

HOT AIR CIRCULATING FURNACE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a hot air circulating furnace, and more particularly to a circulation system for circulating atmospheric gas supplied to a heat treating chamber.

2. Description of Related Art

Conventionally, for heat treatment such as sintering of ceramic products, a hot air circulating furnace as shown by Fig. 4 has been used. Under temperature less than about 500°C to 600°C, heat transfer is caused mainly by convection rather than by radiation. Therefore, it is proper for the uniformity of inside temperature to use the hot air circulating furnace wherein heated gas flows in a heat treating chamber. The hot air circulating furnace comprises a heat insulating furnace casing 11, a muffle furnace 12 which is a heat treating chamber assembled by heat resisting metal boards and a gas passage 13 in which atmospheric gas G, such as heated nitrogen, supplied from outside flows.

Further, boxes (not shown) which contain ceramic products or other subjects are piled in the muffle furnace 12, and mutually opposite side walls of the muffle furnace 12 have small openings 14 through which the atmospheric gas G

flows. Above the muffle furnace 12, a gas supply pipe 15 is led into the gas passage 13, and further, a sirocco fan 16 for circulating the atmospheric gas G and an electric heater 17 for heating the atmospheric gas G to a specified temperature are provided. The sirocco fan 16 is connected to a motor 19 via a seal bearing 18 and is driven by the motor 19.

In the hot air circulating furnace, the sirocco fan 16 must be highly heat resisting, and the bearing 18 and other members must have a good sealing function, which increases the cost. Additionally, the special material and performance of these members set a limit to the temperature of the atmospheric gas G, which prevents improvement in the production efficiency. However, deterioration of the sealing performance of the seal bearing 18 cannot be avoided because the seal bearing 18 is greatly influenced by the temperature difference between the inside and the outside of the hot air circulating furnace. Accordingly, it becomes difficult to prevent outside air (oxygen) from penetrating into the furnace, which makes it difficult to keep the high purity of the atmospheric gas G.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a hot air circulating furnace which is improved in production efficiency and in control of the purity of atmospheric gas in

a simple structure without using special instruments.

In order to attain the object, a hot air circulating furnace according to the present invention comprises a heat treating chamber in which subjects are placed, a gas passage which is provided around and connected to the heat treating chamber such that the gas passage and the heat treating chamber form a circuit in which atmospheric gas circulates, a gas supply pipe which is led in the gas passage to extend in a gas circulating direction, and an injection nozzle which is provided at an end of the gas supply pipe to inject the atmospheric gas. The gas circuit is formed of the gas passage and the heat treating chamber in such a way that the atmospheric gas flows through the heat treating chamber in a horizontal direction or in a vertical direction.

In the structure, the atmospheric gas is supplied from the gas supply pipe through the injection nozzle. When the atmospheric gas is newly injected into the gas passage, gas around the injection nozzle is drawn by the injected gas in the gas circulating direction. Then, the atmospheric gas flows in the gas passage to the heat treating chamber and flows therethrough.

According to the present invention, atmospheric gas around the injection nozzle is drawn by newly supplied atmospheric gas, and thus, circulation of the atmospheric gas is carried out without using any special instruments such as a sirocco fan and a motor thereof. Thereby, the cost can be

reduced, and control for keeping the high purity of the atmospheric gas becomes possible in a simple structure. Also, it is no more necessary to limit the temperature of the atmospheric gas in consideration of the material and performance of the instruments. Therefore, the atmospheric gas can be heated over 900°C, and the production efficiency can be improved.

BRIEF DESCRIPTION OF THE DRAWINGS

This and other objects and features of the present invention will be apparent from the following description with reference to the accompanying drawings, in which:

Fig. 1 is an elevational sectional view of a hot air circulating furnace which is a first embodiment of the present invention;

Fig. 2 is an elevational sectional view of a hot air circulating furnace which is a second embodiment of the present invention;

Fig. 3 is an elevational sectional view of a hot air circulating furnace which is a third embodiment of the present invention; and

Fig. 4 is an elevational sectional view of a conventional hot air circulating furnace.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention are described.

Figs. 1, 2 and 3 show a first embodiment, a second embodiment and a third embodiment of the present invention, respectively. In the drawings, the same parts and members are provided with the same reference symbols.

The first embodiment is a batch type hot air circulating furnace which comprises a heat insulating furnace casing 2 with an electric heater 1 embedded therein, a muffle furnace 3 assembled by heat resisting metal boards and a gas passage 4 provided around the muffle furnace 3. The muffle furnace 3 is a heat treating chamber, and boxes (not shown) containing subjects, such as ceramic products, are piled in the muffle furnace 3. The gas passage 4 communicates with the muffle furnace 3 so as to form a circuit for atmospheric gas G. The gas passage 4 is a tube made of heat resisting metal. The gas passage 4 communicates with the muffle furnace 3 in such a way that the atmospheric gas G which is heated by the electric heater 1 flows through the muffle furnace 3 in a horizontal direction. In mutually opposite side walls of the muffle furnace 3 where the gas passage 4 abuts, a lot of small openings 5 are made.

A gas supply pipe 6 is led in the gas circuit. The gas supply pipe 6 is straight, and the pipe 6 led in the gas

circuit is fixed in a position to extend in a direction in which the atmospheric gas G circulates. In the first embodiment, the gas supply pipe 6 is led in the upper portion of the gas passage 4 which is located above the muffle furnace 3 until the end of the pipe 6 reaches substantially the center of the upper portion of the gas passage 4. An injection nozzle 7 is fitted to the end of the gas supply pipe 6, and the atmospheric gas G supplied from the pipe 6 is further compressed by the injection nozzle 7 and injected into the gas passage 4 through the nozzle 7.

In the hot air circulating furnace of the first embodiment, when the atmospheric gas G supplied from the gas supply pipe 6 is newly injected through the injection nozzle 7 in the gas circulating direction, gas G around the nozzle 7 is drawn by the injected gas. More specifically, the movement of the injected gas G influences the gas G around the nozzle 7, and the gas G moves in the circulating direction together. The atmospheric gas G is heated by the electric heater 1 embedded in the furnace casing 2 while flowing in the gas passage 4 toward the muffle furnace 3. Then, the atmospheric gas G flows into the muffle furnace 3 through the small openings 5, and the subjects, such as ceramic products, put in the muffle furnace 3 are sintered by the heated gas G.

By controlling the volume of gas G supplied from the gas supply pipe 6, the volume of atmospheric gas G circulating in the gas circuit can be proportionally controlled.

Experimentally, nearly seven times as much atmospheric gas G as newly supplied from the pipe 6 can be circulated. Further, although it is not shown, an exhaust port is provided in the gas passage 4, and a volume of used gas G, which depends on the volume of supplied gas G, is taken out of the gas passage 4 through the exhaust port.

Further, in the portion of the gas passage 4 into which the atmospheric gas G flows from the muffle furnace 3 immediately, a sampling port S which communicates with a gas content detector, for example, an oxygen concentration meter, is provided. The contents of the atmospheric gas G immediately after sintering the ceramic products in the muffle furnace 3 are detected, whereby appropriate gas control such as appropriate oxygen density control is possible.

In the first embodiment, the gas passage 4 is connected to the muffle furnace 3 in such a way that the gas G flows through the muffle furnace 3 in a horizontal direction. However, as will be described later in connection with the second and third embodiments referring to Figs. 2 and 3, it is possible to connect the gas passage 4 to the muffle furnace 3 in such a way that the atmospheric gas G flows through the muffle furnace 3 in a vertical direction. The same parts and members of the second and third embodiments shown in Figs. 2 and 3 which are also used in the first embodiment are provided with the same reference symbols as provided in Fig. 1, and the detailed description of these parts and

members is omitted.

Referring to Fig. 2, a hot air circulating furnace of the second embodiment is described. In the second embodiment, the gas passage 4 is connected to a ceiling board and a bottom board of the muffle furnace 3 such that the atmospheric gas G flows through the muffle furnace 3 in a vertical direction. In the ceiling board and the bottom board of the muffle furnace 3, a lot of small openings 5 are made. The atmospheric gas G flows into the muffle furnace 3 through the small openings 5 made in the bottom board and flows upward in the muffle furnace 3. Then, the atmospheric gas G flows out of the muffle furnace 3 through the small openings 5 made in the ceiling board. In this structure, the temperature distribution in the muffle furnace 3, in which boxes (not shown) containing ceramic products are piled, is not so uneven as that in the structure of Fig. 1.

Referring to Fig. 3, a hot air circulating furnace of the third embodiment is described. In the third embodiment, the gas passage 4 is connected to mutually opposite side walls of the muffle furnace 3 in the lower half, and a tube 8 diverged from the gas passage 4 is led in the muffle furnace 3 through the ceiling board thereof. In the lower half of each of the side walls, a lot of small openings 5 are made. The atmospheric gas G flows in the muffle furnace 3 through the small openings 5 made in the side walls and flows upward in the muffle furnace 3. Then, the atmospheric gas G flows

out of the muffle furnace 3 through the tube 8.

In the second embodiment and the third embodiment, the sampling port S which communicates with a gas content detector is provided in the portion of the gas passage 4 in which the atmospheric gas G flows from the muffle furnace 3 immediately. In the second and third embodiments, the sampling port S is located in a position on which the atmospheric gas G converges after flowing through the ceramic products put in the muffle furnace 3, for example, in the tube 8 through which the atmospheric gas G returns from the muffle furnace 3 to the gas passage 4, and therefore, detection of the contents of the atmospheric gas G is more accurate.

In the hot air circulating furnaces of the above embodiments, the electric heater 1 for heating the atmospheric gas G is embedded in the furnace casing 2. However, the electric heater 1 can be set on an inner surface of the furnace casing 2 or inside the gas passage 4. In a case that the electric heater 1 is embedded in the furnace casing 2 or is set on the inner surface of the furnace casing 2, the electric heater 1 directly heats the muffle furnace 3 as well as the atmospheric gas G, and thereby, the temperature distribution and the thermal responsibility in the muffle furnace 3 are improved.

Although the above embodiments are batch furnaces, the present invention is applicable to other types of furnaces. For example, a continuous furnace according to the

present invention can be structured by connecting a plurality of muffle furnaces 3 and by providing a gas passage 4, a gas supply pipe 6 and an injection nozzle 7 for each of the muffle furnaces 3.

Although the present invention has been described in connection with the preferred embodiments above, it is to be noted that various changes and modifications are possible to those who are skilled in the art. Such changes and modifications are to be understood as being within the scope of the present invention.



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WHAT IS CLAIMED IS:

1. A hot air circulating furnace comprising:
a heat treating chamber in which subjects are placed;
a gas passage which is provided around and connected to the heat treating chamber, the gas passage and the heat treating chamber forming a circuit in which atmospheric gas circulates;
a gas supply pipe for supplying the atmospheric gas to the gas passage, the gas supply pipe being led in the gas passage to extend in a gas circulating direction; and
an injection nozzle which is provided at an end of the gas pipe to inject the atmospheric gas into the gas passage in the gas circulating direction.
2. A hot air circulating furnace as claimed in claim 1, wherein the gas passage is connected to the heat treating chamber in such a way that the atmospheric gas flows through the heat treating chamber in a horizontal direction.
3. A hot air circulating furnace as claimed in claim 1, wherein the gas passage is connected to the heat treating chamber in such a way that the atmospheric gas flows through the heat treating chamber in a vertical direction.
4. A hot air circulating furnace as claimed in claim 1,



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2 or 3, further comprising a sampling port for collecting the atmospheric gas for sampling, the sampling port being provided in the gas passage at a position to which the atmospheric gas flows immediately after flowing through the heat treating chamber.