DIRECT FLAME INCINERATOR

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The present invention relates to a direct flame incinerating apparatus and more particularly to an improved design utilizing centrifugal distribution of the combustible waste gas stream directly into flame and hot combustion gases being projected into an incinerator housing.

The usual forms of direct flame incineration provide for connecting burners to a waste gas stack to in turn emit flame and heat directly into the gas stream, or alternatively, provide a refractory lined furnace which has one or more burners directing flame and heat into the interior of the furnace housing also receiving the combustible waste gas stream. The waste gas stream, containing the noxious or combustible components is necessarily heated to an autogenous combustion temperature in order to effect the oxidation of the gaseous contaminants therein.

The effective elimination of obnoxious fumes and combustibles in a waste gas stream requires the customary three elements of combustion, i.e., time, temperature and turbulence. For complete combustion oxygen must come into intimate contact with the combustible molecule of the stream at a sufficient temperature and for a sufficient length of time in order that the reaction be completed. Incomplete reactions may result in the generation of aldehydes, hydrocarbons, carbon monoxide, and thus provide an undesirable result.

Complete oxidation may be achieved with a variety of flame characteristics through variation in design of the burner, by influencing the time, temperature and turbulence factors. For example, a luminous flame results when air and fuel flow through separate ports and are ignited at the burner nozzle. Combustion occurs over an extended area in the combustion chamber producing a highly radiant flame. The expansion of the gases as flame progresses provides the necessary turbulence, while a large combustible chamber assures the necessary temperature at temperature to complete the reaction. On the other hand, a burner utilizing the same fuel may be arranged to premix the air and fuel prior to delivery to the burner nozzle so as to produce a short intense blue flame, permitting complete oxidation within a confined space. With any type of burner, whether of the luminous or premixed type, the continuity of the oxidation reaction depends upon maintaining the air-gas supply to the burner within the flammable range.

It is an object of the present invention to provide an incinerating apparatus with a long, thin, high temperature flame pattern which will preclude flame from contacting or sweeping the interior walls of the furnace housing and which will have waste gas distributing means entirely encircling the flame pattern entering the furnace housing.

It is a further object of the present invention to provide a volute or scroll shaped gas distributing means in conjunction with the burner and flame introducing means so that the waste gas stream is concentrically and spirally mixed with the flame and hot combustion gases entering the furnace chamber.

In one embodiment, the present improved direct flame incinerating apparatus for effecting the thermal combustion of the oxidizable components of a waste gas stream comprises in combination, a confined furnace housing having a waste gas inlet and a combustion gas outlet, burner means projecting through one end of the housing and having a nozzle suitable for effecting a short compact flame pattern within said housing, fuel and air supply means connecting with the burner means, a scroll or volute shaped gas distributing section positioned in the end of the furnace housing and circumferentially peripheral to the perimeter of the burner nozzle, said scroll section having a tangential inlet portion connecting to the waste gas inlet to said housing at a side gas discharge passage that is in axial alignment with the central eye portion of the scroll or volute with the gas discharge nozzle of the burner means, and partitioning means within the housing forming a passageway from the interior thereof to said gas outlet from the housing for directing combustion gases therefrom.

Burner means for the improved incinerating apparatus may comprise one or more burners; however, a preferred embodiment utilizes a relatively large diameter or extended cross sectional area nozzle means, so that the flame being emitted from the one or more burners has a short compact configuration with a high B.t.u. output. Where more than one burner is utilized, then it is necessary to use more than one scroll or volute shaped gas distributing section, inasmuch as each point of flame introduction into the housing shall have means for centrifugally spiraling the waste gas stream around and axially into the flame pattern, or burner means.

Suitable fan or blower means may be incorporated in the inlet of the incinerating apparatus to direct the fumes or waste gas stream to the volute shaped distribution section encompassing the burner means. Alternatively, the blower means may be utilized and positioned upstream from the incinerating apparatus to move the fume containing stream under suitable velocity and pressure to the scroll or volute shaped distributing section at conditions which will insire a strong spiral flow around the flame from the burner means.

The scroll shaped gas distribution section is formed in a manner similar to that used with centrifugal fans or blowers which utilize paddle wheel or multiple shallow concave blades. However, in the present incinerating apparatus, the flow through the scroll or volute shaped section is the reverse of that in a blower, in that the waste gas stream enters the enlarged tangential portion and then spirals inwardly to a side outlet port which is maintained in alignment with the eye of volute and with the flame from the burner means, whereby the fumes and combustible components will be spirally intermixed with the flame and hot combustion gases. The outlet port from the scroll shaped section introduces the hot combustion gases and waste gas stream into an enlarged furnace housing to provide the necessary contacting time for complete incineration of combustibles at an autogenous temperature level. The resulting combustion gases from the incinerated waste stream and from the burner subsequently pass from a downstream portion of the furnace housing into a suitable outlet duct or stack.

A preferred form of incinerating means also provides for the countercurrent indirect heat exchange flow of the hot combustion gases with the incoming waste gas stream. The heat exchange flow effects a preheating of the waste gas stream and a desirable reduction in the amount of fuel necessary at the burner means to bring the waste gas stream to an autogenous temperature. Preferable incinerator designs also position the burner means at locations which will permit the introduction of the flame and hot combustion gases into the furnace housing at points which will preclude high temperature flame or gases from sweeping the inner walls of the housing. This eliminates the necessity for a refractory lining in the furnace housing, although it may be necessary to utilize heat resisting
alloy steels in all, or a portion, of the housing to withstand the high internal temperatures. Suitable exterior insulation may be applied to the housing to maintain a desired temperature level and to prevent an excessive transfer of heat to a furnace room or to nearby equipment.

Reference to the accompanying drawing will serve to further illustrate, in one embodiment of the invention, the improved design and arrangement for effecting direct flame combustion of a waste gas stream containing combustible components.

FIGURE 1 of the drawing is an elevational view, partially in section, of one embodiment of a direct flame incinerating apparatus providing heat exchange between the inlet stream and the hot combustion gas outlet stream. FIGURE 2 of the drawing is an elevational end view, partially in section, as indicated by line 2—2 in FIGURE 1.

Referring now to the drawing, there is indicated a large rectangularly shaped chamber or housing 1 provided with external insulation 2, a fume inlet port 3 and a treated fume and combustion gas outlet port 4. In the present embodiment the fume inlet port 3 opens into an external duct and header section 5 which is separated from the interior lower portion of the housing 1 by a tube sheet 6. A plurality of heat exchange tubes 7 connect between the upstream tube sheet 6 and a downstream tube sheet 8 so that the incoming waste gas stream is carried through the tube to the opposite interior end of the housing 1 and into an internal plenum or gas distributing section 9. The latter connects to, and is in open communication with, the large tangential inlet end of a volute or scroll shaped section 10 which serves to channel the gas stream into a concentrated spiral flow for distribution into flame and into hot combustion gases 17 being introduced through the end of the housing 1.

The present embodiment indicates a single burner 11, having fuel inlet means 12 and an air inlet 13, suitable for introducing high temperature flame and combustion gases longitudinally through one end of the housing 1. In accordance with the present invention, a preferable flame pattern from the burner means 11 is a short compact cylinder-like configuration such that the waste gas stream with entrained fumes and combustible materials may be centrifugally and spirally intermixed with the flame and hot combustion gases 17 to be subsequently emitted longitudinally into the interior combustion section 14 of the incinerator. Since a short high temperature compact flame pattern is desired in an improved incinerating apparatus, then the burner means 11 preferably utilizes a relatively wide, or large cross-sectional area discharge nozzle 15 to emit the short, large diameter flame pattern into the housing. A gas discharge port 16 is provided in the wall of the scroll shaped gas distributing section 10 in axial alignment with what would be considered a line extending through the eye of the scroll or volute, so as to permit the flame and hot combustion gases, outlined in the drawing as 17, through the gas distributing section 10 and into the internal combustion section 14.

In the operation of the unit, the waste gas stream, flowing under pressure, is caused to converge and be forced into a concentrated spiralling flow as it enters the scroll portion of the distributing section that is positioned around and in axial alignment with the burner nozzle 15. The internal decreasing area scroll portion 18 of the waste stream distributing section 10, as best shown in FIGURE 2, is similar in shape to a centrifugal fan housing; however, it is not intended to limit the construction to any one design or size. In the present description the terms "volute" and "scroll-shaped" are used synonymously with respect to the gas distributing chamber, which rotates to force the gas stream into an ever decreasing area path prior to discharge into and along with the flame 17 passing through the outlet port 16 and into the internal combustion section 14. The spiralling flow is of particular advantage in providing turbulence and intermixing between the flame stream and the hot combustion gas stream from the burner means. The burner means itself is, of course, adjusted to provide a suitable autogenous temperature for effecting the complete oxidation and elimination of the combustible components in the waste gas stream. Suitable time is provided for the completion of the oxidation reaction by the longitudinal path or length of the combustion section 14 in the housing 1. In this manner, all of the three T's for effecting efficient combustion are obtained and satisfied, i.e., turbulence is provided by the scroll-shaped path; temperature is provided by the burner means 11 with the short, wide diameter, compact flame pattern 17 having a high B.T.U. output, and time provided by the longitudinal flow through the interior combustion section 14. Generally, holding time in the combustion section is small, being less than about 0.5 to 1.0 second. Residence temperature may vary from 950° F. for naphtha vapors to 1600° F. for methane and somewhat higher for aromatic hydrocarbons. High percentages of inert in the fume stream which act as oxidation depressants will demand still higher temperatures.

Regarding products from the combustion section 14 flow downstream from the burner end of the housing 1 around an internal longitudinal baffie 19 into a return section 20 which is defined between the baffle plate 19 and a partitioning plate 21. Partitioning plate 21 is provided with an opening 22 to receive the combustion product stream and pass it into a longitudinal heat exchange section 23 which surrounds the plurality of pipes or tubular members 7. The partitioning thus provides a countercurrent heat exchange flow between the incoming fume stream and the hot combustion product stream. The hot combustion gas stream, after passing in heat exchange relationship with the incoming stream within heat exchange section 23, is discharged through a treated fume and combustion gas outlet 24 in the side of the housing 1. In a large unit, or in an alternative design arrangement, more than one burner means, with accompanying scroll-shaped gas distributing means in combination therewith, may be utilized to effect the incineration of the waste gas stream. In other words, after the fume laden gas stream passes into the housing and is preheated it may be divided and channeled into the two or more scroll-shaped gas distributing sections to in turn be channeled into the two or more spiralling high velocity flow streams which will intermix the waste gas stream into the two or more projecting flame patterns 17 before being discharged within the incinerator housing. In all cases, however, the scroll-shaped gas distributing sections have a decreasing area scroll or volute portion which encompasses the flame from the burner means and a side gas outlet port which is in axial alignment with the burner means.

It is not intended to limit the present improved apparatus to any one type of countercurrent heat exchange flow between the incoming waste gas stream and the hot combustion product stream inasmuch as various baffle arrangements may be utilized in any particular housing to effect said countercurrent arrangements. Also, where desirable, additional fan or blower means may be provided at, or in connection with, the fume inlet section so as to insure obtaining proper flow of the waste gas stream through the heat exchange section and a suitable high velocity flow within the scroll-shaped gas distributing sections in order to effect the desired spiralling turbulent flow of gases into the flame pattern, or patterns, from the burner means.

We claim as our invention:
1. A direct flame incinerating apparatus for effecting the thermal combustion of oxidizable components in a waste gas stream, which comprises in combination, (a) a confined furnace housing having a waste gas inlet and a combustion gas outlet,
(b) at least one burner means projecting through one end of said housing and having nozzle means emitting a short compact cylindrically shaped flame pattern into said housing,

(c) fuel and air supply means connecting to said burner means,

(d) volute-shaped gas distributing means positioned in the end of said furnace housing and around each of the burner nozzle means,

(e) said volute-shaped distributing means having tangential inlet means connecting to said waste gas inlet to said housing and gas discharge port means positioned in axial alignment with the flame discharge nozzle means of said burner means, and

(f) partitioning means within said housing forming gas passageway means to said gas outlet from said housing for conducting resulting combustion gases from the interior thereof.

3. The apparatus of claim 2 further characterized in that in addition

(a) partitioning means in said housing forms an elongated heat exchange section therein for the flow of hot combustion gases and has a plurality of confined tubular gas passageways extending therethrough,

(b) a flame header section is positioned at one end of said heat exchange section connecting to said waste gas inlet, and a preheated waste gas plenum section is positioned at the opposing end of said heat exchange section,

(c) said preheated gas plenum section connects with said tangential inlet of said volute-shaped section, and

(d) a combustion gas port is provided in said partitioning means between the interior of said housing and the interior of said heat exchange section, and said combustion gas outlet from said housing connects with the heat exchange section whereby resulting combustion gases from the interior of said housing will pass in indirect heat exchange with the incoming waste gas stream prior to discharge from the housing.

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