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(54) **A method for regulating the combustion process in solid fuel central heating boilers**

(57) The method for regulating the combustion processes in solid fuel central heating boilers, whereby the energy parameters of the combustion are set at the level relevant for the type of solid fuel and the type of boiler and the combustion process is regulated by changing the amount of solid fuel and air introduced on the basis of temperature measurements, consists in that the temperature t_{mg} of the heating medium is measured as well as temperature t_{sp} of the combustion product in at least one place in the bottom layer of the solid fuel aftercombustion zone or additionally temperature t_p of the combustion product in the ash zone is measured and then the temperature t_{mg} of the heating medium is compared with the preset temperature, and that the amount of pri-

mary air p_p introduced into the process is measured or additionally also the amount of secondary air p_w and then the amount of primary air p_p or the total amount of primary p_p and secondary air p_w is compared with the preset amount and subsequently, based on the algorithm appropriate for the given boiler, it is converted into an impulse for adjusting the settings of solid fuel and/or air inflow, whereby the algorithm takes into account a relevant deviation of the primary air Δp_p or primary and secondary air Δp_{pw} and the known deviation of temperature Δt_{mg} of the heating medium and temperature t_{sp} of the combustion product or additionally also the corresponding in time temperature t_p of the combustion product in the ash zone.

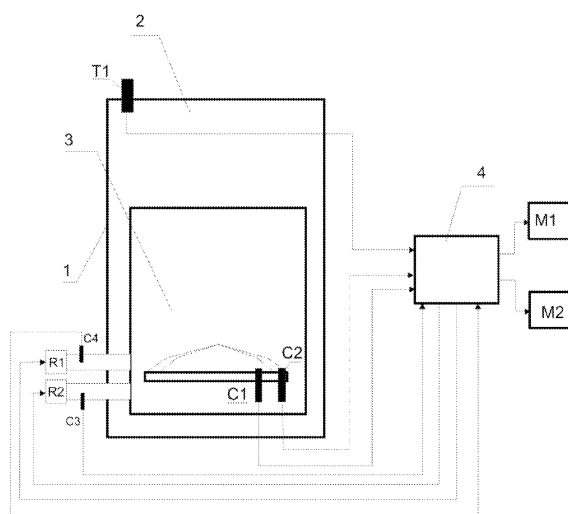


Fig. 2

Description

[0001] The invention relates to a method for regulating the combustion processes in solid fuel central heating boilers.

[0002] Known in the art are methods and systems for regulating the combustion process, whereby the heating units are equipped with air/fuel ratio automatic control systems, which operate based on a flue gas composition measurement. Depending on the amount of oxygen in the flue gas, the composition of the fuel/air mixture is adjusted so that the oxygen content in the flue gas has a fixed and preset value or so that the composition of the flue gas complies with the parameters of model mixtures. Another known method is regulating the combustion efficiency depending on the mass-flow of the vapor produced or measuring other factors using infrared video cameras. The description of the PL 175985 B1 invention describes a method for regulating particular or all factors influencing combustion on a fire grate, in particular for burning garbage, whereby the three-dimensional fuel mass diffusion is defined for the whole of the grate or its parts by reading the fuel mass profile by means of a radar. The obtained signals are used as regulatory values for determining temperature distribution, the amount of primary or secondary air as well as the rate of slag build-up on the grate. The measurements obtained in the described method relate to the outer layer of the deposit.

[0003] Also known in the art is a device for regulating the combustion process in a solid fuel central heating boiler, equipped with an electronic system controlled by the change in resistance of the thermistor operating as a heating factor temperature sensor. The air inflow to the grate is regulated stepwise and the temperature of the heating factor is kept at a required level. In other known methods for regulating the combustion process, electronic devices are used to control the process based on temperature readings of the flue gas or heating medium, the temperature of the combustion chamber as well as other additional parameters e.g.: vapor pressure coupled with protection systems for the process and executive systems regulating the inflow of the fuel mass and air into the process.

[0004] The method for regulating the combustion process according to the invention, whereby the combustion process is regulated by changing the amount of the solid fuel and the amount of air introduced into the process on the basis of temperature measurements, while the combustion energy parameters are set at the level relevant to the type of the solid fuel and the type of the boiler, characteristic in that the heating medium temperature is measured as well as the temperature in at least one place in the bottom layer of the combustion product in the solid fuel aftercombustion zone and subsequently the temperature of the heating medium is compared to the preset temperature and the temperature deviation is converted into an impulse for changing the settings of the solid fuel and/or air inflow based on the algorithm specific for the

particular boiler type, which takes into account the combustion product temperature.

[0005] Favourably, the combustion product temperature is measured in the ash zone and the algorithm specific for the particular boiler takes into account the combustion product temperature in the ash zone and the corresponding in time combustion product temperature in the solid fuel aftercombustion zone. Favourably, the amount of primary air introduced into the process is measured or additionally also the amount of secondary air and subsequently the measured amount of primary air or the total amount of primary and secondary air is compared to a preset amount and then, based on the algorithm specific for the boiler type, it is converted into an impulse for changing the solid fuel/air flow whereby the algorithm takes into account a specific deviation of the amount of primary air or primary and secondary air as well as the known deviations of the heating medium temperature and the combustion product temperature or additionally also the corresponding in time temperature of the combustion product temperature in the ash zone.

[0006] The combustion product temperature is measured in the borderline area of the solid fuel aftercombustion zone and the ash zone.

[0007] The method according to the invention is based on measuring one parameter — temperature, albeit measured in places in the boiler which are significant for the process of regulating the combustion. It simplifies the measurement systems, which makes the solution more economical. Moreover, measuring the temperature in the fuel aftercombustion zone and in the ash zone combined with the information about the type of fuel makes it possible to choose precise settings for the solid fuel and/or air inflow as well as to identify problems in the combustion process and their consequences.

[0008] In one variation of the invention, the method according to the invention is based on measuring two parameters - temperature measured in places in the boiler which are significant for the process of regulating the combustion, and the amount of air introduced into the process. Information about the current amount of air introduced into the combustion chamber combined with the known amount of fuel introduced, makes it possible to control the combustion conditions and thus to optimize the process which results in using less fuel and reduces the emission of harmful products. Moreover, it reduces the influence of atmospheric conditions e.g. wind and pressure on the combustion process as well as the influence of other conditions such as some technical conditions like the chimney draught, its dimensions or other devices used. It simplifies the measuring systems and eliminates the necessity to use probes to measure flue composition, which are difficult to use with solid fuels because of measuring errors resulting from their impurity.

[0009] An example of the method for regulating the combustion process in solid fuel central heating boilers whereby the combustion process is regulated by changing the amount of solid fuel introduced and by changing

the air introduced based on temperature measurements, takes place in a boiler equipped with a grate. The conditions in the boiler are defined by the variable temperature measured in its combustion chamber as well as in the heating element. The status of the combustion process is dynamic and may be altered in different ways, in particular by changing the setting parameters of temperature and air inflow, energy parameters resulting from the quality and quantity of coal as well as exploitation factors connected with the impurity and wear of the boiler. In order to monitor and control the process on an on-going basis, a model algorithm of the process is defined, taking into account the change of temperature resulting from the above-mentioned factors.

[0010] In the central heating boiler during the combustion process the solid fuel on the grate is in all combustion phases from the initial phase to ash, however, the most significant for controlling the process is the information concerning the phase preceding total incineration. The temperature in this area should be considered as characteristic for the described system as it results from the calorific properties of the fuel, fuel and air inflow and the heat exchange in the system itself. Temperature measurements taken before this zone introduce an additional variable in the form of partial combustion of the fuel whereas in the case of measurements taken exclusively in the ash zone the cooling stage of the ash travelling from the aftercombustion zone to the place where the measurement is taken, remains unknown.

[0011] The invention is significant due to its practical and economical aspects particularly in the case of low-power boilers to be installed in residential buildings. It significantly improves the quality of combustion and eliminates the necessity to regulate the settings for fuel dosage manually.

[0012] The subject of the invention in its embodiments is presented as example systems, whereby:

Fig. 1 - presents a diagram of regulating the combustion process by adjusting the amount of fuel and/or air using the measurement of embers at a specific point of the grate.

Fig. 2 - presents a diagram of regulating the combustion process using the signal from the embers temperature measurement (taken at a specific place on the grate), and the measurement of the amount of air introduced into the process.

Embodiment 1

[0013] A method according to the invention is presented in more detail on the basis of a model system as shown in Fig.1, the combustion energy parameters are set at the level relevant for the type of solid fuel and the type of boiler. The temperature sensor T1 placed in the heating unit 2 of the boiler 1 measures temperature t_{mg} of the heating medium, while at least one sensor C1 placed in the combustion chamber 3 of the boiler 1 in the solid fuel

aftercombustion zone measures temperature t_{sp} in at least one place in the bottom layer of the combustion product. Temperature measurement t_{sp} of the combustion product is taken on the borderline between the solid fuel aftercombustion zone and the ash zone.

Embodiment 2

[0014] In a variation of the method according to the invention (fig. 1), the temperature t_p of the combustion product in the ash zone is also taken, which carries information about the calorific value of the fuel. The summing/processing controller 4, coupled with the temperature sensors C1 and T1, compares temperature t_{mg} of the heating medium with the preset temperature and converts the deviation Δt_{mg} from that temperature based on an algorithm appropriate for the given boiler taking into account the temperature t_{sp} of the combustion product into a signal for adjusting the settings for the inflow of the solid fuel and/or air.

[0015] In a variation of the method whereby the temperature sensor C2 also takes the temperature measurement in the ash zone, the algorithm takes into account the corresponding to each other in time temperature t_p of the combustion product in the ash zone and temperature t_{sp} of the combustion product in the solid fuel aftercombustion zone. The summing/processing controller 4, depending on the settings defined by the program, sends a signal to the controller M1 of the solid fuel (e.g. coal) feeder receiver on the output side or to the controller M2 of the air inflow regulator, thus increasing or reducing the amount of fuel introduced to the combustion chamber 3 of the boiler 1 and/or changing the amount of air introduced into the system.

Embodiment 3

[0016] A method according to the invention is presented in more detail on the basis of a model system as shown in Fig.2. In the method the energy parameters of the combustion are set at the level relevant for the type of solid fuel and the type of boiler. The temperature sensor T1 placed in the heating unit 2 of the boiler 1 measures temperature t_{mg} of the heating medium, and at least one sensor C1 placed in the combustion chamber 3 of the boiler 1 in the solid fuel aftercombustion zone measures temperature t_{sp} in at least one place in the bottom layer of the combustion product. The temperature measurement t_{sp} of the combustion product is taken on the borderline between the solid fuel aftercombustion zone and the ash zone. In a variation of the method according to the invention, sensor C2 additionally measures temperature t_p of the combustion product in the ash zone, which carries information about the calorific value of the fuel. Measuring instrument C3 measures the amount of primary air introduced into the combustion chamber 3 or, optionally, measuring instrument C4 measures the amount of secondary air introduced therein. The sum-

ming/processing controller 4 is coupled with temperature sensors C1 and T1 as well as with measuring instruments of primary air C3 and secondary air C4, whereby the controller compares temperature t_{mg} of the heating medium with the preset temperature and compares the measured amount of primary air p_p or the total amount of primary air p_p and secondary air p_w with the preset amount and subsequently, based on the algorithm appropriate for the given boiler taking into account a relevant deviation of primary air Δp_p or primary and secondary air Δp_{pw} and the temperature t_{sp} of the combustion product and the temperature deviation Δt_{mg} of the heating medium, converts into an impulse for adjusting the settings of solid fuel and/or air inflow.

[0017] Air regulators R1 and R2 are controlled based on the C3 and C4 measurement. These measurements are compared with a model air inflow established in laboratory conditions. On such basis the summing controller adjusts the regulators R1 and R2. The purpose of this extension, in relation to the first application, is a better reconstruction of the combustion conditions in series produced boilers with good repeatability of dimensions, yet installed in different boiler-houses. The dimensions and the height of the chimney, the voltage of the power supply (which in accordance with applicable standards can vary by over $\pm 5\%$) as well as the technological spread of the blowers (different capacities and same parameters) are very significant.

[0018] The measurement of t_{sp} and t_p on the other hand, is the basis for the adjustment of the amount of fuel introduced. On the basis of t_{mg} the regulator determines the preliminary amount of fuel that should be combusted based on model data characteristic of the structure of the particular boiler established empirically by means of tests. Subsequently, such amount of fuel is combusted, while temperature T_{sp} is simultaneously measured. If the fuel burns more quickly, T_{sp} decreases and so more fuel is introduced, when it increases - less fuel is introduced. Information from the sensor T_p is necessary in the case of bigger grates, as it allows for a more precise adjustment of fuel dosage and for maintaining the embers in the best possible position on the grate (it is especially significant in the case of bigger grates).

Embodiment 4

[0019] In a variation of the method (fig.2) whereby the temperature sensor C2, also coupled with the summing/processing controller 4, additionally measures the temperature in the ash zone, the algorithm takes into account the corresponding to each other in time temperature t_p of the combustion product in the ash zone and temperature t_{sp} of the combustion product in the solid fuel aftercombustion zone.

[0020] The summing/processing controller 4, depending on the settings defined by the program, sends a signal to the controller M1 of the solid fuel (e.g. coal) feeder receiver on the output side or to the controller M2 of the

primary and secondary air inflow regulators R1 and R2, thus increasing or reducing the amount of fuel introduced to the combustion chamber 3 of the boiler 1 and/or changing the amount of air introduced into the process.

Claims

1. A method for regulating the combustion processes in solid fuel central heating boilers, whereby the combustion process is regulated by changing the amount of the solid fuel and the amount of air introduced based on temperature measurements while the combustion energy parameters are set at the level relevant to the type of the solid fuel and the type of the boiler, characteristic in that the heating medium temperature t_{mg} is measured as well as temperature t_{sp} in at least one place in the bottom layer of the combustion product in the solid fuel aftercombustion zone and subsequently the temperature t_{mg} of the heating medium is compared to the preset temperature and the temperature deviation Δt_{mg} is converted into an impulse for changing the settings of the solid fuel and/or air inflow based on the algorithm specific for the particular boiler type, which takes into account the combustion product temperature t_{sp} .
2. A method according to claim 1, characteristic in that the amount of primary air p_p introduced into the process is measured or additionally also the amount of secondary air p_w and subsequently the measured amount of primary air p_p or the total amount of primary air p_p and secondary air p_w is compared with the preset amount and then, based on the algorithm appropriate for the particular boiler, it is converted into an impulse for changing the settings of solid fuel and/or air inflow, whereby the algorithm takes into account a relevant deviation of the primary air Δp_p or primary and secondary air Δp_{pw} and the known deviation of temperature Δt_{mg} of the heating medium and temperature t_{sp} of the combustion product or additionally also the corresponding in time temperature t_p of the combustion product in the ash zone.
3. A method according to claim 1 or 2, **characteristic in that** temperature t_p of the combustion product in the ash zone is measured and the algorithm appropriate for the particular boiler takes into account the corresponding to each other in time temperature t_p of the combustion product in the ash zone and temperature t_{sp} of the combustion product in the solid fuel aftercombustion zone.
4. A method according to claim 1 or 2, **characteristic in that** the temperature t_{sp} of the combustion product is measured on the borderline between the solid fuel aftercombustion zone and the ash zone.

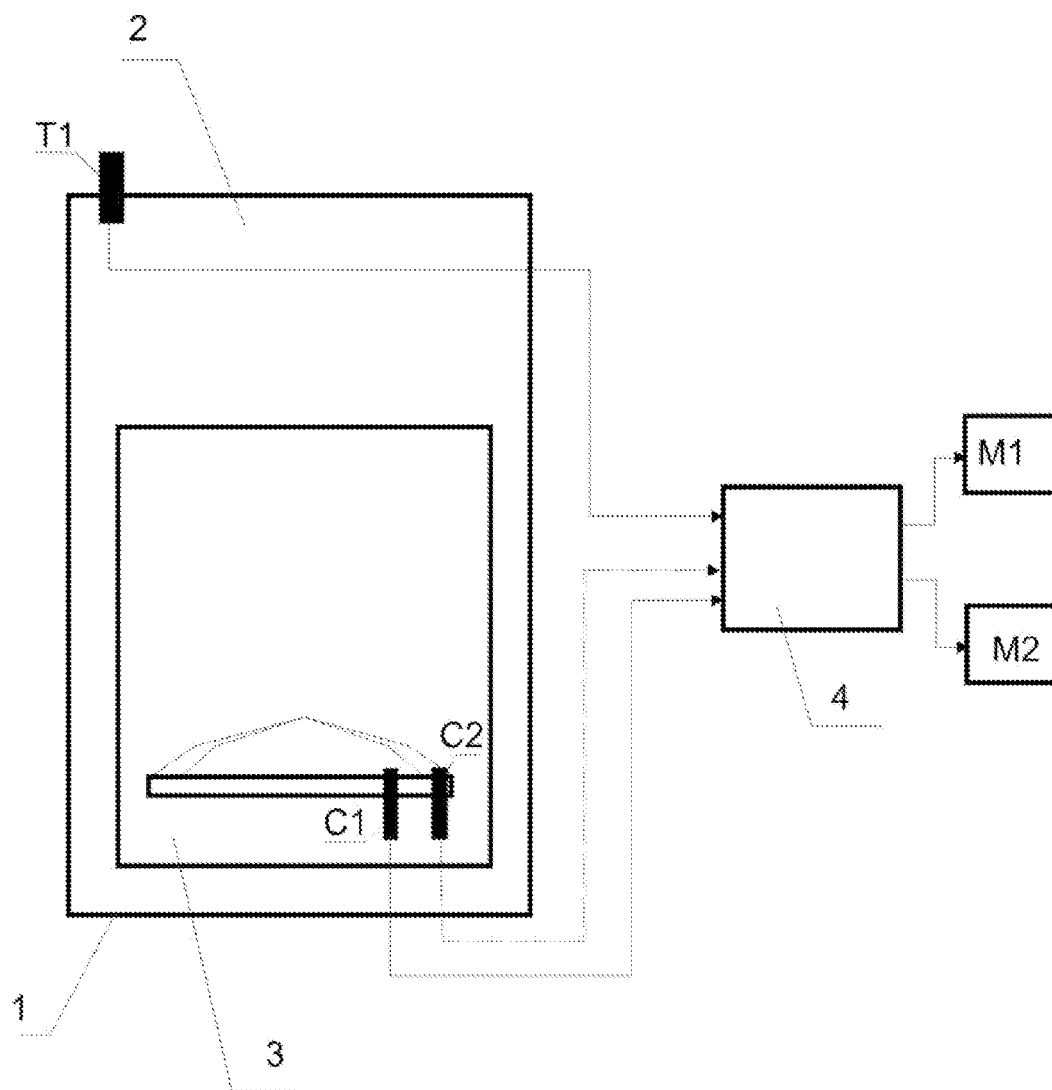


Fig.1

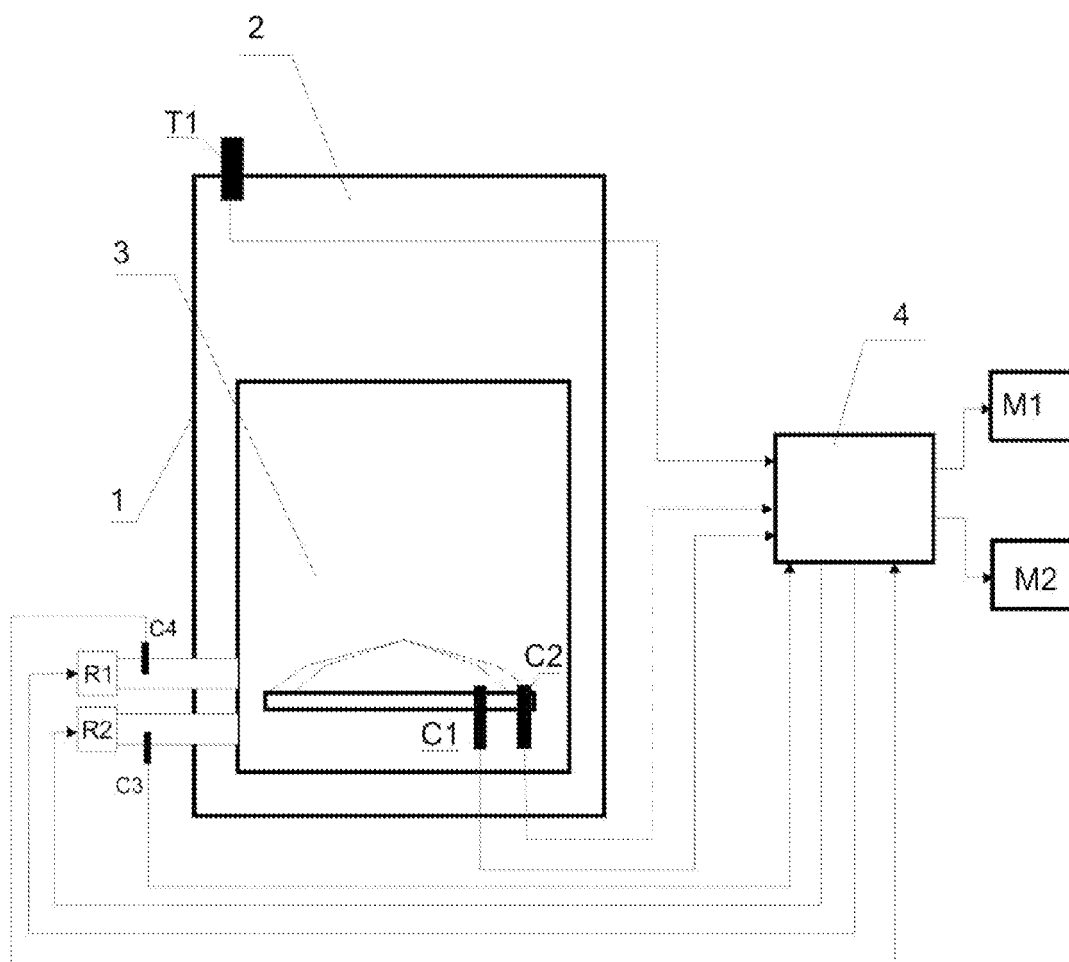


Fig. 2

REFERENCES CITED IN THE DESCRIPTION

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