

HIGH EFFICIENCY LOW NO_x EMISSION BURNER APPARATUS

STATEMENT OF PRIORITY

This application claims priority to U.S. Application No. 13/423,311 which was filed on March 19, 2012.

5 FIELD OF THE INVENTION.

The present invention is directed to a high efficiency low NO_x emission burner apparatus and method. In particular, the present invention is directed to a thermal oxidizer burner apparatus and method which utilizes waste gas or tail gas from an independent source to achieve high efficiency and low emission of nitrogen oxides.

10 DESCRIPTION OF THE RELATED ART.

Oxides of nitrogen form as a result of combustion emitting from burners. Various prior configurations and designs have been utilized in the past to increase the efficiency of thermal oxidizer burners and to reduce nitrogen oxides content of the flue gas effluent. There are a variety of oxides of nitrogen in flue gas effluent, such as nitrogen oxide (NO), nitrogen
15 dioxide (NO₂) and others which are together generally labeled NO_x.

It is known that high oxygen content can increase the formation of nitrogen oxides. It is also known that increasing combustion temperatures may increase production of NO_x.

In at least one other prior past approach, a portion of the flue gas, waste or tail gas created by the combustion emitting from the burner is mixed and recirculated with inlet
20 combustion air.

European Patent No. 1,203,188 illustrates an example of premixing fuel with internally recirculated waste gases drawn from the furnace chamber and then recirculated.

U.S. Patent No. 5,135,387 discloses a flue gas gathering member in a burner which forms a passage so that combustion air and recirculated flue gas are combined.

25 In flue gas recirculating systems in the past, the amount and percentage of waste gas would be dependent upon the combustion occurring in the furnace and various other factors. Additional issues have arisen in attempting to recirculate the waste gas or tail gas with the combustion air.

The composition of the waste gas or tail gas will vary but in one non-limiting example would be 98% nitrogen with the balance being combustibles such as methane, carbon monoxide, hydrogen and various sulfur compounds. Because the waste gas or tail gas has little or no oxygen content, the introduction of waste gas or tail gas to the combustion air will influence the oxygen content. The recirculation of a portion of the waste or tail gas is known to decrease and/or control the amount of oxygen content in the combustion air. Decreasing the oxygen content decreases the partial pressure of oxygen, thereby reducing the rate of the reactions forming oxides.

Accordingly, it is an object and purpose of the present invention to provide a thermal oxidizer burner apparatus which utilizes flue gas from an external source separate from the ongoing combustion in the combustion chamber associated with the burner.

It is a further object and purpose of the present invention to provide a high efficiency low NO_x emission thermal oxidizer burner apparatus having a lobed tip nozzle within a mix chamber to thoroughly mix combustion air with waste gas or tail gas from an independent source.

It is a further object and purpose of the present invention to control the composition and content of waste gas or tail gas utilized by a burner.

It is a further object and purpose of the present invention to provide a thermal oxidizer burner wherein waste gas or tail gas is introduced through a burner plenum to a combustion chamber in stages.

SUMMARY OF THE INVENTION

The present invention is directed to a high efficiency low NO_x emission burner apparatus. A plenum chamber includes an inlet for introduction of combustion air which moves into and through the plenum chamber.

A combustion chamber is in fluid communication and connected to the plenum chamber. An inlet is in communication with one or more primary waste gas pipes in order to introduce waste gas or tail gas into the combustion chamber through the plenum chamber. The waste gas or tail gas will be delivered from an independent, external source not associated with the combustion herein.

In one preferred arrangement, the primary waste gas pipe or pipes terminate in a lobed tip nozzle which extends from one end at the waste gas pipe to an opposed end terminating in a plurality of radially extending lobes symmetrically arranged around a center axis.

A primary fuel gas line provides a source for fuel to the combustion reaction.

5 The waste gas inlet is also in communication with a secondary waste pipe or pipes for introduction of a portion of the waste gas or tail gas into the combustion chamber so that the introduction of waste gas is staged.

10 Additionally, in one preferred embodiment, a secondary fuel gas line or lines are in communication with the combustion chamber for staged introduction of secondary fuel gas into the combustion chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a simplified schematic diagram of a preferred embodiment of a high efficiency low NO_x emission burner apparatus constructed in accordance with the present invention;

15 Figure 2A illustrates a simplified view of the burner apparatus shown in Figure 1 from the combustion chamber into the mixing plenum and Figures 2B and 2C illustrate external views of the burner apparatus;

Figures 3, 4 and 5 illustrate alternate views of a lobed tip nozzle of the burner apparatus shown in Figure 1;

20 Figure 6 illustrates an alternate preferred embodiment of the burner apparatus; and

Figure 7 illustrates a further alternate preferred embodiment of the burner apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

25 The embodiments discussed herein are merely illustrative of specific manners in which to make and use the invention and are not to be interpreted as limiting the scope of the instant invention.

While the invention has been described with a certain degree of particularity, it is to be noted that many modifications may be made in the details of the invention's construction and the arrangement of its components without departing from the spirit and scope of this

disclosure. It is understood that the invention is not limited to the embodiments set forth herein for purposes of exemplification.

Referring to the drawings in detail, Figure 1 illustrates a sectional view of a first preferred embodiment of a high efficiency low NO_x emission thermal oxidizer burner apparatus 10 constructed in accordance with the present invention. In a preferred embodiment, a substantially tubular or cylindrical plenum chamber 12 is provided although other configurations are possible. The plenum chamber 12 includes an inlet 14 for introduction of combustion air as illustrated by arrow 16. The combustion air may be drawn or forced into the combustion chamber through the plenum chamber 12 in a variety of ways. The combustion air moves into and through the plenum chamber 12 as illustrated by arrow 18. Various fans or other mechanisms along with controls may be used to force or induce combustion air through the plenum chamber 12.

A combustion chamber 20 is in fluid communication with and connected to the plenum chamber 12. Thermal oxidation occurs in the combustion chamber. The combustion chamber 20 may be cylindrical or tubular or take other configurations. In a preferred arrangement, the combustion chamber is coaxial with the plenum chamber 12 although other configurations are possible.

An inlet 28 is in communication with one or more primary waste gas pipes or tubes 30 in order to introduce waste gas or tail gas into the combustion chamber 20 through the plenum chamber 12 as illustrated by arrow 32. The waste gas or tail gas may be delivered from an independent, external source not associated with the combustion herein. A non-limiting example of a tail gas or waste gas from an independent source would be waste gas or tail gas from a sulfur recovery unit as a part of a petrochemical or natural gas processing plant.

At least a portion of the primary waste gas pipe or pipes 30 may be coaxial with the cylindrical plenum chamber 12. The primary waste gas pipe or pipes 30 terminate in a lobed tip nozzle 34, to be described herein in detail, or terminate in an open ended device or other mixing device. Accordingly, primary waste gas is delivered and mixed with the combustion air through the plenum chamber 12.

A primary fuel gas line or lines 40 provide a source for fuel to the combustion reaction. Natural gas or various other types of fuel might be employed within the spirit and scope of the invention.

In one preferred embodiment, the waste gas inlet 28 is in communication with a secondary waste gas pipe or tube 50 for introduction of a portion of waste gas or tail gas into the combustion chamber 20. Accordingly, introduction of the waste gas or tail gas is staged.

Additionally, in one preferred embodiment, a secondary fuel gas line or lines 60 are in communication with the combustion chamber 20 for introduction of secondary fuel gas into the combustion chamber 20. Accordingly, introduction of fuel gas is staged. Natural gas or other various types of fuel might be employed within the spirit or scope of the invention.

Refractory material or refractory tiles 52 may be used between the fuel gas lines.

Figure 2A illustrates an end view taken from the combustion chamber 20 into the plenum chamber 12 of the apparatus 10 shown in Figure 1 while Figures 2B and 2C illustrate external views of the apparatus 10.

Figures 3, 4 and 5 illustrate alternate views of the lobed tip nozzle 34 apart from the apparatus 10. The lobed tip nozzle 34 is connected at inlet end 42 to the primary waste gas pipe 30. The lobed tip nozzle 34 extends from the inlet end 42 at the primary waste gas pipe to an opposed outlet end 44 terminating in a plurality of radially extending lobes 36 symmetrically arranged around a center axis. The lobes 36 are rounded protuberances projecting radially outward from the axis.

The primary waste gas flows through the nozzle 34 as illustrated by arrows 46.

The cross-sectional area of the inlet end 42 of the lobed nozzle 34 is the same as the cross-sectional area of the outlet end 44 of the nozzle whereas the perimeter of the outlet end 44 is greater than the perimeter of the inlet end 42, thereby increasing the surface area of contact of both fluid streams passing through or surrounding the nozzle, in this case waste or tail gas and combustion air respectively, thereby increasing the rate of mixing of the two fluid streams.

In the arrangement, shown in Figure 1, the secondary fuel gas from secondary fuel gas line or lines 60 mixes with combustion air and the primary fuel gas and waste gas before introduction of secondary waste gas.

Accordingly, the arrangement of the present invention causes a thorough mixing of the combustion air, the fuel gas and the waste gas in order to better modulate, control and predict NO_x, carbon monoxide and unburned hydrogen emissions from the combustion chamber. The arrangement disclosed in Figures 1 through 5 will tend to minimize carbon monoxide (CO) and unburned hydrocarbon emissions.

Figure 6 discloses an alternate preferred embodiment 70 of the burner apparatus 10. The arrangement is similar to that in Figures 1 through 5 with the exception of the introduction of the secondary fuel gas and secondary tail gas or waste gas in conjunction with an alternate arrangement of refractory tile 62. In the alternate embodiment shown in Figure 6, the secondary fuel gas delivered through secondary fuel gas line 60 mixes with the secondary tail gas or waste gas through secondary waste gas pipe or pipes 50 and then simultaneously mixes with the combustion air, primary fuel gas and primary waste gas.

Figure 7 illustrates a further, alternate preferred embodiment 80 of the present invention. The alternate embodiment shown in Figure 7 is similar to the arrangement of the foregoing with the exception of the secondary fuel gas and secondary waste gas introduction in conjunction with a further alternate arrangement of refractory tile 72. In the alternate embodiment shown in Figure 7, the secondary tail gas or waste gas delivered through secondary waste pipe 50 fully or partially mixes with the secondary fuel gas delivered through secondary fuel gas line 60 prior to or before mixing with the combustion air, primary fuel gas through primary fuel gas line 40 and primary waste gas from the primary waste gas pipe or pipes 30. The arrangement disclosed in Figure 7 will tend to minimize NO_x emissions.

Whereas, the devices and methods have been described in relation to the drawings and claims, it should be understood that other and further modifications, apart from those shown or suggested herein, may be made within the spirit and scope of this invention.

WHAT IS CLAIMED IS:

1. A high efficiency low NO_x emission thermal oxidizer burner apparatus, which apparatus comprises:
 - a plenum chamber having an inlet for introduction of combustion air;
 - a combustion chamber in fluid communication with said plenum chamber;
 - at least one primary waste gas pipe passing through the plenum chamber terminating at the chamber for introduction of primary waste gas into said mix chamber; and
 - a primary fuel gas line through said plenum chamber for introduction of primary fuel gas into said combustion chamber, resulting in improved mixing of internal and external fluid streams.
2. A high efficiency low NO_x emission thermal oxidizer burner apparatus as set forth in Claim 1 including:
 - a secondary waste gas pipe in fluid communication with said combustion chamber for introduction of waste secondary gas into said combustion chamber.
3. A high efficiency low NO_x emission thermal oxidizer burner apparatus as set forth in Claim 1 including:
 - a secondary fuel gas line terminating at said combustion chamber for introduction of secondary fuel gas therein.
4. A high efficiency low NO_x emission thermal oxidizer burner apparatus as set forth in Claim 1 wherein said primary waste gas pipe terminates in a lobed tip nozzle.
5. A high efficiency low NO_x emission thermal oxidizer burner apparatus as set forth in Claim 4 wherein said lobed tip nozzle includes a plurality of radially extending lobes symmetrically arranged around a center axis.
6. A high efficiency low NO_x emission thermal oxidizer burner apparatus as set forth in Claim 4 wherein each of said plurality of radially extending lobes tapers from said primary waste gas pipe.
7. A high efficiency low NO_x emission thermal oxidizer burner apparatus as set forth in Claim 5 wherein the cross-sectional area of the nozzle remains the same throughout while the perimeter of the cross-sectional area increases.

8. A high efficiency low NO_x emission thermal oxidizer burner apparatus as set forth in Claim 4 wherein said lobed tip nozzle having a plurality of radially extending lobes is centrally located in said plenum chamber.

9. A high efficiency low NO_x emission thermal oxidizer burner apparatus as set forth in Claim 4 wherein said lobed tip nozzle having a plurality of radially extending lobes is centrally located in said plenum chamber.

10. A method of high efficiency thermal oxidation resulting in low NO_x emission, which method comprises:

introducing combustion air into a plenum chamber;

introducing primary waste gas through said plenum chamber through a lobed tip nozzle;

mixing said combustion air with said primary waste gas;

introducing primary fuel gas through said plenum chamber to mix said combustion air and said waste gas; and

combusting said fuel gas, said combustion air and said waste gas in a combustion chamber.