UPDATE ON NASHVILLE THERMAL

MILTON E. KIRKPATRICK
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Discussion by

R. B. Engdahl
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The author is rightfully proud of his plant and that plant’s owner is fortunate in having his firm perception and experience to guide it. He had no part in the design mistakes that have now been largely surmounted, and that have been detailed in the many references he cites. One point of uniqueness should have been added: This is the only place in the world where a significant number of large downtown office buildings are both heated and cooled by the energy from a very difficult fuel — garbage, and it’s encouraging to know that with municipal support equivalent to a tipping fee of approximately $8.00 per ton and the generous steam price of $6.00 per thousand pounds, this plant is paying its way while providing a clean method for waste processing. Historically it is a source of some amazement that the plant began operation with no tipping fee at all!

The author is also rightly proud of his plant as an achievement of American technology. However, that good pride must in this instance bear some blemish because it failed to utilize some vital European know-how. It was needless to start this plant up in 1974 without studs and silicon carbide protecting the lower furnace walls. Long experience in Europe had demonstrated that no high-temperature steam-generating plant could operate for long without wall tube protection for 20 or 30 ft above the grate. Norfolk and other low temperature plants have been able to do it. The critical factor seems to be the temperature of the chloride deposit resting against the tubes as detailed in the research of Vaughan, Krause and colleagues. As the author points out, since the first wall tube failure after only 1000 hr, the addition of silicon carbide protection has been very satisfactory.

Regarding the continuing corrosion higher up in the boiler, the author reminds us that all fossil-fuel fired boilers have some tube corrosion. True, but not this much, and although a few very perceptive designers in Europe knew at the time this plant was designed, that superheaters can avoid corrosion if they are remote or protected from flame, high temperature radiation, and very hot furnace gases, that fact had not been spelled out in any publication and, hence, was not understood in the U.S.

Based on the successful avoidance of superheater corrosion at Zurich-Hagenholz, Oberhausen, Winterthur, the Hague and various other plants, even when generating superheated steam ranging from 730 F to 900 F, it seems now to be well demonstrated that only those high-temperature plants escape rapid superheater corrosion which have their superheater located in the second or third pass. Also, sometimes the superheater is protected by an upstream bank of evaporator tubes.

In view of this experience, it appears to me very likely that the Nashville superheaters, which are in an exposed position, will always suffer high cor-
rosion rate. The search for protective coatings should continue. For one thing, the design for remote location is more expensive. Hence, if the more compact design as at Nashville could be made corrosion free by coatings, the saving in boiler capital cost would be worthwhile.

Another protection against superheater corrosion that has been learned by many European operators is: don’t overload the boiler-furnace; don’t push it too hard. The point here is that MSW is often a distressingly variable fuel. If the boiler is pushed to the limit continually, there will be many “excursions” where excess burning will cause flame to extend into the first pass. During such excursions, if the superheaters are in the furnace, or in the first pass, corrosion can be rapid.

Discussion by

Robert S. Rochford
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North Canton, Ohio

Mr. Kirkpatrick’s paper describes a success story — how a community takes its solid waste and recovers its energy values and supplies steam and chilled water to a municipality in an environmentally acceptable way. We agree with his assessment that this is a financially sound project which is doing the job it was intended to do. We know Mr. Kirkpatrick has been asked repeatedly to give details on how he accomplished this task, and he has obliged in this account.

While he and his people have done an exemplary job of managing, operating and maintaining this system and appear satisfied with its performance, we as suppliers of the boilers and burning equipment are not satisfied with the maintenance and availability of the equipment furnished. Changing the stoker feed mechanism from a reciprocating grate to a ram feed and making changes to the overfire air system have greatly improved the combustion in these units. Recommended additional changes to the overfire air system would undoubtedly show further improvements. We believe the general furnace shape of the Nashville units is good from a combustion standpoint, and the gas pattern across the superheater and boiler bank is very desirable when considering distribution and cleanability.

The two boilers at this plant are operated in the same way they are operated all over the world. Plants that are required to dispose of waste and produce a continuous and reliable supply of steam must have a standby refuse boiler upon which to rely. This is what is done at Nashville but, unfortunately, in doing this, one boiler must carry the total load and, in doing so, is frequently forced to operate at greater than design throughputs and higher than design steam flows on refuse. We believe this is one of the main causes of the high maintenance experienced at this facility.

As Mr. Kirkpatrick pointed out, these units were designed to have the capacity to burn 360 tons of refuse/day when burning 6000 Btu/lb waste, which is a relatively high heating value material. Under these conditions, the steaming capacity of each boiler was 109,000 lb/hr. Because of the high demand on this equipment, Mr. Kirkpatrick has increased each boiler’s rating to 530 tons/day and 125,000 lb of steam/hr when burning 4500 Btu/lb refuse. Under these conditions, the stoker’s burning rate is higher than intended, the fuel’s residence time in the furnace is reduced, and the design furnace exit gas temperature and gas velocities throughout the unit are exceeded. If B&W had known the units were going to be required to operate under these conditions, we would have considerably increased the size of the stoker, furnace and boiler.

Mr. Kirkpatrick has told it the way it is in this status report on Nashville Thermal and has done it in a positive vein. In reading the paper, it is obvious he and his staff are strong advocates of this approach of recovering energy from waste and that this is a reliable way of supplying a city’s heating and cooling needs.

Discussion by

D. C. Reschly
Detroit Stoker Company
Detroit, Michigan

We wish to commend the management and operating staff at the Nashville Thermal Plant for their achievements. We believe the experiences at this plant demonstrate that good management and a skilled, well trained operating crew is of primary importance in a plant such as this.

Changing economic and environmental conditions have severely impacted the operation of this plant since it was originally conceived and designed and the fact that the management of the plant has been able to respond to these conditions while
maintaining their record of service is a tribute to them.

In the original design of this plant, the stokers were to be rated at a nominal burning rate of 300 tons/day based on a typical refuse having a heating value of 4,500 to 5,000 Btu/lb. During the design and bidding stages of the plant, this rating was increased to a burning rate of 360 tons/day based on 6,000 Btu/lb refuse. The increased rating was necessary to make the plant economically feasible and the relatively high heating value of the refuse was based on the assumption that the downtown location of the plant would result in a higher percentage of dry, high Btu fuel consisting largely of paper and cardboard.

It was also anticipated that normal operation would involve burning both refuse and natural gas in combination and that peak loads over the nominal rating for refuse firing would be obtained by burning natural gas. The original design ratings of the boilers were 135,000 lb of steam per hour firing natural gas or #2 oil and 109,000 lb of steam per hour when burning 360 tons/day of refuse having a heating value of 6,000 Btu/lb. When burning refuse having only 4,500 Btu/lb, the design rating of the unit was 113,000 lb of steam per hour with 77,400 lb of steam from the refuse firing and 35,600 lb of steam from the auxiliary gas or oil firing. By the time the plant was actually built, the energy situation in the United States had substantially changed and it became uneconomical to burn either natural gas or oil, except under emergency conditions.

In order to avoid burning auxiliary fuel, Nashville Thermal has now rerated these units as indicated by this paper to a rating of 530 tons/day during cold weather based on 4,500 Btu/lb refuse with peak ratings up to 590 tons/day.

This 530 tons/day rating results in a burning rate on the stokers of 107.5 lb of refuse per square foot of grate and a heat release of 16.6 million Btu/ft of stoker width. These burning rates are far beyond design ratings on any stoker fired units and the fact these ratings can even be achieved on a continuous bases with reasonable satisfactory results is surprising and again, a tribute to the operating skills of the Nashville operating staff.

These overload operating conditions have obviously had a severe and substantial affect on the maintenance costs and reliability of the equipment in this plant. At overload ratings 75 percent above design ratings it is difficult to predict how much impact this has had on these costs. The other item which has had a substantial affect on the life and operating costs of this equipment was the initial operating conditions with the scrubber. Scrubber modifications added in an attempt to meet polution requirements forced the units to operate with insufficient draft at overload conditions since environmental restrictions only allowed operating one unit at a time. These overload conditions with a pressurized furnace and low excess air greatly increased maintenance costs and shortened the life of the stoker and contributed to the high maintenance costs and relatively low availability of the firing equipment.

Experience at Nashville points out the importance of matching the capacity of the boiler units and the number of units to provide sufficient capacity for the maximum load requirements and allow for maintenance of the units, without requiring overload conditions or auxiliary fuel firing.

**AUTHOR'S REPLY**

I seem to have missed the key points of our operation. First, our normal steady state steam rate on the incinerator boilers is 100,000 lb/hr. On the times when we do have additional loads on our system we do increase the steam rate to 125,000 lb/hr. We still regard this as well within the design capability of the unit and feel it prudent to have increased the rating on solid waste to the original rating on gas or oil.

Second, our combustion process is significantly improved. We maintain an oxidizing atmosphere in the furnace, and the flame is now maintained below the level of the silicon carbide, i.e., the lower 20 ft in this 50-55 ft high furnace. This same condition applies at any steam rate up to the maximum.

It is certainly true that stoker and grate maintenance costs are higher than any of us would like, but it is worthy to note the significant difference in the design of our stoker vs. the heavier sections throughout in the German technology.

**ERRATA**

On page 456, the last paragraph, second column, fourth line from the bottom, the sentence should read “The combustion process” instead of “The combination process”.

On page 458 in the Section called “Superheaters” the 15th line should read “field installation vs shop installation.” instead of “field installation or shop installation.”