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Project Summary

Summary Report on Corrosivity Studies in Coincineration of Sewage Sludge and Solid Waste

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Corrosion probe exposures were conducted in the Harrisburg, Pennsylvania Incinerator to determine the effects of burning low-chloride sewage sludge with municipal refuse. Probes having controlled temperature gradients were used to measure corrosion rates for exposure times up to 816 hours. The effects of exposure time, metal temperature, and gas temperature were studied. The results demonstrated that the addition of the sludge reduced the initial corrosion rates of carbon and low-alloy steels to about half of that from refuse alone. Little effect was observed on the rates for Types 310 and 347 stainless steel. An aluminized coating on steel resisted corrosion effectively and offers promise as a cost-effective substitute for expensive alloys. In the range 260-482°C (500-900°F), corrosion rates were significantly reduced and were less dependent on metal temperature. The addition of sludge to refuse is recommended as a corrosion prevention measure and a waste disposal technique.

This Project Summary was developed by EPA's Hazardous Waste Engineering Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Background

Construction of the Harrisburg Incinerator was started on December 22, 1969, and it began operation in October 1972. This facility has two identical boilers, each with a nominal capacity of 327 Mg/day (360 tons/day) of refuse. At this rate of 13.6 Mg (tons) of refuse per hour, the normal steam production is 42.0 Mg/hr (92,500 lb/hr) with a peak of 54.5 Mg (120,000 lb). Design values are also generally maintained for superheater steam quality of 18.6 kg/cm^2 (250 psig) outlet pressure at a temperature of 236°C (456°F). These two multidrum boilers with welded waterwalls are fed from a single refuse pit and are exhausted through individual electrostatic precipitators before discharge into the single stack.

Figure 1 shows the location of the superheaters where the first tube failure occurred and where the corrosion probes were located for this study. Although Boiler Unit No. 1 started in operation (October 1972) before Unit No. 2, the shortest-lived superheater tube was in Unit No. 2 where a failure occurred after about 3000 hours. It failed with a ductile split several inches long while the wall thickness of adjacent tubes was reduced to 0.051 cm (0.020 inch) from their original 0.42 cm (0.165 inch) wall. Wall thickness of tubes remote from the soot blower was reduced to about 0.38 cm (0.150 inch). By March 1974, the entire bank of carbon steel superheater tubes had been replaced with T22 alloy. Fortunately, by this time the effect of soot blowing on metal wastage had been recognized and the blowers were used sparingly. Then in June 1975 the burning of sewage sludge with the refuse was begun, and this mode of operation has continued to the present.

Prior to delivery to the incinerator the sludge is processed conventionally. Wastes from the entire city and some of

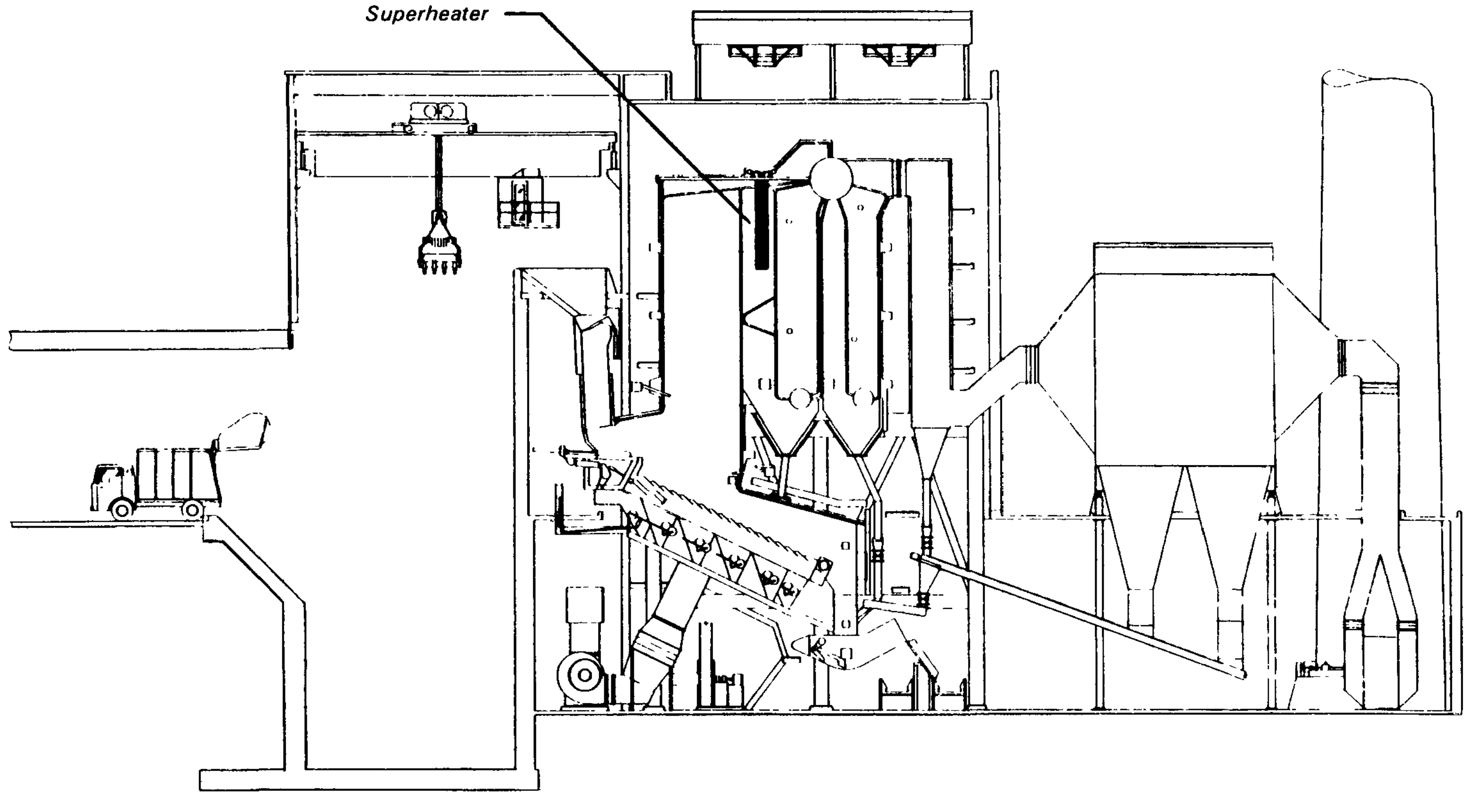

Figure 1. Harrisburg, Pennsylvania, refuse burning facility.

the adjacent regions are treated first by grinding, grit removal, and preliminary settling. Subsequently anaerobic digesters are used with a polymer treatment to thicken the supernatant liquid. The coagulant used in the sludge treatment process is an organic-based filter aid, employed at the rate of 12.3 kg (27 lb) per 4545 kg (10,000 lb) of dry solids. As this organic polymer is probably a combination of amines and acrylates, it is much more suitable for use in sludge to be incinerated than is ferric chloride, which was used previously.

About 13.6-18.2 Mg (15-20 tons) of partially dried sewage sludge are delivered by truck to the incinerator every 24 hours, and the sludge is dumped onto the refuse in the pit. This material contains 20-22 percent solids, so the incinerator handles the equivalent of about 4500-5500 kg (5-6 tons) per day of dry solids. During the course of these corrosion studies the partially dried sludge was delivered at an average rate of 15,000 kg (16.5 tons) per working day.

Introduction

Corrosion of boiler tubes has been a significant problem for waterwall incinerators in which bulk refuse is burned, particularly if superheated steam is generated. During the initial operation of the Harrisburg, Pennsylvania Incinerator, when only bulk solid waste was burned, tube failures occurred every three to five months. However, for the past two and a half years no tube failures have occurred, but during this period municipal sewage sludge has been burned along with the solid waste. In addition, soot blowing was reduced in frequency and some of the carbon steel tubes were replaced with a low chromium alloy. Consequently, the reason for the reduced metal wastage at the Harrisburg Incinerator was uncertain and corrosivity studies were needed to evaluate the effect of adding the sewage sludge to the refuse combustion environment.

As currently practiced, the dewatered sludge filter cake containing about 22 percent solids is mixed with the municipal refuse in the receiving pit. Considerable mixing occurs in the pit before the sludge and refuse are fed into the furnace charging chute. The weight ratio of sludge to solid waste is about 1 to 10 on an as-received basis, and it seemed likely that the sulfur and silica in the sewage sludge are present in sufficient quantity and are burned effectively to overcome the corrosive effects of chlorine in the refuse.

The objective of this research program was to determine the effect of the addition of low chloride sewage sludge to municipal solid waste on the wastage rates of boiler tube metals. Both short- and long-term wastage was measured during this program

Conclusions

Corrosion probe exposures conducted at the Harrisburg, Pennsylvania, Incinerator demonstrated that the addition of low-chloride sewage sludge to municipal refuse reduced the corrosion of susceptible metals caused by chlorine in the refuse. Specific conclusions from this research program were:

1. The corrosiveness of the refuse combustion environment to carbon steel as indicated by 8-hour exposures was only one half as great with sewage sludge present. Less reduction occurred with T22 steel, although the corrosion rate with sludge was the same as that for carbon steel. Very little reduction

occurred with Incoloy 825 and essentially none with Types 310 and 347 stainless steel, which have very low corrosion rates with refuse alone.

2. The corrosion resistance of alloys to the refuse-sludge combination in decreasing order was Incoloy 825; 310 stainless steel; 347 stainless steel; T22 low chromium alloy; and A106 carbon steel. A diffusion-bonded aluminum coating on steel remained intact during the exposures and could be a cost-effective alternative.
3. The corrosion rates decreased with exposure time in the presence of sewage sludge and appeared to level off at about 1000 hours.
4. For carbon and low alloy steels the corrosion rates increased with metal temperature in the range 260-482°C (500-900°F), while those for stainless steel decreased.
5. The short-term corrosion rates at gas temperatures of 593-649°C (1100-1200°F) were only one-fifth as great as at 815°C (1500°F) and showed less increase with metal temperature.
6. The increased superheater tube life at the Harrisburg Incinerator is the result of (1) addition of sewage sludge, which contributes large amounts of SiO_2 to the combustion environment; (2) reduced frequency of soot blowing, leaving protective oxidation products on the metal; and (3) use of T22 alloy tubing, which showed greater resistance to corrosion than carbon steel when the refuse was burned without sludge.

Recommendations

As a result of this research program, it is recommended that cofiring of sewage sludge with municipal refuse be encouraged as a means of reducing corrosion of heat recovery surfaces and at the same time providing sludge disposal. However, it should be pointed out that the sewage should not have been treated with ferric chloride, because the chloride residue in the sludge would promote corrosion.

It also is recommended that boilers intended to burn refuse be designed so that gas temperature in the superheater zone is as low as possible. In this way superheater metal temperatures can be used with little increase in corrosion. The design should also provide combustion air in a manner that will minimize carbon monoxide formation near tube metal surfaces.

The corrosion resistance of aluminized coatings on carbon steel to the refuse combustion environment should be investigated more extensively. This type of coating offers a less expensive alternative to high chromium-nickel alloys to obtain longer tube life in refuse burning.

The use of silica as an additive to combat corrosion from refuse burning should be investigated. The beneficial effect of the sewage sludge observed in this program can be attributed in part to the silica content, because the total sulfur in the system was not great enough to account for the corrosion reduction.

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The complete report, entitled "Summary Report on Corrosivity Studies in Coincineration of Sewage Sludge and Solid Waste," (Order No. PB 85-243 731/AS; Cost: $11.95, subject to change) will be available only from:
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