Abstract

For the complex structure of incinerator furnace enclosures the characteristics of suspended construction are described. These include flexibility in design, means of carrying load, allowance for expansion, ease in making repairs, and other features. Comments are made on the functions of the various chambers and the types of construction suitable for each. In the primary chamber ignition occurs and there is a wide range of temperature. Combustion continues in the secondary chamber where temperatures are still high. In the expansion chamber velocity and temperature of the gases are reduced and thinner walls with insulation are suitable. The spray chamber provides fly ash removal and is subject to lower temperature. Care must be taken in handling the corrosive waste water. The flue to the stack can be built with thin walls, but should be tight so as not to reduce draft.

Introduction

The primary function of the refractory enclosure of an incinerator furnace is to provide a chamber for combustion. It is also related to the combustion process in providing radiant heat for ignition and furnishing a heat reservoir to promote even burning temperatures. These enclosures in today's municipal incinerators are huge complex structures, requiring high walls with numerous changes in direction and built to various elevations. Roof spans are large and contours complicated.

Suspended arch and supported wall constructions have demonstrated their advantages on large incinerator units over the past years. They allow the flexibility in design and selection of materials to provide the answer to design problems of any type incinerator, rectangular or cylindrical.

Sectional walls are supported from an exterior structural steel framework. The load from each refractory tile section is carried through support castings to the supporting structure, eliminating any possibility of accumulative loading and failure of refractories because of deformation under load.

Sectional support also allows control of expansion both horizontally and vertically by providing expansion joints in small unit areas. Each unit or zone is allowed to move independently under expansion or contraction of the refractory material. There is no accumulation of expansion stresses.

Refractory thickness is not required for wall stability and therefore, it can be governed by temperature and operating conditions. In an area requiring a high heat storage capacity, or where resistance to flame impingement and other severe service conditions are encountered the depth of the refractory can be increased. In areas of relatively low temperature the refractory can be thin and act merely as a sheath or interior protective covering for the wall against the action of the furnace gases.

Insulation can be applied as an integral part of the arch or wall construction and be supported and tied back by the same components. It can be made gas and
air-tight with a scaling layer of insulating castable between the insulation and refractory layer. Individual wall zones can be either insulated or air-cooled, depending upon service requirements. Air-cooled walls can be used as ducts for distributing over-fired air.

The refractory tile used in the supported construction are preburned at the refractory plant, allowing close control over thermal and physical characteristics. Selection on a quality standpoint can be made for individual zones based on expected service conditions. Lastly, sectional support allows repairs to be made in localized areas without disturbing adjacent areas — repairs are easier to make and replacements may be rapidly and simply installed.

The complete enclosure involved in incinerator construction is divided into several chambers, each having separate and distinct functions and each calling for a type of supported arch or wall construction to fulfill service requirements.

- There are the primary or furnace chamber, the secondary or combustion chamber following furnaces of small volume, and expansion or subsidence chamber. In some installations spray chambers are used, and there are flues connecting the various chambers and leading to the stack.

**Primary or Furnace Chamber**

In this chamber the refuse is received, ignited and burned, with the non-combustible residue discharged to the ash pit. Proper placement of the wall and arches in relation to the fuel pile is important because the radiant heat from these areas helps to ignite the new charge and promotes combustion.

The wall and arch area is designed with high heat storage capacity so it can act as a heat reservoir to equalize the heat release of non-uniform refuse and promote even burning temperatures. The calorific value of refuse on an as received basis is variable and therefore, this chamber is subject to wide temperature fluctuations. These temperatures may range from 1600 F to 2000 F. Excess air is used as a coolant during periods of high heat release and heat storage from the walls and arches helps to maintain temperature during periods of low heat release.

The furnace chamber is the section of highest refractory maintenance. The destructive influences on refractories are high temperatures, flame impingement, thermal shock, slagging and abrasive action of the charged refuse. At localized areas temperature can go as high as 2800 F. Refractories of Super Duty quality best meets the physical and thermal requirements as listed above. Silicon Carbide refractories are frequently used at the grate line to overcome the abrasive action of the charge.

Suspended walls in this chamber are usually a combination of insulated and air-cooled construction. Insulation can be applied to reduce heat loss and maintain heat storage to a depth consistent with temperature conditions. In high temperature zones insulation can be reduced or omitted and the space utilized for air-cooling.

Special attention should be given to the charging openings in this chamber. Proper design is important because the enclosure at this point must resist the abrasive action of the charge. In batch fed furnaces there is also thermal shock from opening and closing the charging gates. Rugged construction is required for this area along with a design that permits easy entrance of the refuse without interference.

**Secondary or Combustion Chamber**

Combustion of the volatile gases is completed in this chamber. Therefore, it is necessary to maintain temperatures sufficiently high and to thoroughly mix the gases from the ignition chamber with excess air in the gas stream. Turbulence is imparted to the gas stream by changing direction of travel through the use of bridge or baffle walls. Temperatures are maintained in the 1600 F to 1800 F range. To adequately destroy particulate matter and eliminate noxious odors, temperatures should always be maintained above 1200 F.

This chamber is also subject to varying temperatures and thermal shock but not to the same degree as the primary chamber. At times of overload, however, with adequate volumes of excess air there can be periods of high temperature.

Suspended walls in this chamber are usually of the insulated design having a refractory depth of 9 in. and sufficient insulation to maintain heat storage but not cause any refractory trouble during periods of high temperature. As an added safety factor, refractories should be of Super Duty quality to properly withstand possible service conditions.

**Expansion or Subsidence Chamber**

The function of this chamber is to slow down the gases and settle out the fly ash from the gas stream. The gas stream is given a circuitous path by use of baffle, bridge and curb walls. Gas velocity is held low and fly ash or other particulate matter is trapped by the baffle walls and is finally removed through clean out doors or automatic methods. Temperatures are generally maintained at 1200 F so as to complete combustion on any unburned particles.

Refractory maintenance in this chamber is relatively low because of moderate and stable temperature conditions. Refractories should be of High Heat Duty quality and may be relatively thin, perhaps 3 in. or 4-1/2 in. in
thickness. Suspended walls are of the insulated type with insulation depth sufficient to reduce heat loss through the walls to a minimum and provide comfortable working conditions in the incinerator plant. Low heat storage capacity is adequate, as here heat in the gases may be dissipated, reducing volume and slowing down gas velocity.

**Spray Chambers**

When fly ash and particulate matter have to be removed to a greater extent than a dry expansion chamber will provide, spray chambers may be used. Water spray curtains are introduced across the path of the gases or other application of sprays may be used to entrap the fine particles and remove them from the gas stream.

Temperatures may be reduced to 500°F to 800°F, and therefore, water consumption is high. The presence of chemicals in the flue gas produces a mild acid condition which, if allowed to migrate to the exterior furnace structure, could cause trouble. Suspended walls and arches using a low porosity, acid resistant refractory, laid up in acid resistant mortar are required for this service. Walls should be backed up with an insulation castable to resist migration of moisture to the supporting structure.

**Flues**

Flues are required to connect the several chambers and to pass from the incinerator unit to the stack. In multiple incinerator units flues are interconnected so one stack can serve two or more incinerators. In this case they may be provided with dampers so one unit can be closed down while the other operates.

This portion of the incinerator is closest to the stack and therefore, in an area of high draft. Enclosure must be air tight. Supported walls of thin refractory tile backed up with insulation and a layer of castable insulation for air tightness meet the service requirements.

**Conclusion**

The refractory enclosures are a vulnerable part of the incinerator unit. They must tolerate the high temperatures required for complete combustion and withstand the operating conditions of abrasion, slag erosion, flame impingement and thermal shock. So, it is obvious that this important part of the unit demands in its engineering design a proper coordination of layout, structure, and materials to provide a long life at low cost. Suspended pre-fired refractory arch and wall constructions are meeting these conditions.