

LEARNING FROM FIRE SIDE FURNACE-BOILER CORROSION EXPERIENCES

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The Hampton Refuse-Fired Steam Generating Facility, a joint project of the Federal Government-NASA Langley Research Center, Langley Air Force Base, and the City of Hampton, Virginia, has been on-line since November of 1980. This 200 TPD system, consisting of two 100 TPD trains producing saturated steam for the government, has encountered unique experiences from which the waste-to-energy industry can learn. The most prevalent problem is acid corrosion in the furnace-boiler sections, mostly caused by chlorides and, to a lesser degree, by sulfides, nitrides, and other halogens found in the fuel source. Much knowledge has been gained toward reducing and controlling this continuous threat.

The situations and solutions summarized below affect the following areas of the waterwall furnace-boiler trains:

- (a) Refractory Zone.
- (b) Boiler Tube (Fire Side).
- (c) Economizer Tube.
- (d) Boiler Casing.

REFRACTORY ZONE SPALLING

Several years ago, it was established that the waterwall tubes of a refuse furnace should be protected from

chloride or acid corrosion and flame impingement by covering them with a special heat transfer refractory up to a level just above the overfire air nozzles, or about one-half the height of the furnace. A castable silicon carbide refractory was used at the Hampton facility, originally applied by forming and pouring over studded tubes. This proved unsatisfactory because acid vapors permeated through the very porous castable refractory material, condensed and attacked the securing stud material. The studs, made of a 430 stainless steel material, provided poor thermal conductivity. The studs corroded and the refractory spalled off the side wall tubes within about 18 months of operation. Other areas deteriorated more slowly. It appears that the deterioration rates were related to temperature and location within the combustion zone.

To provide for better thermal conductivity, carbon steel was used. The stud pattern was increased from 1 1/2-in. to 1-in. centers and changed from alternating 0 deg. and 45 deg. from center to alternating 22 deg. and 45 deg. from center. This provided a better mechanical interlocking bond with the refractory. The silicon carbide refractory is applied by the gunite method to achieve better density control in the finished product. This method proved successful and is specified in all refractory repairs or additions. This technique has been adopted by vendors in the refuse boiler industry.

BOILER TUBE (FIRE SIDE) CORROSION

Two waterwall tube ruptures occurred after about three years of operation. These ruptures were on the fire side of the tubes, just above the silicon carbide, one on each side of No. 1 Boiler. Laboratory analyses confirmed that the ruptures were caused by acid corrosion. Extensive ultrasonic tube testing was conducted in the upper half of the waterwall furnace and steam generator. A general thinning of the tubes was documented, with the worst area being just inches above the protective silicon carbide coating. Ultrasonic testing was performed periodically to track the rate of deterioration. During the following year, many sidewall and bridgewall tubes ruptured due to the fire side corrosion phenomenon.

After 4 ½ years of operation, all bridgewall tubes (approximately a 10 ft section) in front of the steam generator were replaced; all sidewall tubes, in both furnaces, were replaced in the area just above the silicon carbide coating up to 8 ft long sections. Studs and refractory were applied to protect this new section. Some thinning was also found in the steam generator where the tubes are sprayed by steam from soot blowing. The soot blowing schedule was reduced to once per day to reduce the rate of deterioration. After seven (7) years of operation, approximately 180 tubes were replaced in each steam generator in the area of the soot blower lanes. Stainless steel shields were installed on the new tubes for protection.

ECONOMIZER TUBE FAILURE

A typical example of dewpoint corrosion occurred within the third year of operation in the No. 1 boiler economizer, due to a mechanically faulty steam soot

blower. After two tube ruptures occurred in the lower section of No. 1 economizer, it was found that the soot blower element was not rotating on the inside of the casing. The steam was being directed to one isolated section of tubing, thus causing a chain reaction of ruptures, each an aggravating situation. After nine tube ruptures and subsequent extensive ultrasonic testing in that section, the complete lower section of the economizer was retubed. There has been no further recurring rupture or documented tube thinning in that area. In addition, an increased preventative maintenance program was initiated on the soot blowers.

BOILER CASING CORROSION

The outer casing of both furnaces in the area from just above the silicon carbide to the steam generator outlet was destroyed by hydrochloric acid dewpoint corrosion within the first two years of operation. The outer casing, made of 10 gage steel, was exposed to ambient temperatures (100°F) with furnace temperature ranging from 1500°F to 750°F. The insulation next to the casing was soggy. The chlorides permeated through the block and insulation, passing through the dewpoint, and condensing to HCL on the inner side of the outer metal casing. All damaged metal casing was first repaired or replaced, then the furnace casing temperature was raised to above the HCL dewpoint of 175°F. By applying 3 in. of insulation to the outer casing, then installing a lagging with a 3 in. air space between the two, a casing temperature of approximately 300°F was achieved. With this approach, the life of the furnace casing was increased considerably. A better, but more expensive, solution would be to use membrane wall construction.