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(54) **Control of a furnace for heat-treatment of products**

(57) A furnace control for heat treatment of products such as metals, glass or ceramics, in particular roof tiles, comprising adjusting elements for gas and air supply and a control unit for the gas/air ratio, wherein said furnace control has a time-temperature range wherein the control in a predetermined first phase controls the gas/air ratio, and the control in a predetermined second phase, in successive time frames, causes the gas and air supply to open for the duration of a pulse time, while for the duration of a pause time substantially or completely causing it to close, the pulse time and pause time together forming one time frame.

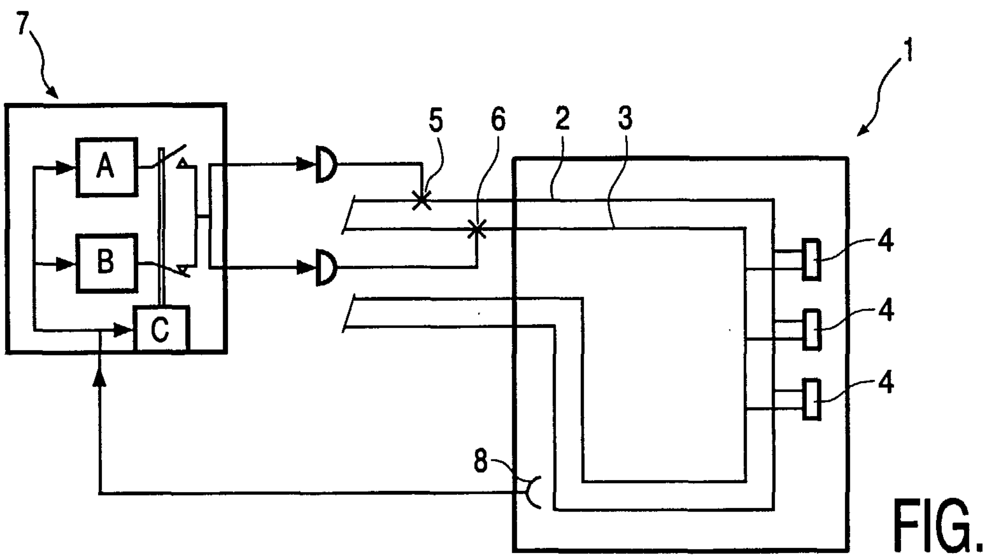

FIG. 2

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Description

[0001] The invention relates to a control for a furnace for heat treatment of products such as metals, glass or ceramics, in particular roof tiles, comprising adjusting elements for gas and air supply and a control unit for the gas/air ratio.

[0002] In practice, such a furnace control is used for numerous products. In order to elucidate the invention however, only the application for roof tiles, their process from the green stage to the finished state, will be explained below. However, the invention is not limited thereto.

[0003] For the manufacture of finished roof tiles it is necessary to fire the excess moisture out of the green clay from which the roof tiles are made, to burn the humus out of the clay, and to effectuate sintering of the clay in order to bring the product into a finished ceramic form. It is important to pass through all the stages of firing in the most optimal manner possible. In order to be able to make the necessary adjustments, the prior art teaches the use of adjusting elements for the gas and air supply to the furnace, as well as the use of a control unit for adjusting the ratio between the amounts of gas and air injected into the furnace.

[0004] It is an object of the invention to provide a furnace control of the kind mentioned in the preamble, which is capable in all stages of the firing process to automatically comply with the optimal process conditions expedient at that moment.

[0005] To this end the furnace control according to the invention is characterized in that said furnace control has a time-temperature range wherein the control in a predetermined first phase controls the gas/air ratio, and the control in a predetermined second phase, in successive time frames, causes the gas and air supply to open for the duration of a pulse time, while for the duration of a pause time causing it to substantially or completely close, the pulse time and pause time together forming one time frame. The duration of this time frame may be constant or variable.

[0006] This makes it possible to work with an excess of air in the firing-up curve of the firing period, resulting in the development of a relatively large amount of furnace gases. The thus caused turbulence results in an effective heat transfer, as a consequence of which any residual moisture and humus can be readily burnt off. The warming-through phase following the firing-up curve preferably proceeds such that the gas/air ratio is maintained substantially constantly at stoichiometric combustion. The energetically optimal process conditions realized thereby are very desirable for the sintering of the clay molecules which are in the meantime for the most part free from moisture and humus.

[0007] The inventors have found that the furnace control according to the invention saves approximately 25% energy as opposed to the furnace control for ceramics known from the prior art.

[0008] It is as such possible to embody the furnace control such that a predetermined and calculated temperature range is realized by means of controlling the gas/air ratio on the basis of predetermined model calculations, and to realize the ratio between pulse time and pause time also on the basis of such model calculations.

[0009] However, it is preferred for the control in the second phase to adjust the pulse time and pause time subject to a temperature in the furnace.

[0010] A first embodiment of the control according to the invention is characterized in that the first phase and the second phase are consecutive, and in that the control in the first phase controls the gas/air ratio subject to a temperature in the furnace. Preferably the gas/air ratio is adjusted in the second phase to stoichiometric combustion.

[0011] A more preferred second embodiment of the invention is characterized in that the first phase and the second phase coincide, so that the control of the gas/air ratio and the control of the pulse time and pause time are active simultaneously, and that the control of the gas/air ratio adjusts to a desirable air excess, which is set to at least stoichiometric combustion.

[0012] Consequently, in this embodiment the gas/air ratio control and the pulse-/pause -time control are active simultaneously. Depending on the type of process it is then possible, in concurrence with the control according to the first embodiment, to control the desired air excess during the firing-up curve to an oxidizing atmosphere (ample air excess), while the desired air excess during the warming-through phase may be adjusted to stoichiometric combustion. The pulse-/pause-time control then depends on a temperature in the furnace.

[0013] Referring to the drawing, the invention will now be further elucidated with the aid of the following non-limiting exemplary embodiment.

[0014] Figure 1 in the drawing shows a normal time-temperature path as is typical for a furnace for ceramics, in particular roof tiles.

[0015] Figure 2 schematically shows a furnace including gas/air ducts and burners, and a control according to the first embodiment.

[0016] Figure 3 schematically shows a furnace including gas/air ducts and burners, and a control according to the second embodiment.

[0017] Referring first to Figure 1, a typical time-temperature path is shown which is applicable to the manufacture of finished roof tiles starting from their green phase. In the beginning of the firing process, which lasts until the furnace has reached a temperature of approximately 200°C, residual moisture is removed from the clay, and until a temperature of approximately 600°C has been reached, also chemically bound water is burnt out of the clay. Subsequently, at an intermediate range from approximately 600 to 850°C humus is burnt out, after which temperatures above 850°C to approximately 1100°C serve to sinter the clay to allow the finished roof tiles to form. After sintering, a controlled cooling down takes place as schematically shown in Figure 1. Hereafter, the sintering process between the points in time t_1 and t_2 is referred to as the warming-through phase. The period preceding the point in time t_1 is hereafter referred to as the firing-up phase.

[0018] Figure 2 schematically, and merely for the sake of elucidating the functionality of a first embodiment of the furnace control according to the invention, shows a furnace 1, which is provided with supply ducts 2 for air and 3 for gas. In the furnace 1, burners 4 are connected to said supply ducts 2 and 3. The air supply duct 2 has an adjusting element 5 for adjusting the amount of air. The gas supply duct 3 has an adjusting element 6 for adjusting the amount of gas. Both adjusting elements 5 and 6 are controlled by a furnace control 7 that is realized, for example, by a process computer. In a first embodiment of the furnace control 7 according to the invention there are two types of temperature control, to wit A and B. Which of these two types is chosen depends on in which phase of the time-temperature path the furnace 1 is. This time-temperature path is also processed in the furnace control 7 and included in the block indicated with reference letter C. The time-temperature path C determines the choice between the adjustment of the gas/air ratio indicated by A and the adjustment with the control of the pulse time and pause time indicated by B. In the figure this is depicted schematically with coupled switches.

[0019] The control according to the first embodiment works such that the control in the previously indicated firing-up phase, controls the gas/air ratio A, and that the control in the previously indicated warming-through phase, in consecutive time frames during a pulse time causes the gas and air supply to open, and during a pause time to close, this pulse time and pause time together forming one time frame. As a rule, the seamlessly connected time frames all have the same duration. It is also possible to have time frames of a varying duration. In order to make it possible for the process to proceed in a controlled manner, the furnace control 7 is preferably equipped with a sensor 8 for measuring the for the process relevant temperature in the furnace 1. This temperature serves to determine the actual position reached in the time-temperature path according to Figure 1, that is to say whether the furnace 1 is in the firing-up phase or in the warming-through phase. The temperature that is measured further serves as feedback parameter to feed the adjustment of the gas/air ratio A or the ratio of pulse time and pause time, respectively, according to control B. It is remarked, that when the gas/air ratio control A is active, the ratio is controlled by the extent to which the adjusting elements 5 and 6 of the air duct 2 and the gas duct 3, respectively, are opened. If the pulse-time, pause-time control B is active, the ratio between the opening of the adjusting elements 5 and 6 is set to be constant such as to allow substantially stoichiometric combustion of the gas. The control B then progresses such that during a pulse time, while maintaining their mutually constant ratio, the adjusting elements 5 and 6 are set to be open, while during a pause time the adjusting elements 5 and 6 are closed.

[0020] Incidentally, for closing the air duct 2 and gas duct 3 during the pause time, it is also possible to use separate valves. This provides the advantage that the adjusting elements 5 and 6 may remain open in their constant mutual ratio.

[0021] With reference now to Figure 3, a second preferred embodiment of the furnace control according to be invention is shown schematically. The furnace 1 shown in Fig 3 also possesses burners 4 fed by an air duct 2 and a gas duct 3. The air duct 2 comprises regulating valves 5 and 9, while the gas duct 3 comprise regulating valves 6 and 10. The regulating valves 5 and 6 are operated by a control A accommodated in the process computers 7 for controlling the desired air excess. This control adjusts the ratio of the regulating valves 5 and 6 in order to realize a particular desired air/gas ratio. During the progress of the time-temperature path as illustrated in Figure 1, this desirable air excess may vary between a strongly oxidizing atmosphere, namely during the firing-up phase preceding the point in time t_1, and a virtually stoichiometric combustion in the warming-through phase between the points in time t_1 and t_2. This is symbolized in the figure by the function block C, in which the time-temperature path is included providing a setting point for the function block A, which includes the air/gas ratio control. Simultaneously with the air/gas ratio regulator A, a pulse time/pause time regulator B is active, operating the valves 9 and 10 in the air duct 2 and gas duct 3, respectively. The ratio between the pulse time and pause time as adjusted by the regulator B is derived from a temperature measured in the furnace as determined by, for example, the sensor 8.

Claims

1. A furnace control for heat treatment of products such as metals, glass or ceramics, in particular roof tiles, comprising adjusting elements for gas and air supply and a control unit for the gas/air ratio, **characterized in that** said furnace control has a time-temperature range wherein the control in a predetermined first phase controls the gas/air ratio, and the control in a predetermined second phase, in successive time frames, causes the gas and air supply to open for the duration of a pulse time, while for the duration of a pause time substantially or completely causing it to close, the pulse time and pause time together forming one time frame.

2. A furnace control according to claim 1, **characterized in that** the control in the second phase adjusts the pulse time and pause time subject to a temperature in the furnace.

3. A furnace control according to claim 1 or 2, **characterized in that** the first phase and the second phase are consecutive, and **in that** the control in the first phase controls the gas/air ratio subject to a temperature in the furnace.

4. A furnace control according to claim 3, **characterized in that** the gas/air ratio is set to stoichiometric combustion.

5. A furnace control according to one of the preceding claims, **characterized in that** the first phase coincides with a firing-up process and/or cooling-down process of the furnace, and the second phase coincides with a sintering process occurring between the firing-up process and the cooling-down process of the furnace.

6. A furnace control according to claim 1 or 2, **characterized in that** the first phase and the second phase coincide, so that the control of the gas/air ratio and the control of the pulse time and pause time are active simultaneously, and that the control of the gas/air ratio adjusts to a desirable air excess, which is set to at least stoichiometric combustion.

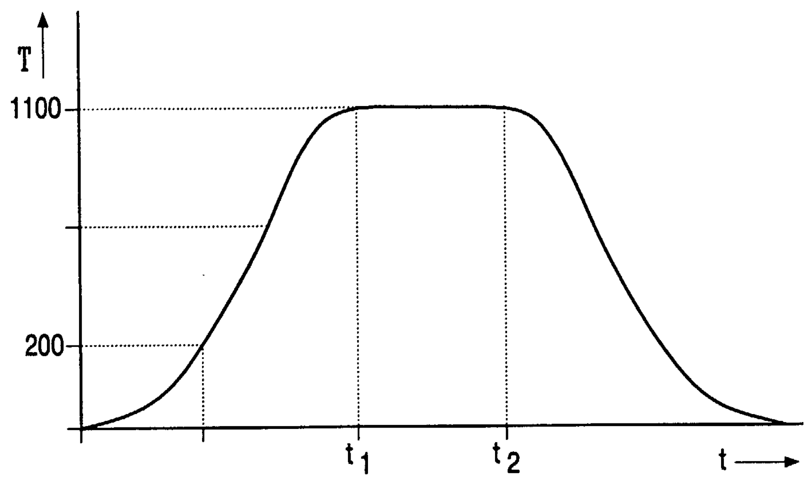

FIG. 1

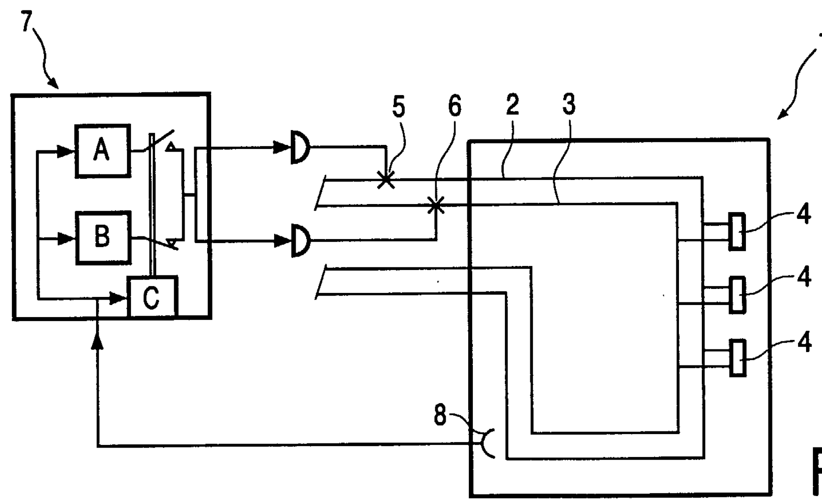

FIG. 2

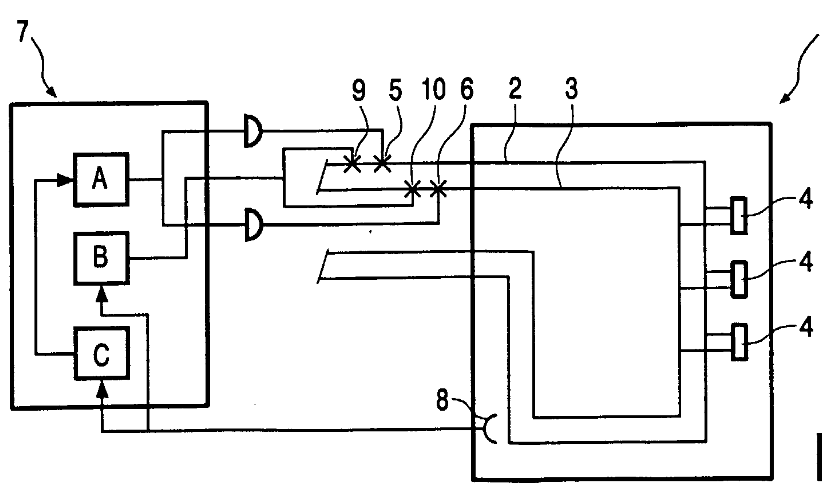

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 02 07 5759

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

F27D
F26B
C21D
F27B
F24C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 April 2002	Coulomb, J

CATEGORY OF CITED DOCUMENTS

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