HYDROCARBON ENGINEERING

Volume 14 Number 6 - June 2009

Incinerate AND eliminate

Roop Bhan, Callidus Technologies by Honeywell, USA, provides an overview of the application of downfired salt thermal oxidisers.

Applications requiring the use of a thermal oxidation system to incinerate and eliminate wastes are widely diverse. Callidus Technologies by Honeywell provides engineering and manufacturing of thermal oxidation systems commonly known as thermal oxidisers (TOs). These systems are equally diverse in design from relatively straight forward and simple to very complex and sophisticated. The type of thermal oxidiser described in this article is a complex system.

Wastes incinerated in downfired salt systems are characterised by the presence of inorganic salts (NaCl, Na_2SO_4, Na_2S), organic salts (acetates and oxalates of alkali metals), and non-combustible solid materials. It is important to remember that only the organics in the waste stream are destroyed during the combustion process. Materials such as inorganic salts, other than Na_2S and Na_2CO_3, pass through with only a phase change. Organic salts are converted to CO_2, H_2O and inorganic oxides of alkali metals. The waste streams are usually liquid and may be

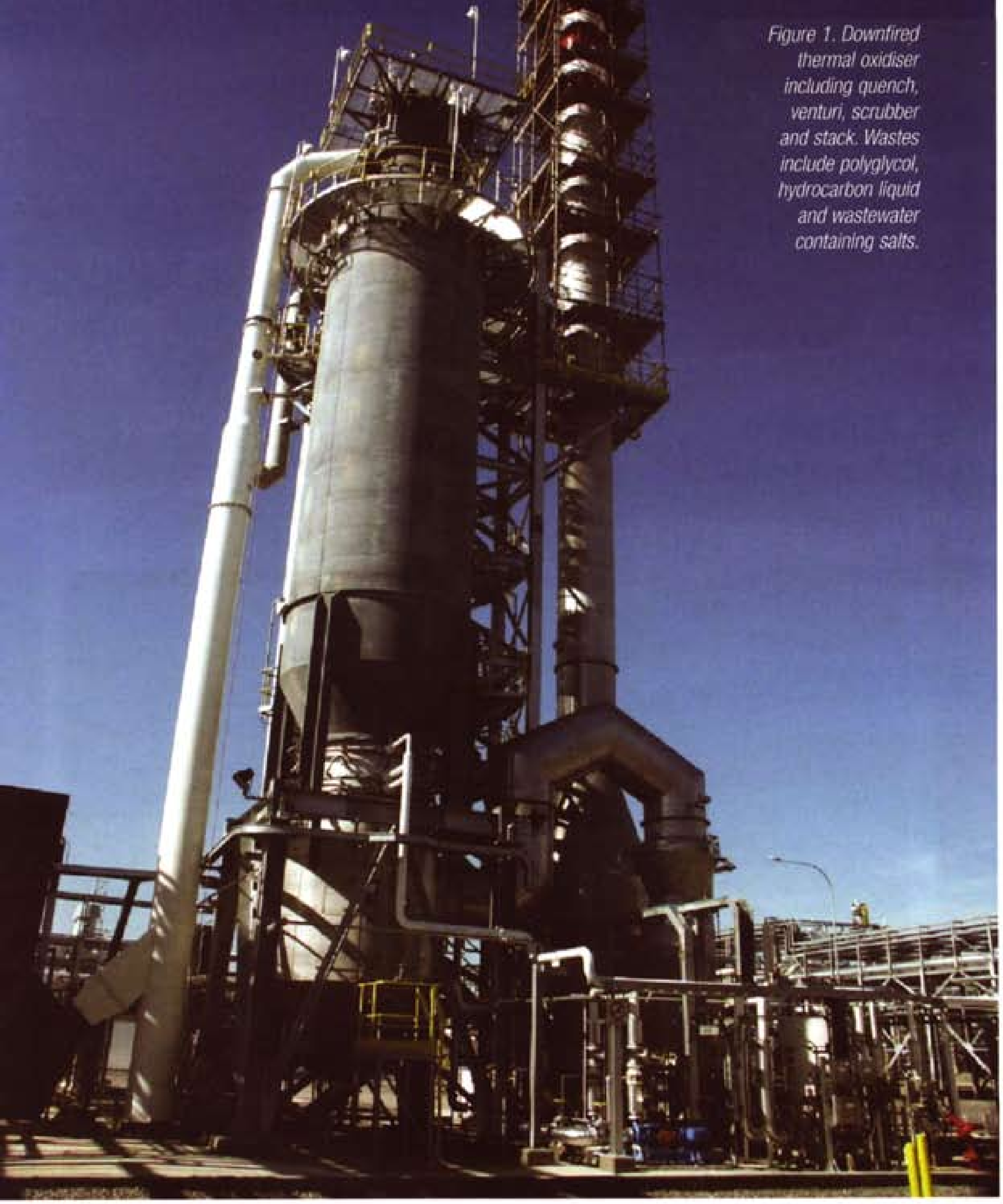

Figure 1. Downfired thermal oxidiser including quench, venturi, scrubber and stack. Wastes include polyglycol, hydrocarbon liquid and wastewater containing salts.

organic or water based. The presence of organics in water based wastes makes the latter a candidate for disposal by incineration.

Liquid wastes

Liquid wastes of this type are generally incinerated at higher temperatures. This presents a challenge in that higher temperatures and the presence of alkali metal salts can be damaging to refractory used within the system. When selecting a temperature, an attempt is made to balance the need to use higher temperatures for higher destruction efficiency with the need to prolong refractory life. Temperatures ranging from 1650 – 2000 °F and residence times of 1.5 - 2.0 seconds are commonly used. If practical, a lower incineration temperature is preferred. Moderate to low pressure drop burners are preferred since a high pressure drop burner, with its associated turbulence, can sling the salts in the waste towards the furnace walls, causing the refractory to deteriorate more rapidly. A moderate pressure drop burner with no cyclonic action tends to keep the salts in suspension and away from the furnace walls, lessening salt contact with the refractory, thereby limiting refractory degradation.

Water based wastes are injected into the thermal oxidiser furnace itself, downstream of the burner. This is because firing such wastes into the burner would destabilise the burner and lead to soot formation. Since the water in these wastes has to be evaporated before the combustion of organic materials can commence, it is not uncommon to burn some amount of auxiliary fuel in the burner upstream. The amount of auxiliary fuel burnt is dependent on the incineration temperature and the heating value of the waste which, in turn, depends on the amount of water in the waste. A moderate to high pressure drop burner is used to ensure near complete combustion of the auxiliary fuel before the resulting products of combustion are injected with the water based waste downstream. Incomplete combustion of the auxiliary fuel at the time of waste injection can lead to soot formation and incomplete combustion of the waste. Organic based wastes containing little or no water are fired into the burner as they have fairly high heating values.

The thermal oxidiser is nearly always vertical with the burner mounted on top, firing downwards. The vertical design and subsequent downward flow of the flue gases create conditions in which the molten salts have less of a tendency to contact the refractory. Because molten salts do not accumulate on the refractory walls, there is a reduction in refractory deterioration.

Wet or dry?

The products of combustion exiting the thermal oxidiser will contain particulate matter and may contain acidic gases such as SO_2, if sulfides are present in the waste stream. Particulate matter (ash) removal can be accomplished by either a dry or a wet method. Examples of the dry method are baghouses and electrostatic precipitators (ESPs) and examples of the wet method are wet scrubbers and wet

Figure 3. Downfired salt thermal oxidiser with wastes consisting of slop oil and miscellaneous solvents.

electrostatic precipitators (WESPs). In either case, the flue gases have to be conditioned for the method used. For instance, in the case of electrostatic precipitators, the flue gases need to be cooled to at least 600 °F whereas for the baghouse, they need to be cooled to approximately 450 °F. Cooling for the dry method can be accomplished by injecting water, air or cooled flue gases into the hot products of combustion. A major advantage of the dry method is that it produces a small quantity of dry ash, which is easier to dispose of. It also uses a relatively small quantity of quench water.

When flue gases contain both ash and acidic gases, the wet method is preferred over the dry because of the necessity to remove acid gases. Flue gases for the wet scrubbers have to be saturated with water vapour before scrubbing can be effective. This is generally done by spraying enough water into them to reach their adiabatic saturation temperature. Wet scrubbers remove particulate matter by intimately contacting the scrubbing medium, usually water, with the flue gases, resulting in encapsulation of the particulate matter by the liquid, coalescing of the particulate containing droplets to form larger droplets, and the collection of these large droplets either by cyclonic action or impacting them against a collecting surface.

WESPs are generally used downstream of the scrubbers to further reduce particulate matter content in the vented flue gas.

Depending on the properties of particulate matter removed, the blowdown stream from the scrubbing system, containing 5 - 8% solids, may require special treatment before its introduction into the waste water system.

In recent years, there has been a trend towards producing a relatively inconspicuous stack effluent; in other words, one without a steam plume. This is accomplished by any number of combinations of the following methods. A substantial portion of the water vapour contained in the flue gas is removed, reducing the dew point. The flue gas is heated to well above its dew point. Finally, heated air is injected into the flue gas to reduce the dew point and raise the temperature of the resulting mixture to well above the dew point.

Standards

A destruction efficiency as high as 99.99% can be achieved routinely in downfired salt thermal oxidisers. Particulate matter concentration of 0.08 grains/DSCF was generally the standard used by the process industry in the US. In recent years, the international trend has been towards lower emissions (35 mg/DSCM). This generally necessitates the use of a more sophisticated removal system (such as a WESP) downstream of a traditional scrubber. NO_x and CO are generally within the limits set by environmental authorities.