Sludge Incinerator RTO Upgrade with MLM-160-6®
$50,000+ Yearly Power Savings

Introduction

The city of Fitchburg, Massachusetts operates a multiple hearth incinerator that burns municipal sludge to minimize waste volumes. Although not universally used by municipalities in the United States, incineration is a widely accepted and used method of sludge disposal. The major benefit of incineration is a greatly reduced need for landfill space. An 85 - 95% volume reduction of material needed to be sent to a landfill dump is normal as the result of incineration[1].

Incineration is used extensively in countries with limited open space. Japan incinerates approximately 75% of its municipal solid waste[2]. In Europe, on the other hand, Finland reported 90% of such waste is sent to landfill, where as in tiny Denmark 75% of such waste is incinerated[3]. How to ultimately dispose of solid waste remains a challenge to municipalities worldwide. In Texas alone, 6.5 pounds of solid waste was generated per person per day in 1998.[4]

The City of Fitchburg Municipal Incinerator

Burning of solid waste will generate harmful gases that must be treated before exiting the stack into the atmosphere[5]. The city of Fitchburg, Massachusetts, burns solid sewage sludge in a multiple hearth incinerator located at the East Fitchburg WWTP. In addition to sludge generated there, the city accepts biosolids from other New England municipalities. Fitchburg is paid, on average, $250 per dry ton to destroy this sludge. The incinerator is located next to the municipal airport.

Exhaust gas produced by the incinerator is treated extensively before being allowed to exit the stack and disperse into the environment. Following the incinerator is a tray tower, a venturi scrubber and a wet electrostatic precipitator (WESP). These air pollution control steps remove particulates and heavy metals from the gas exiting the multiple-hearth incinerator.

Figure 1. East Fitchburg Wastewater Treatment Plant

The final step in air pollution control is a Regenerative Thermal Oxidizer (RTO). Such process units are also known as 'afterburners' as a RTO is often the last step in an air pollution control application. Afterburning is used to destroy volatile organic compounds (VOCs) and malodorous gases that otherwise would exit the stack[6]. VOCs are known to support 'smog' air pollution[7]. The most common VOC present in the off gas from the Fitchburg incinerator is acetone [$(CH_3)_2CO$]. The high temperature maintained in the RTO combustion chamber, 1500°F (816°C) assures complete oxidation of such compounds to CO_2 and H_2O.

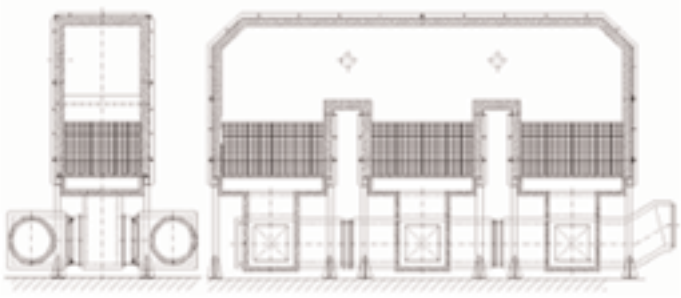

Figure 2. Three Canister RTO

The RTO is a typical three canister unit, shown in figure 2. A series of valves open/close every 90 seconds to change the air flow direction. As the air flow changes, the gas entering the combustion chamber is preheated while the gas exiting the combustion chamber is cooled before final release out the stack. The purpose of this process flow is to capture and reuse heat in the RTO. In this manner, natural gas

burning, required to maintain the high combustion temperature, is minimized and fuel cost is controlled. This capture and release of heat is accomplished by the presence of heat recovery media in canisters (or 'cans') that adjoin the combustion chamber of the RTO.

The original heat recovery media in the RTO at Fitchburg was 1" ceramic saddles. Normal pressure drop across the RTO was 25" WC (at 14,000 scfm air flow). At this condition, the theoretical fan power required to overcome this head loss was 60 hp (44.7 kW).

Ceramic saddles have been the historic choice of heat recovery media in RTO units. Saddles operate with a high pressure loss, so although fuel gas cost is controlled, saddles have been the reason that RTO units have traditionally been major consumers of electric power. And as power costs have increased in recent years, so has the operating cost increased for RTO units containing saddles.

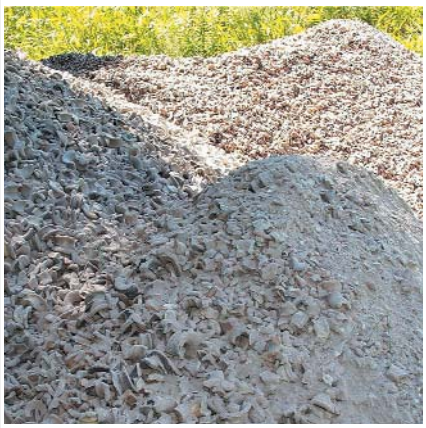

Figure 3. Fitchburg 1" Saddles

Saddles also tend to 'nest' or 'mesh' together over time as the bed of saddles settles. This not only will increase pressure drop (and further raise power costs) but will also aggravate plugging and fouling problems inherent with beds of saddles. Indeed, plugging of a saddle bed may raise the pressure drop across the bed long before the bed has the opportunity to fully settle. This is one of the primary reasons RTOs have been associated with high maintenance costs. The problem at Fitchburg was so severe that the saddles had in large part ground themselves down to a fine sand. Note the condition of the saddles that were removed from the RTO in Figure 3. In addition to the sizable volume of sand, close inspection revealed that only a fraction of the saddles remained physically whole.

Figure 4. Saddle impressions on insulation inside RTO cans.

As the saddle bed compressed, distinct marks were left in the insulation at different stages of settling. Eventually, compression of the saddle bed was severe enough to force the saddles into the insulation lining the inside of the canisters. Note these effects in Figure 4.

So in addition to high power costs, RTO units containing saddles also traditionally have very high maintenance expenses as the saddle beds must frequently be backwashed to clear deposits. The operating history of the Fitchburg RTO with saddles was that wash outs were required every other month. The need for frequent wash outs of saddle beds in RTOs has been noted in field installations previously[8]. In addition to the need for frequent maintenance shutdowns, the pressure drop of saddle beds tend to never return to the pre-maintenance value. This 'creep' of pressure drop eventually necessitates dumping the existing bed of saddles and replacement of the bed with a load of new saddles.

Multi-Layer Media (MLM®) from Lantec Products

First introduced as an alternative heat recovery media for use in RTO units in 1996, MLM® offered the city of Fitchburg amajor savings in electric power usage, with no loss of thermal efficiency (so no increased fuel cost) compared the old saddles. The loose plate design of MLM® allows for a much lower pressure drop compared to saddles. MLM® also has both more surface area as well as more mass than saddles, so the heat recovery by MLM® in an RTO is actually superior to that of saddles. Additionally, the parallel plate design of MLM® has proven extremely resistant to fouling in field applications where saddles had very short useful life[8]. MLM-160-6® has beEndeveloped by Lantec Products for use in RTOs that treat air volumes of possible high particulate content such as the RTO at Fitchburg.

sales@lantecp.com

MLM® is Installed in the City of Fitchburg Municipal Incinerator RTO

As a result of these considerations, MLM-160-6® was installed in the Fitchburg RTO in early December, 2005. After startup the pressure drop came to steady state at less than 4" WC, as opposed to the 25" WC with saddles. The lower pressure drop represents a theoretical power requirement of 10 hp (7.5 kW) vs. 60 hp using saddles. The power requirement of the fan moving the air through the RTO has been reduced by 50 hp (37 kW). This reduction in power consumption represents a savings of approximately **$52,000** per year[9].

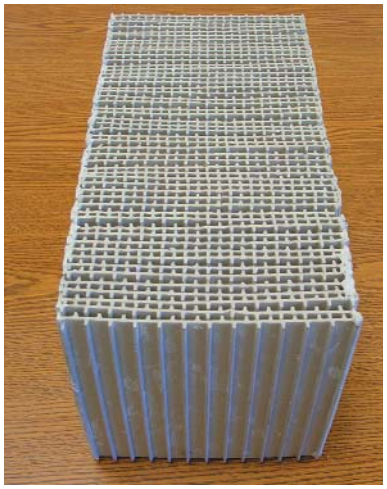

Figure 5. MLM-160-6®

Environmental Benefits - Greenhouse Gas Emission Reduction

In addition to saving money - reducing power consumption also reduces greenhouse gas emissions. One horsepower is the equivalent of 0.746 kW of power. The generation of a kWh is estimated to cause the release into the atmosphere of 1.341 pounds of CO_2 gas[10]. Therefore, elimination of 50 hp can be equated to a reduction of 547,000 pounds (assuming a 340 day operating year) of CO_2 gas emissions per year.

Conclusion

Fitchburg has made a major step in conserving both electric power and has also boosted municipal financial resources. The cost of the project (MLM® purchase price, installation costs) has been returned to the city several fold in less than a year. The city is also now in the position to increase capacity in their RTO unit with no major rebuild or new equipment acquisition costs.

Further savings have been realized by the city in reduced maintenance costs for the RTO now that the old saddles have been replaced with MLM®. Two or three washouts yearly suffice with MLM®, versus the previous schedule of 6 washouts per year. Also it should be noted that after washout the pressure drop of the beds of MLM® returns to the pressure drop initially observed after installation of the MLM®.

Finally, the city has accomplished these savings in an environmentally responsible manner.

Contacts

Lantec Products, sales@lantecp.com
City of Fitchburg, Dennis Meunier, 978-345-9622

References

1. "Decision Maker's Guide to Municipal Solid Waste Incineration", 1999, The International Bank for Reconstruction and Development/The World Bank, 1818 H Street, N.W., Washington, D.C., 20433, USA
2. "The Present Level of Municipal Solid Waste Treatment Technologies", Professor Takashi Gunjima, Sanwa Research Institute, http://www.apecvc.or.jp/072298/072298b.htm

References (continued):

3. "Municipal Waste Management", Torben Wallach, Chairman, HELCOM LAND, http://www.helcom.fi/manandsea/municipalities.html
4. "Texas Environmental Profiles No. 2, Municipal Solid Waste in Texas", http://www.texasep.org/html/wst/wst_2mtx.html
5."Municipal Incineration Plant Wastewater Treatment", http://nett21.unep.or.jp/JSM_DATA/WATER_1/html/Document_224.html
6. "Biosolids and Residuals Management - Odor Control in Biosolids Management", US EPA document 832-F-00-067, September 2000
7."Global Issues: Biogenic Volatile Organic Compounds", Rainer Steinbrecher, http://www.gnest.org/Global_Issues/Biogenic.htm
8. "Biosolids Incinerator Operator Retrofits RTO to Improve Air Flow", Ann Hasbach, Pollution Engineering, November 1999, pp 55 - 56, http://www.lantecp.com/mlm/MLMPollEng.htm
9. Pacific Gas & Electric, Palo Alto, CA "Business Customer Fact Sheet", www.pge.com. *Assumes 8,000 hour operating year.
10. US Department of Energy and the US Environmental Protection Agency, "Carbon Dioxide Emissions from the Generation of Electric Power in the United States", July 2000

Three Canister Regenerative Thermal Oxidizer
Upper Blackstone WWTP, Worcester MA
Retrofitted to MLM® Heat Recovery Media October 2004

Lantec Products provides free bed designs for:

- Wet Scrubbers (Acids, NH_3, Amines, H_2S, Alcohols)
- Biological Odor Control Systems
- Volatile Organic Compound Air Pollution Control
- Regenerative Thermal Oxidizers
- Oil - Water Separators (EN 858-1 Compliant)
- H_2S and CO_2 Degasifiers
- Gas Cooling/Drying Towers
- Groundwater Remediation
- Air Strippers to Remove VOCs or NH_3 from water

sales@lantecp.com