METHOD AND APPARATUS FOR PRODUCING A PROTECTIVE ATMOSPHERE IN HEATING FURNACES

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ABSTRACT
The present invention relates to a method and a plant for producing a protective atmosphere in a heating furnace. The invention provides for the incomplete combustion of an insufficient amount of an air-fuel mixture in a secondary combustion chamber and the directing of the combustion products produced therein to the main combustion chamber, also for incomplete combustion. As a result, a protective atmosphere is obtained with an air excess ratio not exceeding 0.5. The present invention is particularly well suited for heating steel bodies.

8 Claims, 2 Drawing Figures
METHOD AND APPARATUS FOR PRODUCING A PROTECTIVE ATMOSPHERE IN HEATING FURNACES

The invention contemplates providing for stabilization of the combustion process at an air excess ratio of 0.5 alongside with simultaneous improvement in the blending of gaseous fuel and air due to chemically active gaseous products.

A plant for putting into effect the method of the invention comprises a burning device with a main nozzle and auxiliary nozzles in communication with a special chamber of combustion.

The present invention is best suited for the precise hot working of metal bodies in preference for high-precision stamping, rolling and die stamping of blanks (e.g., turbine blanks), all the above operations being final in the production process.

No less successfully the present invention can be utilized in metallurgical furnaces, for instance, in cupolas as well as in gas-fired boilers.

The present invention relates to heating furnaces for heating metal bodies either during heat-treating processes or for subsequent processing by plastic flow at elevated temperatures. More particularly the present invention relates to a method and a plant for producing a protective atmosphere directly in said furnaces.

The present invention is best suited for precise hot working of metal bodies, and preferably, for high-precision stamping, rolling and die stamping of blanks (e.g., turbine blades), with all the above operations being final in the production process.

No less successfully this invention can be utilized in metallurgical furnaces, for instance, in cupolas as well as in gas-fired boilers.

Methods of producing a protective atmosphere directly in a heating furnace which uses a combustible air-gas mixture being burnt in the aforesaid furnace at an excess air ratio of about 0.5 are known in the prior art. Accordingly, before the mixture is prepared and burnt, both the gas and combustion air are preheated in recuperators to temperature of from 300°C to 700°C. Then the mixture may be burnt by means of intermixing in gas burners mounted at one end of the furnace.

The products of incomplete combustion reach the metal bodies to be heated, and go up to the furnace roof where they are burnt up at an excess air ratio of 1.0 due to air nozzles arranged in the furnace roof which are designed to supply secondary air.

The products of complete combustion (fuel gases) are partially directed to a zone accommodating the metal bodies being preheated, with the intention of utilizing the heat of these products. The combustion products then passed from the furnace to recuperators (see, for instance, the GFR Patent N 1116255).

However inherent in this procedure are inevitable difficulties associated with the fact that methane, being a major combustible component of the gas employed in the above procedure, is difficult to ignite at an air excess ratio approaching 0.5. This leads to an unstable process of combustion and leaves excess oxygen in the products of combustion amounting to 1.0 percent, a methane percentage amounting to 4 percent and soot at 8 g/m³. The composition of the products of combustion and their temperature are not compatible with the latter being gradually decreasing with the ensuing cessation of the combustion process.

Attempts to stabilize the combustion process and increase air preheat temperature to 900°-1,000°C are commonly known. However in such cases gas and air are fed to the combustion zone separately which tends to hamper the mixing process and results in incomplete combustion. This also leads to a substantial increase in the overall dimensions of the furnaces.

Also well-known are endeavors to increase the air excess ratio to a value of 0.6–0.65. This can stabilize the combustion process, yet the degree of oxidation of the steel pieces will be 2–4 times as great as that obtained using an air excess ratio amounting to 0.5.

The main object of the present invention is to stabilize the combustion process using an air excess ratio of 0.5 which assures simultaneously better mixing of air and gas.

According to the invention, this is achieved by continuously introducing into a flow of an air-gas mixture being ignited and burnt with an insufficient amount of air, chemically active gaseous products, such as aldehydes, peroxides, atoms and radicals of combustible gases amounting to 1 percent by volume of the total quantity of the fuel to be burnt, said additions being aimed at stabilizing the ignition process and provide for more complete combustion. As for the above products, they may be the products of combustion of any combustible gases though preference shall be given to the products of combustion of the air-gas mixture containing the same constituents as those being burnt in the furnace. It would be expedient to burn the major part of the fuel at an air excess ratio exceeding that peculiar to the process of combustion of the minor fuel part, which simplifies appreciably the process of production of the specified chemically active gaseous products.

It would also be sound practice in producing chemically active gaseous products to employ a gaseous fuel having a 3–10 percent excess by volume of the total quantity admitted into the furnace. It is expedient to burn the fuel at the air excess ratio ranging within 0.55–0.7 and passing the resultant products of combustion into the flow of the major portion of the fuel (about 90 percent) being burnt at the air excess ratio of 0.5.

Conforming to the present invention and preferring a plant version comprising a burning device, it would be sound practice to encompass the exterior of a main nozzle of that device with auxiliary nozzles and to provide a chamber for burning a part of the air-gas mixture which communicates with said auxiliary nozzles. The above arrangement of the nozzles assures highly intensive turbulence of the air-gas mixture admitted into the furnace for combustion. A most compact plant design is assured if the chamber for combustion of the minor part of the fuel is ring-shaped and is arranged at the circumference of the exit nozzle of the burning device.

The process of ignition in the chamber for burning the minor portion of the fuel is stabilized by making the chamber inlet in the form of a ring-shaped slot arranged in a radial section. It is also expedient to locate an inlet passage for admitting the above mixture into the slot across one of its sides.

In order to simplify the construction, it would be sound practice to employ the walls of two circular parts, having an appropriate design, as the walls of the said slot. The parts can be positioned in a cavity employed as a combustion chamber.
As for an igniter for the chamber for burning a part of the air-gas mixture, it is expedient to use a constant-acting electro-spark generator. This rules out interruptions which may be hazardous when combustion is carried out with insufficient air.

A substantial advantage of the present invention lies in that the torch temperature remains constant and relatively high at a stable air excess ratio not over 0.5 which can vary, if desired, from 800° to 1250°C.

A detailed description of the preferable version of the plant embodiments for accomplishing the foregoing method while conforming to this invention and of the method proper, examples of the plant operation with due reference to the accompanying drawings are given below, wherein:

FIG. 1 is a fragmentary longitudinal sectional view of a plant conforming to the invention;

FIG. 2 is a view along arrow A of FIG. 1.

A plant is fitted with burning device 1 (FIG. 1) comprising mixer 2 of a conventional design and coupled to it by bolts 4 is a cone-shaped outlet nozzle 3 referred to hereinafter as a main nozzle. Mixer 2 and main nozzle 3 are fastened on flange 5 by means of dowels (not shown in the drawing). The walls of central bore 6 provided in flange 5 and the external walls of main nozzle 3 are separated by asbestos lining 7. Burning device 1 is secured with the aid of flanges 5 and bolts 8 to disc 9 embedded in the brickwork of heating furnace 10. The places of contact of flange 5 and disc 9 are insulated by asbestos annular linings 11 and 12. The linings are placed at the ends of circular centering bosses 13 and 14 made on disc 9. Accordingly flange 5 is fitted with recesses to receive the above bosses. A ring-shaped section between bosses 13 and 14 of disc 9 has annular depression 15. Opposite this depression there is another annular depression 16 in flange 5. Both depressions form cavity 17 acting as a chamber for burning the minor part of the fuel admitted into the chamber after being mixed with air along sleeve 18 welded to flange 5 and conduits 19 and 20 provided in flange 5 and disc 9 respectively.

Sleeve 18 and each of conduits 19 and 20 have similar cross-sections designed for passing 10% of the total amount of the fuel supplied to mixer 2. Mounted in cavity 17 are two annular parts 21 and 22 the first of which is located in depression 16 and the second in depression 15. Both parts are fitted with alternating projections and recesses forming an altogether circular V-shaped radial section slot 23 in the intake of chamber 17. Thus, the walls of the foregoing parts, having an appropriate design, serve as the slot walls.

Conduit 20, which is an inlet passage in relation to chamber 17, and one of the sides of slot 23 are perpendicular to each other. The above arrangement of the plant provides for the stabilization of the process of combustion of the air-gas mixture in chamber 17. The latter is located at the circumference of main nozzle 3 and being in communication with auxiliary nozzles 24 (FIGS. 1 and 2) distributed uniformly around main nozzle 3. The nozzles are cylindrical passages provided in disc 9 with their exits being arranged on the walls of central bore 25 having cone-shaped walls made in disc 9 and positioned opposite main nozzle 3 of burning device 1. Section 26 of the passage of main nozzle 3 is cylindrical at the exit with a large cone-shaped base formed by the wall faces of hole 25 in the middle portion of the furnace. The above embodiment of the plant assures favourable conditions for blending the products of combustion emerging from auxiliary nozzles 24 with the flow of the air-gas mixture issuing from main nozzle 3.

The upper part of chamber 17 is provided with a constant-acting known electro-spark generator 27 set up on lug 28 welded to flange 5. A tall portion of generator 27 is located in passage 29 running in lug 28, passage 30 in flange 5 and in passage 31, located in annular part 21 with all said passages being coaxial.

The plant is designed to obtain a protective atmosphere in heating furnace 10 which serves to heating metal bodies under conditions which prevent the formation of oxides on these bodies in the process of said heating.

Mixer 2 is designed and calculated to form an air-gas mixture, for example, a mixture of natural gas and air, at an air excess ratio of 0.5. From 3 to 10 percent by volume of the fuel, as indicated above, is mixed with air and passed via sleeve 18 and conduit 19 to inlet conduit 20 arranged perpendicularly to one of the circular V-shaped sides of the radial sectioned slot 23 forming the inlet of chamber 17. Due to the arrangement of conduit 20 and slot 23 as well as the said shape of this slot an intense swirling of the air-gas mixture is obtained at the inlet of the relatively small chamber 17, where the mixture is continuously ignited by generator 27. Chemically active products of incomplete combustion, effected at an air excess ratio of 0.55–0.7 which slightly exceeding that of the air excess ratio used for the burning of the main part of the fuel, are added via additional nozzles 24 to the main flow of the air-gas mixture and passed into the zone of the most intense turbulence contributed by the chemical initiation process upon ignition. Thus, a stable high-temperature torch is produced whose temperature can be altered, if required, within the range of from 800° to 1250°C by adjusting the volume of the mixture fed to the burner.

As a result the proposed method assures stable combustion of the overwhelming amount of the air-gas mixture at said air excess ratio of 0.5. This eliminates completely the need for regenerators.

Owing to the stable combustion of the fuel gaseous medium in the furnace free from oxygen and methane and the amount of soot does not exceed 1.5–3 g/m³.

The present invention does not, in any way, preclude the possibility of using the products of combustion of any known combustible gases as chemically active gaseous products amounting to not more than 10 percent of the total fuel being burnt for stabilizing the process of ignition. If that is the case the chamber for burning air-gas mixture becomes useless.

What is claimed is:

1. A method for producing a protective atmosphere in a heating furnace in which the stabilization of an ignition process providing more complete combustion is accomplished, comprising adding chemically active gaseous products amounting to 10% by volume of the total quantity of the fuel being burnt, said gasses being continuously introduced into a flow of an air-gas mixture which is intended to be burnt with an insufficient amount of air.

2. The method of claim 1 in which the products of combustion of an air-gas mixture containing the same constituents as that being burnt in said furnace are employed as the said chemically active gaseous products.
with the first of the said mixtures being burnt at the air excess ratio exceeding that of the second mixture.

3. The method of claim 1 in which gaseous fuel amounting to from 3 to 10 percent by volume of the total quantity of the fuel supplied to the said furnace is burnt at the air excess ratio of 0.55–0.7 and the products of combustion are passed into the flow of the remaining part of the fuel.

4. A plant for producing a protective atmosphere in a heating furnace by burning gaseous fuel with an insufficient amount of combustion air, comprising at least one mixer for blending the gaseous fuel with air, pipe lines means for feeding the said fuel and air to the said mixer, a main nozzle in communication with the said mixer on one side and with the said heating furnace on the other, a chamber for burning the minor part of the said gaseous fuel amounting to 3–10 percent by volume of the total amount of the fuel admitted to be burnt in said heating furnace via the said main nozzle; auxiliary nozzles arranged around said main nozzle and communicating on one side with said chamber with the said heating furnace on the other side.

5. The plant of claim 4 in which said chamber for burning the minor part of the fuel is ring-shaped and is arranged at the circumference of the main nozzle outlet nozzle.

6. The plant of claim 4 in which a constant-acting electro-spark generator is employed as the igniter in the said chamber for burning a portion of the fuel.

7. A plant for producing a protective atmosphere in a heating furnace by burning gaseous fuel with an insufficient amount of combustion air, comprising at least one mixer for blending the gaseous fuel with air, pipe lines means for feeding the said fuel and air to the said mixer, a main nozzle in communication with the said mixer on one side and with the said heating furnace on the other, a chamber for burning the minor part of the said gaseous fuel amounting to 3–10 percent by volume of the total amount of the fuel admitted to be burnt in said heating furnace via the said main nozzle, said chamber being provided with an inlet in the form of a circular V-shaped slot in a radial section with an inlet conduit for feeding said mixture into the slot being located across one of its sides; auxiliary nozzles arranged around said main nozzle and communicating on one side with said chamber with the said heating furnace on the other side.

8. The plant of claim 7 wherein two annular parts of appropriate design serve as the walls of said V-shaped slot.