DESIGN CONCEPTS TO MINIMIZE SUPERHEATER CORROSION IN MUNICIPAL WASTE COMBUSTORS (An Overview)

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This paper provides numerous helpful hints toward avoiding tube wastage. The emphasis on erosion as an important effect on tube wastage is worth special attention. And the important point is made that even when gas flow velocities are modest and well distributed, tube-bank fouling can redistribute the flow in a way that causes excessive localized velocity and erosion. The recommended rapping of vertical tubes has merit if the deposits are soft and not tightly adhered. However, if tube slagging is encountered, rapping may not be enough.

The merit of the multiple, open-pass arrangement preceding the superheater is now, after more than 20 years of use, well established for abatement of superheater corrosion. The first large furnaces using this conservative design feature were by Martin at Issy-les-Moulineaux in 1965. However, the authors fail to mention that this benefit is expensive. The total boiler is bigger and the open passes provide relatively low-rate heat transfer.

The goal of minimum CO is worthwhile, but the authors overemphasize its effect on corrosion. After all, MSW introduces H_2O vapor, an oxidizer, plus CO_2, also an oxidizer, and usually there is 7–9% O_2 (70,000–90,000 ppm O_2!). Hardly a reducing atmosphere.

Where flame impinges on walls or tube banks, the reducing condition and the high temperature within the flame can surely cause corrosion. That's why the lower water walls in mass burners must be protected by refractory. In RDF furnaces, the temperatures in the suspension burning area are lower, there is little flame impingement on the lower furnace walls, and wall coating for protection is unnecessary. I am puzzled that the authors think the ceramic lining is necessary as thermal insulation. Why insulate expensive boiler surface? It really is there to protect the lower wall tubes from flame impingement and corrosion.

While there is ample discussion in this paper of the well-known mixing benefits of costly multiple radiant gas passes, there is only the briefest reference to overfire air. This casual neglect is still common, and is too often carried over into insufficient designs — not enough jets, not enough levels of jets and inadequate overfire air pressures. Such neglect can result in chronic incomplete combustion and long flames, a frequent cause of corrosion.

Discussion by

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The authors have provided a very informative overview of design concepts that could be used to mitigate corrosion and erosion problems. These concepts might be better supported, however, if the referenced research program data and pilot plant/commercial plant data were published with the paper. This would allow a better understanding of the benefits and costs resulting from the implementation of these recommended concepts.

Some of the proposed design concepts require further evaluation in order to determine whether they are truly optimum for a specific application. An example is the recommendation that the flue gas emerging from the combustion chamber be limited to 1300°F before entering the convection passes. I am aware of several installations that use a design exit gas temperature as high as 1600°F. A lower exit gas temperature would certainly minimize the risk of deposition and corrosion, but will also require additional surface area. As an alternative, the tube materials in the first one or two rows could be upgraded, thus allowing the superheater section to be placed in a zone of higher gas temperatures.

A quantitative presentation of operating experiences and benefits associated with the proposed design concepts would greatly assist in determining whether they are appropriate and cost effective for each application.

Discussion by

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It is agreed that good combustion techniques and proper boiler design will minimize the potential for fireside corrosion and erosion problems in MWC superheaters. However, the importance of multiple radiant gas passes is overemphasized. The paper states that multiple passes serve the functions of minimizing gas stratification, shielding from radiant heat and reducing superheater fouling by the fallout of large fly ash particles from the gas stream. These deficiencies can be overcome without the need of multiple passes.

Minimizing gas stratification is accomplished by a furnace design utilizing lower furnace arches and total combustion air control. Shielding the superheater from radiant heat is readily achieved by the use of a upper furnace arch with the superheater directly above. Finally, superheater fouling and cleanability is directly effected by tube spacing and the on-line cleaning system. It is agreed that as far as ensuring uniform tube cleaning, a mechanical rapping system is the preferred choice.

Discussion by

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This paper is a contribution to the field in that it collects in one place many of the lessons learned over the past 20 years on design of boilers for service in energy-from-waste plants to mitigate corrosion of metal tube surfaces exposed to the combustion gases. The fact that such a paper was written indicates to me that this problem, recognized some 20 years ago, has not disappeared, as some would have us believe. However, as the paper points out, the adverse impacts of this operational problem can be minimized by application of proper engineering design.

One point mystifies me in the paper. In the Section on Incomplete Combustion, third paragraph, the authors indicate they can achieve a combustion efficiency of 99.95%. I believe they should define what they mean by "combustion efficiency" in this context. It certainly could not be the "efficiency" of conversion of heat in the waste to useful energy.