Auxiliary Gas Burners for Commercial and Industrial Incinerators

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Abstract

The use of gas burners to supply auxiliary heat to commercial and industrial incinerators is helpful in control of air pollution and general performance. The paper discusses the design and applications of gas burners in this service. Burner pilots and safety controls are described.

Introduction

Engineers know well the necessity for adequate temperatures in incinerators for clean, smokeless combustion. It is also well established that moist or wet refuse may not generate sufficient temperature unaided, particularly in a small incinerator and on a cold start. The need for supplemented heat, and sometimes for furnace preheating, is recognized as a practical solution to the problem of low combustion temperatures.

The burnout of smoke is achieved at 1500 F and the oxidation of most odorous compounds is completed at the same temperature.

Although auxiliary heat can be supplied by preheating the combustion air, a much simpler and more economical method is the auxiliary gas burner firing directly into the incinerator furnace. The mixing of burner flame with refuse gases burns the gases at high temperatures. The radiation from the flame heats, dries and speeds ignition from the top of the refuse charges. The burnout of the carbon in the residue is also fostered.

Modern incinerator burners (See Fig. 1) have reached a high degree of specialization. They are tailored to fulfill the specific function, as they must be if they are to perform efficiently and dependably in incinerator service. They are usually furnished as a complete packaged assembly and can be applied to new or existing incinerators. Various control systems are available to suit the requirements of any installation.

The burner must be correctly matched in capacity to the incinerator size, type and nature of waste to be destroyed.
Classes of Waste

The Incinerator Institute of America classifies waste material as follows:

Type 1 Waste — consisting of dry rubbish made up of combustibles such as paper, rags, wood, and containing little or no wet materials.

Type 2 Waste — consisting of approximately equal portions by weight of Type 1 waste and Type 3 waste.

Type 3 Waste — consisting primarily of combustible but wet waste such as garbage.

Type 4 Waste — consisting primarily of organic materials such as small carcasses, hospital operating room waste, bandages, waste from anatomical or pathological laboratories.

Incinerators intended for the destruction of Type 1 waste do not ordinarily require the use of auxiliary burners. However, auxiliary burners may be applied if completely odorless or smoke free operation is mandatory or if the occasional destruction of wet waste is a possibility.

Auxiliary burners must be used for the remaining classes of waste. They are usually sized to the recommendations of the IIA as follows:

- Type 2 waste — 1,500 Btu per lb.
- Type 3 waste — 3,000 Btu per lb.
- Type 4 waste — 8,000 Btu per lb.

Incinerator Fuels

Two types of fuel can be considered for firing incinerators. They are commercial fuel gas or fuel oil, either of which, or both are available throughout the country.

Gas is the more desirable of the two since it is
1. economical,
2. easily controlled,
3. easily burned, and,
4. requires no storage facilities.

Liquefied petroleum gas (LPG) can be furnished where natural gas is not available, though the latter is usually preferable because of its generally lower cost.

Oil fuel, where necessary, must be of the more expensive domestic grades (No. 1 or 2). Heavier grades are generally not suitable because of equipment complexity, and difficulty in completing combustion within the available space. Care must be exercised in operation of the oil burner or smoky combustion will add to the smoke of the burning waste.

Burner Location

Modern incinerators are designed to locate the "package" burner in the side wall (see Fig. 2) and firing into the combustion chamber above the grate level and above the refuse heap. This method has several advantages over ashpit firing methods:

1. Results in long grate life,
2. Leaves ashpit free for unhindered ash removal,
3. Leaves the burner accessible for maintenance and service,
4. Incinerates fumes and smoke emanating from the burning refuse heap.
The flame should preferably be of the long and luminous type, so that it may sweep across to all sides of the waste and quickly transfer its radiant heat to the combustion chamber (See Fig. 3).

Sidewall location of the burner requires the use of a "power" burner which includes a combustion air blower. The blower is necessary to drive the flame downward into the refuse where it can be most effective, though its force must not be so great as to stir up the ashes.

The above grate installation also enables the burner to function also as a smoke eliminator. The burning refuse naturally tends to give off smoke and odors. However, these effluents must pass through the flames of the auxiliary burner where they are effectively consumed.

A double-chamber incinerator (See Fig. 4) is useful for destroying wastes which characteristically produce dense smoke or particularly offensive odors, such as rubber or plastics and pathological waste. This type of incinerator incorporates a secondary chamber adjacent to the combustion chamber, through which the effluent must pass before entering the chimney. The secondary chamber is fired with its own burner which reheats the effluent to some 1300 or 1400 degrees F, or higher if necessary, at which temperatures it will be completely consumed.

In Fig. 4a the primary burner is located at an unusually low position. This is due to the fact that the incinerator shown is of the Class 4 type for use with pathological waste. For Class 2 waste the burner would be located considerably higher so that it would clear the highest point of the waste. In Class 4 incineration the charge is more compact and more difficult to incinerate; consequently the burner is consistently located in a lower position for more effective incineration.

**Burner Controls**

Package burners, as the term implies, are complete units, requiring only fuel and electric power connection. They are factory assembled and tested, and shipped ready for mounting. Standard, automatic models are available with a variety of options as noted below.

1. Operating control
   a. Manual
   b. Automatic

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**FIG. 3 CLASS I.A INCINERATOR**

Section Thru Grate Chamber

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**FIG. 4**

**FIG. 4A** BURNER LOCATION IN SECONDARY COMBUSTION CHAMBER
2. Ignition:
   a. Standing pilot
   b. Spark ignited pilot

3. Flame safeguard:
   a. Thermoelectric
   b. Electronic

*Manual operating control* consists simply of a toggle switch on the unit. The operating personnel will open or close the switch as desired.

*Automatic operating control.* The burner is arranged for remote control suitable for connection to a timer which shuts off the burner after a preset time interval, a time clock which provides for operation at a given time each day, or a temperature control which maintains a preset temperature in the incinerator.

*Thermoelectric.* A typical wiring diagram is shown in Fig. 5. In this device a thermocouple is positioned in a pilot flame so that it will be heated sufficiently to permit a manually set electromagnet to be held in. The burden of safety lies in the relative locations of the pilot, the thermocouple and the main burner ports to be ignited by the pilot. Simply stated, the pilot must ignite any flow of gas emitted through the main burner port that is rich enough to burn, even though the pilot flame has been turned down so that the thermocouple is no longer generating enough power to hold in the electromagnetic main valve interlock.

Assuming the above conditions are met, then the problem is reduced to one of keeping the pilot lighted regardless of the ambient problems. In an incinerator where the burner is located in the primary section over the grate, the personnel loading the incinerator must be careful not to load the chamber in such a way as to block the opening through which the burner is to fire. If this occurs, the pilot may smother itself. Judicious location of the burner opening and proper loading of the incinerator is required. As difficult as this may sound, it is not the major difficulty. The problems of draft are by far the major source of nuisance pilot outage. Every time the charging door is opened or a load of trash is dumped into a flue-fed unit, the draft changes radically. All things considered, burner designers have been remarkably successful in maintaining pilots in spite of adverse draft conditions, but many units simply cannot be kept lighted no matter what is done.

*Electronic.* In order to overcome these problems automatic spark ignition was applied to burners. Because spark ignition is subject to conditions whereby explosions can occur, a faster, more sophisticated means of detecting safe conditions for operating the main automatic valve was deemed necessary. Therefore the electronic flame safeguard was adopted. These units all operate on the same safety principle as the thermocouple device. A typical wiring diagram is shown in Fig. 6. A pilot flame must be present and located in such a position so as to ignite the main burner under any condition. The means for detecting the pilot flame and the response time in effecting closure of the main valve in the event of a flame failure are what differ.

Through the years, flame rectification has come to be the most practical and popular means of detecting flame presence. The device utilizes the fact that in a flame, a condition of ionization occurs, so that if an a-c source is imposed on a flame rod, the end of which is located in a
position so as to detect a safe pilot, a rectified d-c current is conducted through the flame to ground. The resulting d-c current is detected, evaluated and amplified through an electronic network so that a relay is operated which energizes the main valve. In the majority of these units the flame response time of the electronic network is between 2 and 4 seconds.

The electronic network is quite selective. If too small or too large a d-c current is detected, it is rejected and no main valve operation is allowed. If the flame rod is grounded or displaced outside of the pilot flame zone, the resulting a-c current or the lack of signal is rejected and no main valve operation is allowed.

Non-electronic spark. Recent developments in design have brought out systems of non-electronic spark ignition that have demonstrated their practical safety. The problems of safety in these systems are quite critical inasmuch as the spark, the source of ignition, is not present during the burner standby time and no quickly responsive electronic network is present to operate the main valve.

The nature of the fuel has caused the burner manufacturers to approach this concept with much caution, but the need to overcome the relatively high cost of the electronic systems on burners for smaller incinerators has provided the incentive to solve the problem.

In order to understand their thinking let us examine the problem:

1. When the main valve is opened, a mixture of gas and air is provided, which if allowed to accumulate can become hazardous.

2. Automatic thermal devices are available which when heated will operate switches or gas valves, but their response time is in the order of 15 seconds to 3 minutes to effect valve closure in the event of flame failure. Even at 15 seconds the response time is too long.

3. Heretofore safe application of thermal safety devices required the use of constant pilots which would ignite the fuel before it could accumulate.

Research programs were aimed at speeding up response times, evolving electrical interlocks and examining every system available commercially or otherwise. In recent years many good, direct spark ignition systems were developed for clothes dryers. While it would seem that they would be suitable for this application, they all included one or more objectional features that ruled them out. The problems centered around the dangerous conditions produced when the main gas flow was momentarily interrupted.

These systems all allowed the gas to continue to flow after the interruption, until the thermal element cooled, whereupon an immediate attempt to re-establish ignition took place. In a clothes dryer application this created no problem, because the gas was not allowed to accumulate. The sheer volume of forced air moving through these systems was more than sufficient to dilute the fuel to below the explosive limits. An incinerator is not so designed.

As is frequently the case, a simple concept solved the problem. A constant source for main-burner ignition was provided throughout the entire burner run. The system theory developed this way.
1. If the best dependable response time is between 15 and 30 seconds, a dependable source of ignition must be provided, which will be present to reignite the fuel, thereby eliminating the possibility of accumulation during this delay.

2. The source for ignition should be proved before initial main burner operation.

3. Even though a direct spark ignition system could be relied upon, it was felt that a back-up system of pilot burner ignition and proof enhanced the overall safety.

A typical circuit for this system is shown in Fig. 7. The operating sequence is as follows: The spark ignitor supplies the energy to ignite the pilot, which heats the thermal element. As soon as the element is heated, the main valve is allowed to open and main burner ignition occurs. Note that the pilot, the spark and the main burner operate continuously through the main burner run. The spark is located so that it will light the main burner as dependably as it will light the pilot, but it cannot of itself generate enough heat to cause the thermal element to operate. A momentary power interruption that is re-established before the thermal element can cool results in direct ignition of the main and pilot flames by the spark immediately upon power return. A gas interruption yields the same results.

As with the electronic-spark-ignition flame safeguard a prepurge can be supplied that holds off all ignition and gas flow until conditions are deemed safe to initiate the cycle.

The choice of options will depend on job conditions and economics. For example, the standing pilot system is less costly than the spark ignition system. It is perfectly satisfactory when installed under suitable conditions. However, where conditions are variable and cannot be controlled, such as erratic chimney draft or careless loading of the incinerator, it will generally prove wise to specify the spark system. By the same token the thermal flame safeguard is less costly than the electronic. A burner model containing thermal safety together with spark ignition makes an excellent combination of economy and dependability.

In addition to the above safety controls the incinerator burner must include a blower proving device which will prevent gas flow if the motor fails or if the blower wheel fails to rotate for any reason.

Some burner manufacturers offer a patented burner self-cooling system. It protects the burner from heat damage from back drafts and overloading of the incinerator. A heat sensitive switch is located within the burner housing. If the burner is on standby, this switch will start the burner blower if its temperature reaches 180°F. This cools the internal surfaces of the burner and corrects the condition causing the overheating.

Increased consciousness of air pollution problems at municipal, state and Federal levels has resulted in accelerated research in the field of incineration. Burner equipment is only a part of the entire picture. The combination of incinerator, breeching and auxiliary fuel burners results in the high efficiency and reliability achieved today. As a result of research currently being conducted under the supervision of the Incinerator Institute of America, further improvements are inevitable in the future.