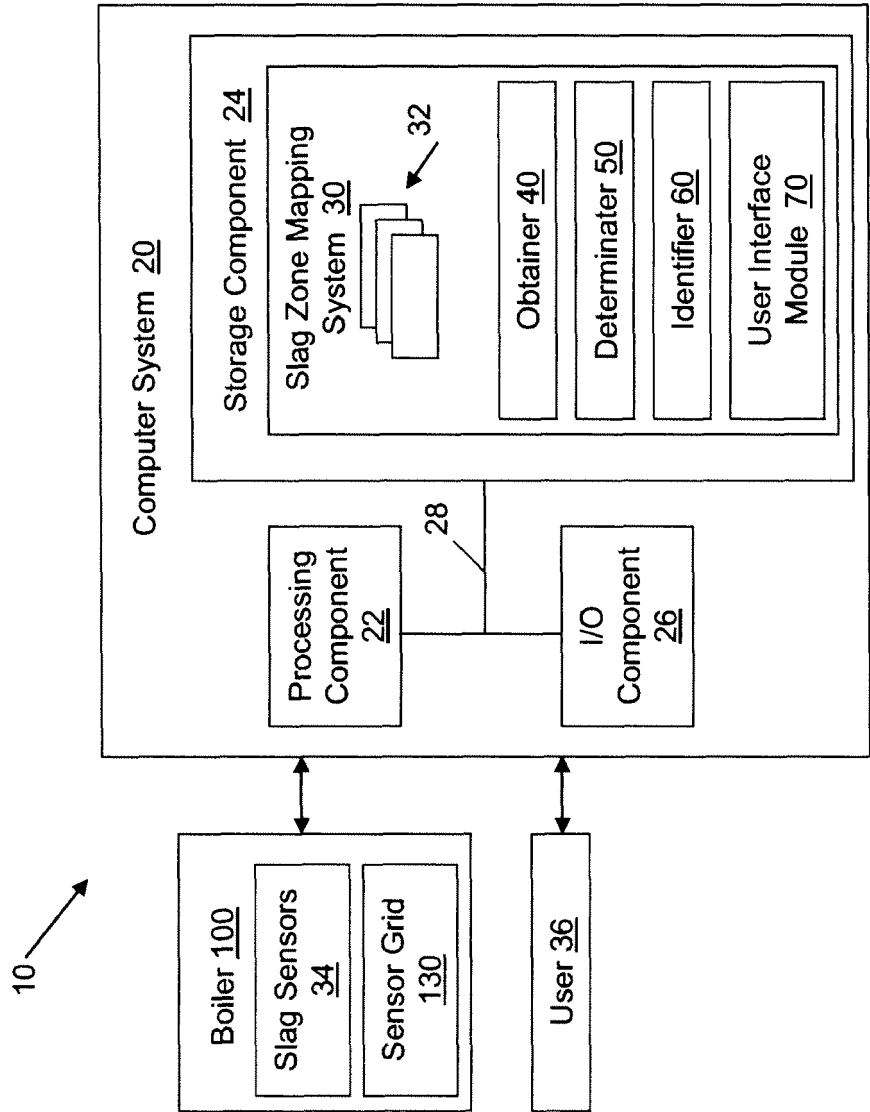


FIG. 1

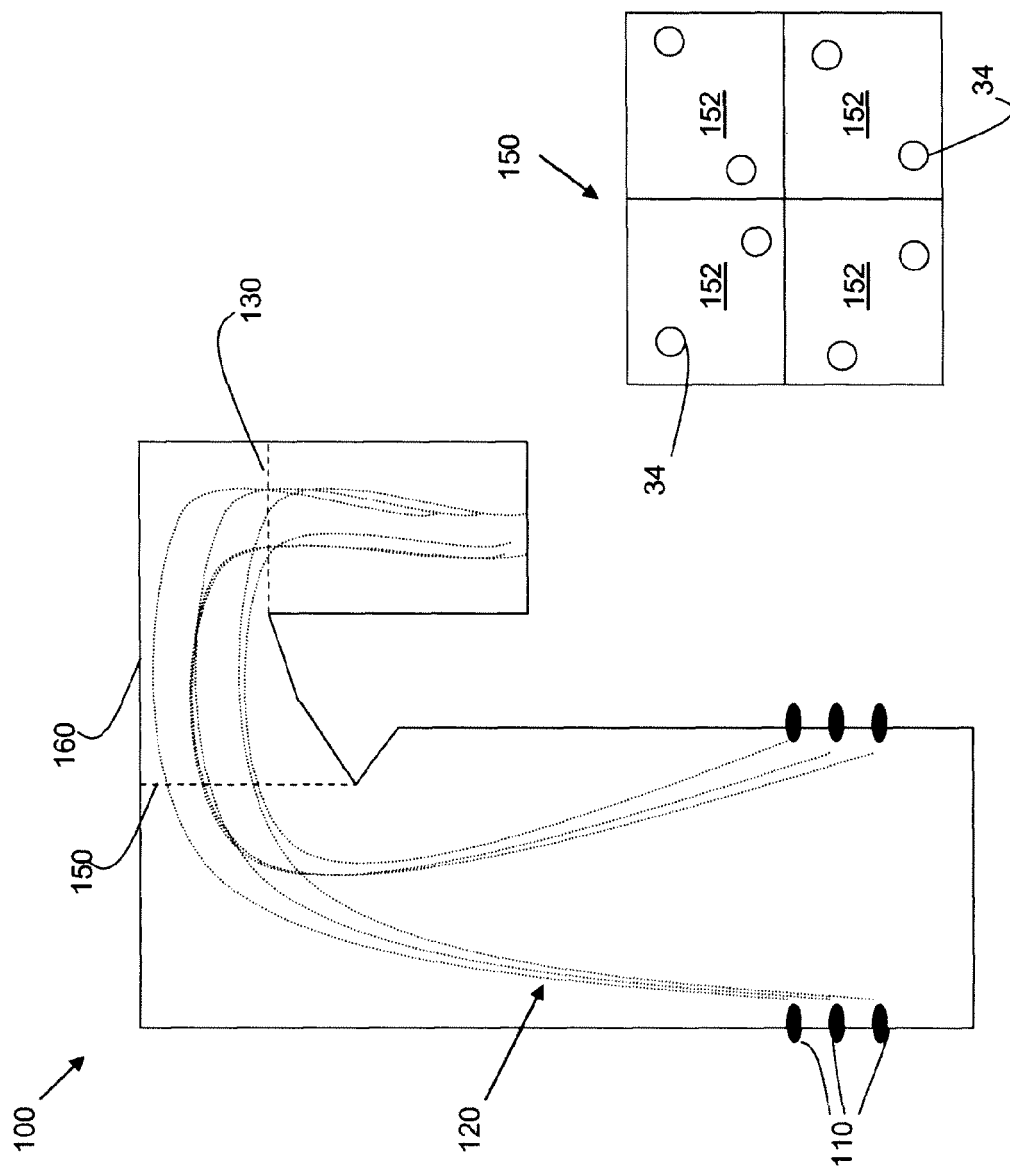


FIG. 2B

FIG. 2A

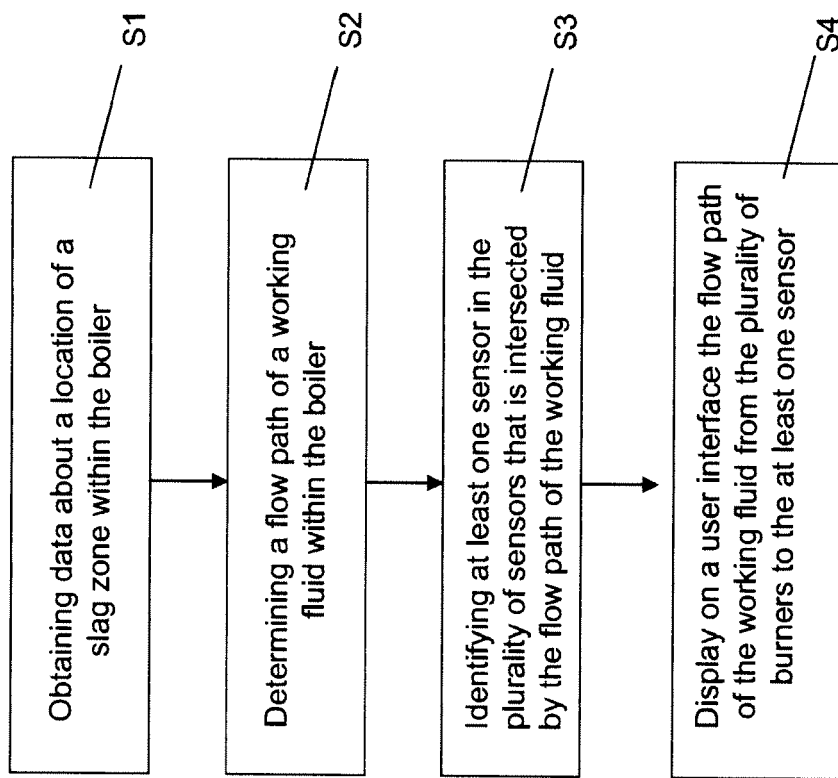


FIG. 3

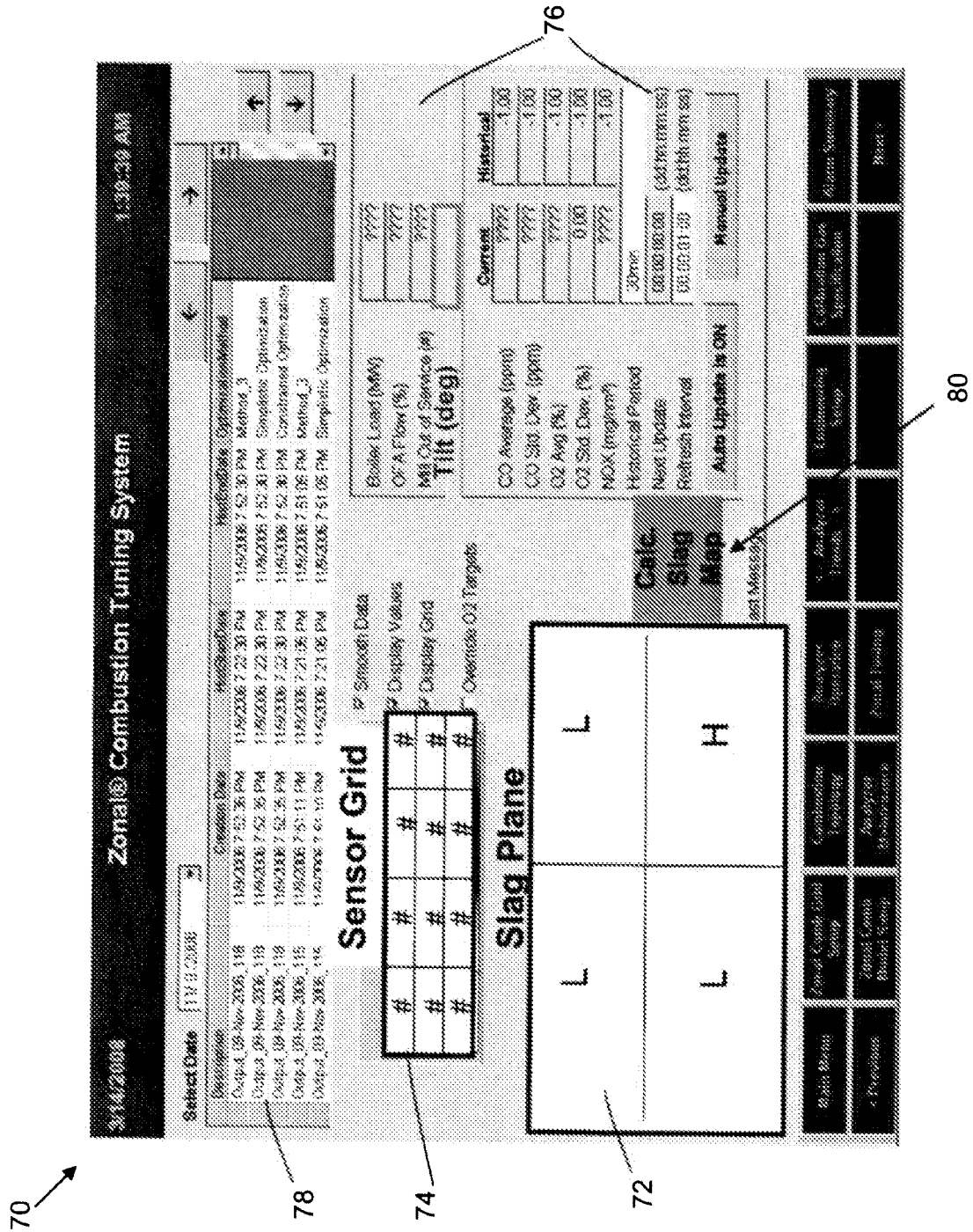


FIG. 4

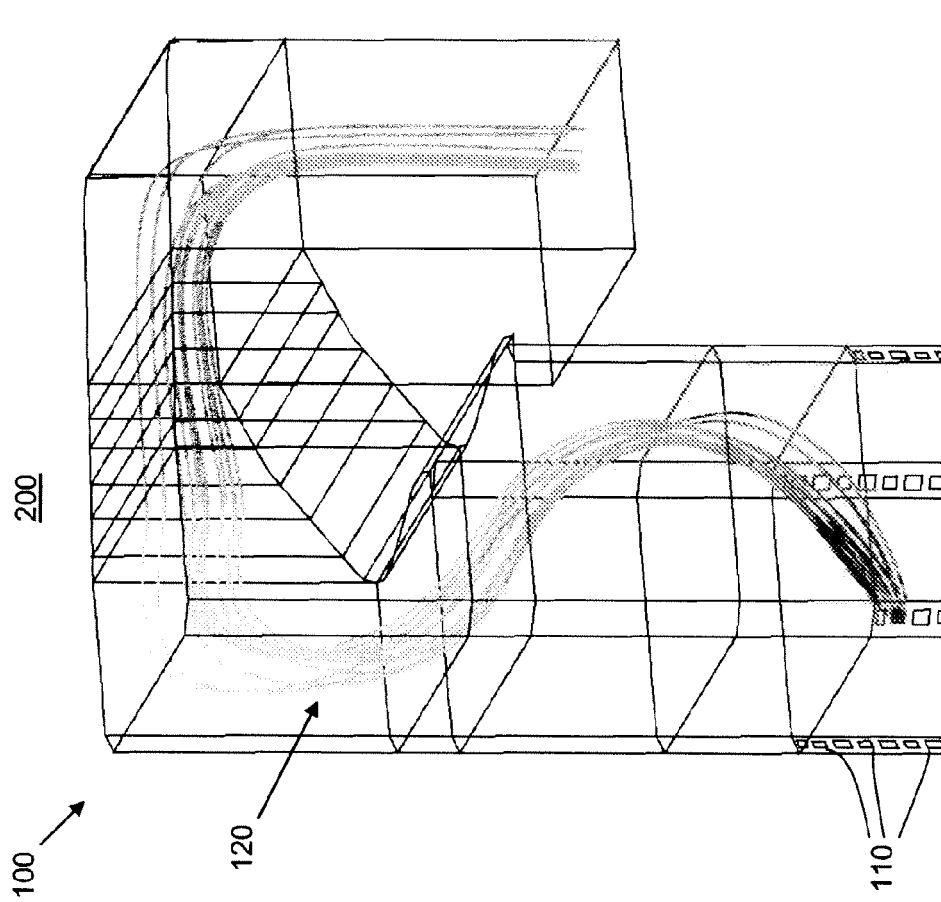


FIG. 5