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(71) Applicant: **Daikin Europe N.V.**
8400 Oostende (BE)

(72) Inventors:
• **GÖKÇE, Ali Erman**
54300 Hendek (TR)
• **TÜR, Volkan**
54300 Hendek (TR)

(74) Representative: **Brantsandpatents bv**
Pauline Van Pottelsberghelaan 24
9051 Ghent (BE)

(54) **CAPACITY VERIFICATION SYSTEM AND METHOD OF OPERATION THEREOF**

(57) This invention relates to a capacity verification system and its operating method that enables the determination of anomalies in the operating conditions of the combustion boiler (10) by comparing the measured tem-

perature difference (dT_o) between sensors (16, 17) with the predefined temperature difference (dT_a) corresponding to certain fan RPM values, while the heating water is circulated in the primary circuit.

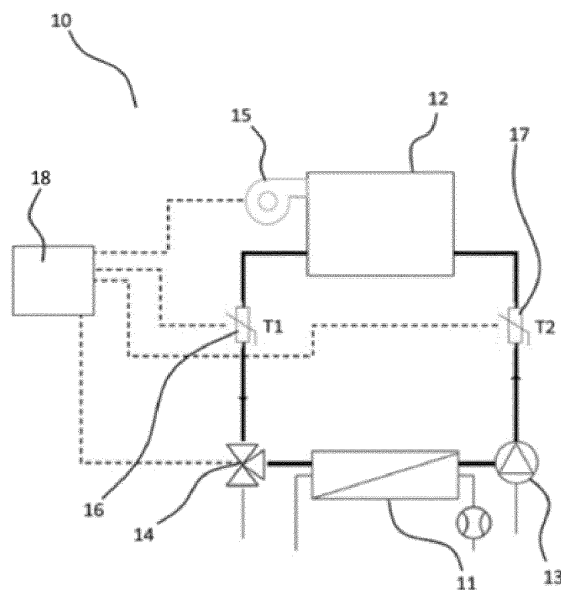


Figure -1

Description**Technical Field**

5 **[0001]** The present invention relates to a capacity verification system and method for detecting anomalies that may occur during operation by comparing the difference between heat exchanger inlet and outlet temperatures measured during field operation of boilers with a pre-assigned temperature difference value for specific fan revolutions.

State of The Art

10 **[0002]** In order to explain the state of the art, we can describe some possible problems as follows. Having a blockage in boilers used for central heating and/or domestic hot water, in the pipes inside the boiler, in the water channels of the main heat exchanger and in the plate heat exchanger, or not working of the circulation pump at the expected capacity are common problems. These problems reduce the water flow rate in the boiler, prevent the efficient transfer of the heat generated by combustion to the water and reduce the heat transfer efficiency.

15 **[0003]** In addition to these, in gas-fired boilers, accumulation of dirt in the combustion chamber and thus congestion, congestion in the chimney that discharges the combustion products, or increased pressure loss due to the use of a very long chimney are also among the frequently encountered problems in the field. These problems cause the nominal capacity of the boiler to decrease by reducing the flow rate of the combustion air-gas mixture in the main heat exchanger.

20 **[0004]** In the known method, early diagnosis of these anomalies that reduce the boiler's heat transfer efficiency is impossible without using additional equipment to measure the water flow rate in the boiler. In addition, early detection of these anomalies that reduce the boiler's nominal capacity is impossible without using additional equipment to measure the gas or air flow rate entering the combustion chamber.

25 **[0005]** In summary, in the known method, it is not possible to detect these anomalies before they cause any customer complaints and before the service/technician examines the product after this complaint. It is important to detect these anomalies before they get big enough to cause customer complaints and to take the necessary precautions for the efficient and safe use of the related device.

30 **[0006]** In the utility model No. CN211668039U, relates to a monitoring platform, in particular to a boiler safety monitoring platform, which comprises a data acquisition communication module used for acquiring data information of water inlet temperature, water inlet pressure, water outlet temperature, water storage pressure and gas leakage of a boiler; the data transmission module is used for transmitting the data information acquired by the data acquisition communication module; and the remote monitoring terminal is used for receiving the data transmitted by the data transmission module and displaying the received data information in real time.

35 **[0007]** In the patent No. NL8102571A, control system is designed for use with gas or oilfired central heating boilers. The following variables are monitored by transducers: water temp., room temp., fan speed, air flow and selected room temp. The transducer outputs are fed to a central electronic processor which controls the fuel flow by means of a series of valves, and the air flow by fan motor control.

40 **[0008]** Although there are so many improvements in the art, there is no known method that can detect possible errors that is disclosed with the invention and problems caused by errors before the user realizes them. Therefore, in order to identify these problems in heating devices through a system and to convey this information to the user, it is necessary to determine the relationship between temperature difference and fan speed values by creating reference values and to interpret the difference according to the values read during the operation of the product in the field.

Objectives and Brief Description of the Invention

45 **[0009]** The aim of the present invention is to determine the anomalies that may occur during the operation of combustion boilers and notify its users.

50 **[0010]** In order to realize above purpose, the invention is a capacity verification system for a combustion boiler which comprises a main heat exchanger, a circulation pump, a fan wherein the fan supplies air/gas mixture to the main heat exchanger at least one inlet temperature sensor to measure the inlet water temperature entering to main heat exchanger, and at least one outlet temperature sensor to measure outlet water temperature exiting from the main heat exchanger wherein the capacity verification system comprises a controller that detects anomalies in the operating conditions of the combustion boiler by comparing measured temperature difference between said sensors with predefined temperature difference corresponding to certain fan RPM values, while the heating water is circulated in the primary circuit.

55 **[0011]** In the preferred embodiment of the invention, mentioned controller is configured to detect the anomalies which causes nominal capacity decrease or heat transfer efficiency decrease in case the temperature difference is less or greater than the predefined temperature difference.

[0012] The controller is configured to estimate the anomalies caused by a blockage on an air/gas passage of heat

exchanger or a flue pipe, in case the measured temperature difference is less than the predefined temperature difference.

[0013] In case the measured temperature difference is greater than the predefined temperature difference, then the controller estimate that the anomalies are caused by a blockage on a water passage on primary circuit or an anomaly of the circulation pump.

[0014] The invention is also a capacity verification system operating method for a combustion boiler which comprises a main heat exchanger, a circulation pump, a fan wherein the fan supplies air/gas mixture to the main heat exchanger at least one inlet temperature sensor to measure inlet water temperature entering to main heat exchanger, and at least one outlet temperature sensor to measure outlet water temperature exiting from the main heat exchanger, and the method comprising the steps of

- measuring the inlet water temperature entering to the main heat exchanger, the outlet water temperature exiting from the main heat exchanger, and the fan RPM values while the heating water is circulated in the primary circuit,
- calculating measured temperature difference between the inlet water temperature and the outlet water temperature,
- comparing this measured temperature difference with predefined temperature difference corresponding to certain fan RPM values,
- according to the result obtained, determining the anomalies in the operating conditions of the combustion boiler.

[0015] In a preferred capacity verification system operating method, in the step of identifying anomalies, it is evaluated whether the predefined temperature difference is greater or less than the measured temperature difference.

[0016] According to the capacity verification system operating method, the controller detects the anomalies which causes nominal capacity decrease in case the measured temperature difference is less than the predefined temperature difference, and the controller detects the anomalies which causes heat transfer efficiency decrease in case the measured temperature difference is greater than the predefined temperature difference.

[0017] After detecting the anomalies, the capacity verification system operating method also comprises the step of notifying user with a warning message about the anomalies in the operating conditions of the combustion boiler.

[0018] The invention is also a combustion boiler having a main heat exchanger, a circulation pump, a fan wherein the fan supplies air/gas mixture to the main heat exchanger, at least one inlet temperature sensor to measure inlet water temperature entering to the main heat exchanger, and at least one outlet temperature sensor to measure outlet water temperature exiting from the main heat exchanger, and further comprises a capacity verification system mentioned above.

Brief Description of the Figures

[0019] Figure 1; A schematic view of combustion boiler having capacity verification system.

Reference Numbers

[0020]

- 10. Combustion boiler
- 11. (Plate) heat exchanger
- 12. Main heat exchanger
- 13. Circulation pump
- 14. 3-way valve
- 15. Fan
- 16. Outlet temperature sensor
- 17. Inlet temperature sensor
- 18. Controller
- T1. Outlet water temperature
- T2. Inlet water temperature
- dTo. Measured temperature difference
- dTa. Predefined temperature difference

Detailed Description of the Invention

[0021] The invention relates to a capacity verification system and operating method for a combustion boiler (10).

[0022] According to the Figure 1, the combustion boiler comprises a main heat exchanger (12), a circulation pump (13), a fan (15) and the fan (15) supplies air/gas mixture to the main heat exchanger (12), at least one inlet temperature sensor (17) to measure inlet water temperature (T2) entering to main heat exchanger (12), and at least one outlet

temperature sensor (16) to measure outlet water temperature (T1) exiting from the main heat exchanger (12). The capacity verification system comprises a controller (18) which is the key element of the verification system and managed by a software. The controller (18) detects anomalies in the operating conditions of the combustion boiler (10) by comparing the measured temperature difference (dTo) between mentioned sensors (16, 17) with the predefined temperature difference (dT_a) corresponding to certain fan RPM values, while the heating water is circulated in the primary circuit.

[0023] The predefined temperature difference (dT_a) corresponding to certain fan RPM values should be uploaded to the software of the controller (18) for a precise comparison. If the predefined temperature difference (dT_a) and fan RPM values are subject to change, a calibration of the software values may be applied.

[0024] A sample table is given below for detecting anomalies based on predefined temperature difference (dT_a) and fan RPM values.

Table 1

Fan RPM	Predefined temperature difference (dT _a)	Measured temperature difference (dTo)	Result
10.000 rpm	20 °C	~ 20 °C	Normal
10.000 rpm	20 °C	<< 20 °C	Abnormal 1
10.000 rpm	20 °C	>> 20 °C	Abnormal 2

[0025] Predefined temperature difference (dT_a) means the temperature difference (expected T1-T2) assigned at the design stage of the combustion boiler (10) in response to the specific fan RPM when the combustion boiler (10) is in domestic hot water mode.

[0026] Measured temperature difference (dTo) represents the difference (actual T1-T2) of the values read by the outlet temperature sensor (16) and inlet temperature sensors (17) when the combustion boiler (10) is operating in the field in domestic water mode.

[0027] While the combustion boiler (10) is operating in domestic water mode, the circulation pump (13) is always running at maximum RPM.

[0028] Abnormal 1: It is the case when measured temperature difference (dTo) during operation is smaller than the predefined temperature difference (dT_a). According to the fan speed at which the device operates, this fan (15) detects that it cannot provide the expected capacity at the speed at which it operates. As a result, the user/service is warned about the possibility of a blockage on the air side of the main heat exchanger (12) and excessive pressure loss in the flue gas line.

[0029] Abnormal 2: It is the case when the measured temperature difference (dTo) operation is greater than the predefined temperature difference (dT_a). It detects that less water passes through the main heat exchanger (12) than expected, according to the fan RPM at which the combustion boiler (10) operates. As a result, the user/service is warned about the possibility of a blockage on the water side of the main heat exchanger (12) or in the circuit, and the circulation pump (13) not working at the expected power.

[0030] It detects that all of the energy of the water heated in the main heat exchanger (12) is not transferred to the domestic water through the plate heat exchanger (11) as it should be. As a result, the user/service is warned about the possibility that some of the water heated in the main heat exchanger (12) may be escaping to the central heating installation due to a malfunction in the 3-way valve (14).

[0031] In sum, the capacity verification system operating method for a combustion boiler (10) comprising the steps of

- measuring the inlet water temperature (T2) entering to the main heat exchanger (12), the outlet water temperature (T1) exiting from the main heat exchanger (12), and the fan RPM values while the heating water is circulated in the primary circuit,
- calculating the measured temperature difference (dTo) between the inlet water temperature (T2) and the outlet water temperature (T1),
- comparing this measured temperature difference (dTo) with the predefined temperature difference (dT_a) corresponding to certain fan RPM values,
- according to the result obtained, determining the anomalies in the operating conditions of the combustion boiler (10).

[0032] In the step of identifying anomalies, it is evaluated whether the predefined temperature difference (dT_a) is greater or less than the measured temperature difference (dTo).

[0033] The controller (18) detects the anomalies which causes nominal capacity decrease in case the measured temperature difference (dTo) is less than the predefined temperature difference (dT_a).

[0034] The controller (18) estimate that the anomalies are caused by a blockage on an air/gas passage of heat

exchanger or a flue pipe, in case the measured temperature difference (dTo) is less than the predefined temperature difference (dT_a).

[0035] In case the measured temperature difference (dTo) is greater than the predefined temperature difference (dT_a), then the controller (18) detects the anomalies which causes heat transfer efficiency decrease.

[0036] In case the measured temperature difference (dTo) is greater than the predefined temperature difference (dT_a), then the controller (18) estimate that the anomalies are caused by a blockage on a water passage on primary circuit or an anomaly of the circulation pump (13).

[0037] The capacity verification system operating method further comprises the step of notifying the user with a warning message about the anomalies in the operating conditions of the combustion boiler (10).

Claims

1. A capacity verification system for a combustion boiler (10) which comprises a main heat exchanger (12), a circulation pump (13), a fan (15) wherein the fan (15) supplies air/gas mixture to the main heat exchanger (12), at least one inlet temperature sensor (17) to measure inlet water temperature (T₂) entering to main heat exchanger (12), and at least one outlet temperature sensor (16) to measure outlet water temperature (T₁) exiting from the main heat exchanger (12) **characterized in that** the capacity verification system comprises a controller (18) that detects anomalies in the operating conditions of the combustion boiler (10) by comparing measured temperature difference (dTo) between said sensors (16, 17) with predefined temperature difference (dT_a) corresponding to certain fan RPM values, while the heating water is circulated in the primary circuit.
2. The capacity verification system according to Claim 1 wherein the controller (18) is configured to detect the anomalies which causes nominal capacity decrease in case the measured temperature difference (dTo) is less than the predefined temperature difference (dT_a).
3. The capacity verification system according to Claim 2 wherein the controller (18) is configured to estimate anomalies caused by a blockage on an air/gas passage of heat exchanger or a flue pipe, in case the measured temperature difference (dTo) is less than the predefined temperature difference (dT_a).
4. The capacity verification system according to Claim 1 wherein the controller (18) is configured to detect the anomalies which causes heat transfer efficiency decrease in case the measured temperature difference (dTo) is greater than the predefined temperature difference (dT_a).
5. The capacity verification system according to Claim 4 wherein the controller (18) is configured to estimate anomalies caused by a blockage on a water passage on primary circuit or an anomaly of the circulation pump (13), in case the measured temperature difference (dTo) is greater than the predefined temperature difference (dT_a).
6. A capacity verification system operating method for a combustion boiler (10) which comprises a main heat exchanger (12), a circulation pump (13), a fan (15) wherein the fan (15) supplies air/gas mixture to the main heat exchanger (12), at least one inlet temperature sensor (17) to measure inlet water temperature (T₂) entering to main heat exchanger (12), and at least one outlet temperature sensor (16) to measure outlet water temperature (T₁) exiting from the main heat exchanger (12), and the method **characterized by** comprising the steps of
 - measuring the inlet water temperature (T₂) entering to the main heat exchanger (12), the outlet water temperature (T₁) exiting from the main heat exchanger (12), and the fan RPM values while the heating water is circulated in the primary circuit,
 - calculating measured temperature difference (dTo) between the inlet water temperature (T₂) and the outlet water temperature (T₁),
 - comparing this measured temperature difference (dTo) with predefined temperature difference (dT_a) corresponding to certain fan RPM values,
 - according to the result obtained, determining the anomalies in the operating conditions of the combustion boiler (10).
7. The capacity verification system operating method according to Claim 6 wherein in the step of identifying anomalies, it is evaluated whether the predefined temperature difference (dT_a) is greater or less than the measured temperature difference (dTo).

8. The capacity verification system operating method according to Claim 6 wherein the controller (18) detects the anomalies which causes nominal capacity decrease in case the measured temperature difference (dT_o) is less than the predefined temperature difference (dT_a).
- 5 9. The capacity verification system operating method according to Claim 6 wherein the controller (18) detects the anomalies which causes heat transfer efficiency decrease in case the measured temperature difference (dT_o) is greater than the predefined temperature difference (dT_a).
- 10 10. The capacity verification system operating method according to Claim 6 wherein after detecting the anomalies, it further comprises the step of notifying user with a warning message about the anomalies in the operating conditions of the combustion boiler (10).
- 15 11. A combustion boiler (10) having a main heat exchanger (12), a circulation pump (13), a fan (15) wherein the fan (15) supplies air/gas mixture to the main heat exchanger (12), at least one inlet temperature sensor (17) to measure inlet water temperature (T₂) entering to the main heat exchanger (12), and at least one outlet temperature sensor (16) to measure outlet water temperature (T₁) exiting from the main heat exchanger (12) **characterized in that** it further comprises a capacity verification system according to any one of Claims 1 to 5.

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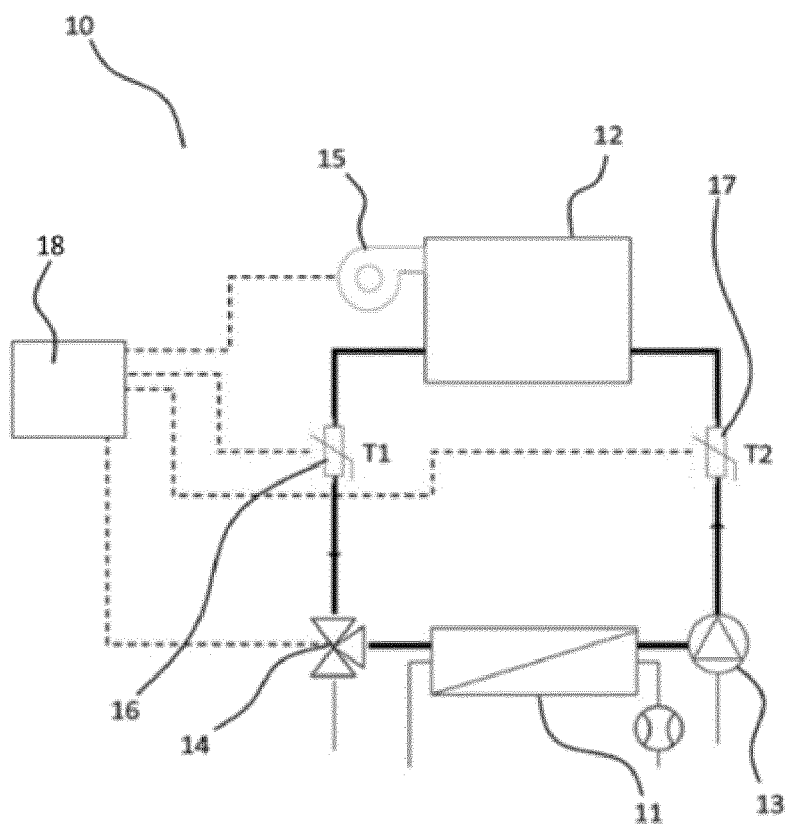


Figure -1



EUROPEAN SEARCH REPORT

Application Number

EP 23 22 0343

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EPO FORM 1503 03.82 (P04C01)

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A	* column 3, line 34 - column 4, line 35; claims 1-5; figures 1-3 *	4, 5, 9	F24H15/104 F24H15/112 F24H15/215
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			TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 9 April 2024	Examiner García Moncayo, O
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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09-04-2024

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