OCEANSIDE DISPOSAL PLANT IMPROVEMENT PROGRAM - DESIGN, CONSTRUCTION AND OPERATING EXPERIENCE

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ABSTRACT

The Oceanside Disposal Plant, Town of Hempstead, Long Island, New York, was commissioned in 1965 to produce steam and electrical power from combustion of municipal solid waste. Early in operation, unexpected problems developed which limited plant capacity. In 1970, an improvement program was undertaken to upgrade plant performance and availability. The first unit that was improved has been operating since 1974. The other two improved units were placed in operation in 1977. General data on design, construction and operating experience during the program is presented and specific information is given regarding boiler tube life, air pollution control, and design considerations in the combustion zone.

INTRODUCTION

Prompted by favorable experience at the Merrick Disposal Plant, in the early 1960's the Town of Hempstead authorized design of a second disposal plant to generate steam and electricity from the combustion of municipal solid waste. Thus, the Oceanside Disposal Plant was commissioned in 1965 with three incinerator furnaces. One furnace, rated at 150 tons (135 t) per day, was equipped with wetted baffle walls as gas cooling and cleaning devices. This unit is not equipped with a steam generator. The remaining two units, rated at 300 tons (270 t) per day, were equipped with forced circulation waste heat steam generators followed by wetted-cyclone mechanical dust collectors. Figure 1 is a cross section of a 300 tons (270 t) per day unit. All three units are arranged for continuous firing of unprocessed municipal solid waste.

Saturated steam generated at 460 psig (3.15 MPa gauge) in the two waste heat boilers was used to generate electricity and, in condensing, to generate fresh water from salt water. Electricity generated was used for all in-plant heat, light and power. The fresh water generated was used for in-plant process use. The Oceanside Disposal Plant was the first plant in the United States with continuous feed furnaces to produce steam and electricity from combustion of municipal solid waste.

Shortly after commissioning, a number of troublesome problems were encountered. The problems, which included rapid boiler tube wastage and slag buildup, have been covered in the literature [1-4]. In addition, Professor Kaiser and others have published a number of papers drawing on data gathered at the Oceanside Disposal Plant [5-8].

In 1970, the Town of Hempstead authorized an improvement program to install high efficiency air pollution control devices required to meet newly applicable particulate emission limits and to make additional modifications to alleviate boiler tube wastage and other problems that had been encountered. The initial phase of the improvement program was to replace one of the
FIG. 1 ORIGINAL 300 TON (270 t) PER DAY UNIT AT THE OCEANSIDE DISPOSAL PLANT

two steam generating units with a different type of boiler and to replace the mechanical collector with an electrostatic precipitator. This work was completed in 1974 [9].

Operation and testing verified that the improved unit could comply with all applicable air pollution emission regulations and could operate for an extended period without incurring tube metal wastage. With this established, the Town authorized improvement of the remaining two units. These two units were placed in operation in 1977. Figure 2 is a cross section of a modified 300 ton (270 t) per day unit. The grate, charging chute, induced draft fan, underfire air fan and portions of the refractory furnace are all that remain of the original “chute-to-stack” system. The improvement program, accomplished while the plant remained in operation, is now essentially complete.

This paper covers the design considerations, construction experience, and operating experience during the improvement program.

DESIGN CONSIDERATIONS

FURNACE

Several basic concepts guided the design of the improved furnace. Furnace volume was maximized to take full advantage of the space available in the existing building to assure that burnout would
FIG. 2 IMPROVED 300 TON (270 t) PER DAY UNIT AT THE OCEANSIDE DISPOSAL PLANT
be complete before the products of combustion entered the boiler convection bank. The furnace envelope was to be, to the extent practical, a cooled surface, thereby reducing the temperature of gases entering the convection bank. Quantity, velocity and point of introduction of overfire air were all important considerations in the layout and design of the furnace.

Once the boiler manufacturer was selected, three-dimensional scale model tests were conducted to finalize the size and shape of the furnace, as well as the location and arrangement of overfire air nozzles. The configuration selected resulted in an average gas velocity up through the furnace of less than 15 ft/sec (5 m/s) and a furnace exit temperature of 1550°F (850°C) when firing at a design rate with 100 percent excess air.

Overfire air can be introduced through 2-in. pipe nozzles at two levels in each side wall, as well as at a single level through the front and rear wall, at a maximum pressure of 25 in. wg. (75 kPa).

Air-cooled silicon carbide walls were selected to inhibit slag buildup along the grate line. Bottom supported, water-cooled walls extend from the top of the air-cooled walls to the furnace outlet. The water-cooled walls were coated to a level 30 ft (9 m) above the grate with a relatively thin silicon carbide coating held in place by closely spaced 3/4 in. (1.9 cm) studs. This provided protection of the tube from metal wastage due to flame impingement and constituents in the products of combustion without unduly inhibiting heat transfer. Tube thickness was also selected to be twice the thickness required by the ASME Boiler and Pressure Vessel Code. Thus, 3¼ in. (8.25 cm) O.D. wall tubes have a minimum thickness of 0.180 in. (4.6 mm).

CONVECTION BANK

A multiple pass convection bank, formed of essentially vertical tubes, was chosen which was of sufficient size to preclude the need for an economizer. Boiler exit gas temperature is 600°F (315°C). The gas velocity in the initial downpass of the convection section, where the gas passes between 2½ in. (6.35 cm), O.D. tubes on 6 in. (15 cm) spacing, is less than 30 ft/sec (10 m/s). Seven sootblower locations were selected. Two half-width, retractable, steam-blowing sootblowers were installed at each location. Again, tube thickness was selected to be twice that required by the Code. The 2½ in. (6.35 cm) O.D. convection tubes have a minimum thickness of 0.135 in. (3.4 mm).

ELECTROSTATIC PRECIPITATOR

In order to minimize the possibility of corrosion in the gas cleaning equipment, electrostatic precipitators were selected to operate at temperatures in excess of 550°F (300°C).

To assure effective collection, two fields in series of rigid-frame discharge electrodes were installed between collection plates on 10 in. (25 cm) centers. Internal inspection walkways were installed upstream, between and downstream of the fields. The flyash handling system selected utilized air locks to remove flyash in a dry form before it is dragged to a sluicing system for sluicing either to the residue conveyors or directly to the flyash lagoon. Average gas velocity through the precipitator was to be no more than 4.5 ft/sec (1.5 m/s).

GRATE SYSTEM

The original, rocking-grate stokers were utilized in the improved furnaces as they had demonstrated the ability to handle unsorted and unprocessed municipal solid waste. However, the original siftings sluicing system was replaced with a siftings conveyor to drag the siftings to the residue conveyors.

DESALINIZATION UNITS

As the copper-nickel evaporator bundles had not held up as well as expected, they were replaced with titanium tubes. Other materials used in the desalination units were specifically selected for the severe operating conditions experienced since original plant startup. Each of four units is capable of producing 50,000 lb (23 t) of fresh water per hour while condensing 58,000 lb (27 t) of steam.

CONTROLS AND INSTRUMENTATION

The philosophy used in developing the controls and instrumentation is dependent upon the operator making simple, straightforward adjustments to air flow based upon his visual observation of the fire bed along with gas and air temperatures, pressures and flows displayed on an adjacent control and instrumentation panel. Underfire air is manually controlled at the panel.
to each of the three burning grate sections. Overfire air is manually controlled at the panel to each of the four levels of nozzles. Other functions such as feed water flow, steam pressure, and furnace draft are automatically controlled.

SODIUM HYPOCHLORITE GENERATION

Mussel growth in the desalinization units was an early operational problem. This was particularly troublesome in the spring of the year. After plant startup, facilities were installed to dose the incoming water with sodium hypochlorite solution. It was also found to be desirable to dose the flyash lagoons where coliform counts were of concern. With the rapid escalation in the price of sodium hypochlorite, it was decided to install an on-site sodium hypochlorite generation system. This system utilizes excess electrical energy generated in the plant and the adjacent salt water to generate sodium hypochlorite by an electrolytic process.

CONSTRUCTION EXPERIENCE

PLANT OPERATION

Throughout the entire improvement program, refuse operations were maintained at the Ocean-side Disposal Plant. As much as 1200 tons (1080 t) of refuse were received and weighed in a single day. One or two of the three furnaces remained in operation throughout the period. Material that could not be burned was disposed of in an adjacent landfill. Operating personnel observed appropriate safety precautions for a construction site. In short, the improvement program in an operating plant imposed additional responsibilities on all concerned which were successfully discharged.

BUILDING ADDITIONS AND STRUCTURAL MODIFICATIONS

In order to accommodate the electrostatic precipitators and the flyash handling system, a portion of the building between El. 42.0 and El. 75.0 was extended 26 ft (8 m) to the rear, as may be seen on Fig. 2. The extension was supported on pile foundations. In order to accommodate soot blowers for one of the boilers, a portion of the building sidewall was moved out 2.25 ft (70 cm). In order to accommodate the boilers and electrostatic precipitators, large sections of the 6 in. (15 cm) poured concrete roof slab had to be removed and new structural steel had to be added to support the portion of the slab left in place.

The boiler is supported on structural steel resting on the stoking floor at El. 16.0. The additional load on the stoking floor is transferred to the basement floor through new steel columns installed during the improvement program. The existing building columns were reinforced by plates to receive the additional loads from the extended portion of the building and the weight of the electrostatic precipitators.

In order to accommodate the siftings conveyor, large sections of the 1 ft (30 cm) thick stoking floor slab at El. 16.0 had to be removed, along with a 3 ft (0.9 m) by 3 ft (0.9 m) concrete beam and a portion of a 2 ft (61 cm) thick load bearing concrete wall. All of this may be seen by comparing Fig. 1 with Fig. 2. The loads borne by the concrete beam and the wall were transferred to new steel columns. Further, the original floor slab had been poured over an extensive electrical conduit system. All conduits in the affected area were identified and rerouted in the course of the improvement program while maintaining plant operation.

SPACE CONDITIONS

Even with the building additions and the removal of concrete floors and walls, there is no “extra” space in the improved plant. The space between the boilers for the two 300 tons/day (270 t/day) units is such that the retracting soot blowers must overlap one another. In fact, the retracted soot blower from one boiler virtually touches the adjacent boiler. With appropriate adjustments to the boilers, structural steel modifications, and piping rerouting, all the soot blowers have been fitted into the available space.

RIGGING

Because the improvement work was accomplished in an existing building, a number of unusual rigging problems were encountered. The boiler steam drums, which weighed 19 tons (17 t) each, had to be raised from grade at El. 11.0, to clear the roof at El. 75.0 and boomed in 60 ft (18 m) over the roof to the access opening. The existing induced draft fans and concrete vibration pads, which weighed in excess of 40 tons (36 t) each, were raised and moved 26 ft (8 m) to the rear within the building at El. 42.0.
GENERAL

The General Contractor for both phases of the improvement program was NAB Construction Corp. of College Point, New York. The total of all construction and material contracts for both phases of the improvement program was $9,802,435.00. The program was completed for less than the budgeted cost. A major portion ($3,380,000) of the final phase of the improvement program was funded by the New York State Environmental Quality Board Act of 1972 as an Air Quality Improvement Project. All other costs were borne by the Town of Hempstead.

OPERATING EXPERIENCE

CORROSION

As part of the Contract for the initial phase of the improvement program, selected tubes were ultrasonically monitored for thickness at intervals to determine if tube wastage was occurring. No tube wastage has been encountered in the furnace screen or the convection banks.

Readings from the furnace side of a selected 3¾ in (8.25 cm) screen tube in the center of the furnace outlet are:

<table>
<thead>
<tr>
<th>Date</th>
<th>Thickness Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/3/74</td>
<td>0.185 in. (4.70 mm)</td>
</tr>
<tr>
<td>4/23/75</td>
<td>0.190 in. (4.83 mm)</td>
</tr>
<tr>
<td>11/5/75</td>
<td>0.190 in. (4.83 mm)</td>
</tr>
<tr>
<td>3/12/77</td>
<td>0.185 in. (4.70 mm)</td>
</tr>
<tr>
<td>4/12/77</td>
<td>0.185 in. (4.70 mm)</td>
</tr>
</tbody>
</table>

Some tube wastage was detected on the furnace sidewalls immediately above the silicon carbide coating. This was attributable to less than optimum use of overfire air during the early stages of operation. To correct this situation, plant operation was modified to assure more effective use of overfire air. The level of silicon carbide coating was also raised 6 ft (1.8 m) to the elevation shown on Fig. 2. Subsequent tube thickness measurements have uncovered no further wastage [10]. The silicon carbide coating has held up well.

SLAGGING

The air-cooled walls have virtually eliminated the problem of uncontrolled slag buildup on the lower walls of the furnace. The original unit, without air-cooled walls, required a full or partial shutdown every few days to shed slag [4]. The improved units have never been shut down to remove slag from the furnace walls. However, structural failure of the air-cooled walls has been a problem. Cooling air is controlled individually to the 5 sections of the air-cooled walls has been furnace sidewall. Nevertheless, swelling of the silicon carbide blocks has occurred in the walls in the hottest zone of the furnace. These walls have been replaced with walls which incorporated improvements by the original wall designer. Based on satisfactory experience in other plants, we expect that these improved designs will significantly prolong the life of the walls.

TUBE FAILURES

Four tube failures have been experienced. The first tube failure was discovered at startup and was attributable to a torch cut — apparently made during boiler erection but after the hydrostatic test. Two tube failures occurred after more than 15,000 hr of operation. They were attributable to cutting from water which condensed in the sootblower system. The failures occurred near the sidewalk in the cavity between the furnace screen and the convection bank where the first sootblower in the blowing sequence enters the boiler. Five nearby tubes had also experienced some cutting. The problem has been corrected by maintaining the sootblower system under steam pressure at all times, realigning the sootblower piping to eliminate a point where condensate could accumulate, reducing sootblower blowing pressure to 75 psig (515 kPa gauge), and by installing tube shields on all 7 tubes where metal loss had been detected [10]. The fourth tube failure occurred after more than 20,000 hr of operation. The failure occurred on the exterior of the furnace where a casing plate was welded to the tubes and was apparently due to a stress concentration at this point. An attempt has been made to relieve concentrations at similar points on the other unit.

TUBE FOULING

At no time has fouling of the furnace screen tube section or the convection bank been a problem. Sootblowers are blown once per day and even with the reduced blowing pressure, ash has never accumulated on the tubes. No time has been expended in more than 3 years of operation.
since startup of the improved unit for hand cleaning or lancing of the boiler convection surface [10].

SIFTINGS CONVEYOR

The drag-type siftings conveyor has, with some adjustment during the shake-down period, enabled the units to operate indefinitely without shutdown to remove siftings. In contrast, the original sluicing system required a shutdown at least once per week to remove siftings that had plugged the sluicing system.

ELECTROSTATIC PRECIPITATOR

Applicable New York State emission regulations have been met without difficulty. Federal standards for new incinerators, which are not applicable to upgraded installations, have also been met. The results of compliance tests are:

<table>
<thead>
<tr>
<th>Unit No.</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Date</td>
<td>3/11/75</td>
<td>6/22/77</td>
</tr>
<tr>
<td>Firing Rate, lb/hr</td>
<td>31,800</td>
<td>12,600</td>
</tr>
</tbody>
</table>

**Emissions**

<table>
<thead>
<tr>
<th>New York State Part 222</th>
<th>34.0</th>
<th>17.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual, lb/hr</td>
<td>13.2</td>
<td>3.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>USEPA</th>
<th>(cor. 12 percent CO₂)</th>
<th>0.08</th>
<th>0.08</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual, gr/scf</td>
<td>0.045</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>(cor. 12 percent CO₂)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The mode of operation has been determined to have an effect on emission rate. Findings in this regard have been published [11]. Periodic inspections have revealed no difficulties with regard to metal corrosion or wastage in the pollution control equipment.

SODIUM HYPOCHLORITE SYSTEM

The sodium hypochlorite system is used to continuously dose the incoming water to the pump house at 1.5 ppm (equivalent chlorine) and to dose the flyash lagoon at 12 ppm (equivalent chlorine). The system has performed well.

DISCUSSION

METAL WASTAGE

Several years of operation demonstrate that with effective use of overfire air, judicious use of protective coatings, and conservative volume and velocity in the furnace and convection bank, tube wastage need not be a problem. The potential for tube wastage remains, however, if the unit is not operated in a conscientious manner.

SLAGGING

Cooled walls along the grate line shed slag effectively. However, design of these walls is critical and more work is required in this area to develop an optimized solution to this problem.

FOULING

Careful selection of tube configuration and spacing to achieve conservative gas velocity along with propitious location of sootblowers can eliminate convection bank tube fouling in incinerator boilers.

STACK EMISSIONS

A two-field electrostatic precipitator following a well operated furnace and boiler appears to be more than adequate to comply with present Federal regulations.

CONTROLS AND INSTRUMENTATION

Controls and instrumentation to automatically control feed water flow, steam pressure and draft while requiring a certain amount of operator attentiveness in controlling the burning bed appear to be a practical means of achieving effective operation of an incinerator boiler.

GENERAL

All of the specialized equipment described in this paper were designed and manufactured in this country by firms that have drawn on their prior experience as well as experience gained wherever municipal solid waste has been burned and steam has been generated. These firms include Beaumont Birch Company, Drake Block Co., Inc., Englehard Industries, Flynn & Emrick Co., Hays-Republic, Honeywell, Inc., Precipitair Pollution Control, Riley-Beaird, Inc., Wheelabrator-Frye Inc., and Zurn Industries Inc.

CONCLUSION

The years of operating experience at the Oceanside Disposal Plant demonstrate that steam
can be effectively generated from combustion of unprocessed municipal solid waste utilizing equipment designed and manufactured in this country.

REFERENCES


Key Words
Combustion
Corrosion
Domestic
Furnace
Slag
Waterwall
Before discussing the paper at hand, it is worthwhile to digress briefly into the historical perspective of the Oceanside Plant, which has contributed greatly to the advancement of basic resource recovery. This paper represents another chapter in the saga of this venerable plant.

As pointed out by the authors, the Oceanside Disposal Plant was the first plant in the United States with continuous feed furnaces which produces steam and electricity from combustion of municipal solid waste. Oceanside was a painful experiment which provided a great deal of information at the bottom of the learning curve regarding steam generation from refuse. Oceanside provided the laboratory for the contributions of such notables as Kaiser, Velzy, McCafferty and Dvirka.

This paper shows that Oceanside is alive and well in 1978 and is likely to provide much further service. The paper provides a good professional summary of the years of work which have converted Oceanside from an early experiment into a modern generating plant. It provides a loud and clear message; in order to provide modern boiler service and reliability, it is necessary to forget all the shortcuts and redesign an existing facility to accept modern generating equipment together with modern air pollution control devices.

This sounds expensive, but the cost quoted in this paper indicates that \$9,802,435/750 ton/day = \$13,070/ton/day \( \text{[$14,407/t/day]} \), which is not a bad price if the steam was only condensed and not sold. This type of conversion may have economic appeal for an older incinerator at the right site.

The paper describes the various phases of activity and generally outlines well the entire project. I would have preferred to see a few tables or more discussion of the basic data of the last two years operation, such as quantities of steam, electricity or water desalted, heat balance, efficiencies, a breakdown of the costs of modifications, use of the products and their value. More data could have been given on air pollution testing. The data is particularly necessary since this paper generally states that an old incinerator can be upgraded to almost new if good engineering and the necessary capital are available. If much of this data is not yet available, then we shall have yet another interesting chapter to the “Oceanside Saga”.

AUTHORS’ REPLY

To Leonard F. O’Reilly

Mr. O’Reilly’s kind words regarding our paper are appreciated. As far as subsequent chapters to the “Oceanside Saga” are concerned, we plan to continue publishing papers as data and experience dictate. In fact, the next chapter, which includes data regarding unit availability, was presented by Charles O. Velzy at the recent “Unit Operations in Resource Recovery Engineering” Conference held at Franklin Pierce College in Rindge, New Hampshire. The paper was entitled “30 Years of Refuse Fired Boiler Experience”.

One final comment regarding our “Conclusion” is perhaps in order. It certainly was not our intent to denigrate the ongoing contributions by our colleagues in Europe, Canada and elsewhere. We merely feel that it has been demonstrated that experience with equipment designed and manufactured in this country should now be considered along with theirs. Further, we sincerely hope that our experience may be of benefit to them and be a small repayment for their data and experience that continues to be so generously shared with us.