STUDY OF A MSW INCINERATOR: OVERALL OPERATION AND ON-SITE MEASUREMENTS OVER THE GRATE

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Discussion by:

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I enjoyed reviewing this paper. It presents previously unavailable information that can be used, as the authors point out, to test theories and validate models. It also suggests a solid waste composition estimating model which will be a useful departure point for further development.

When profiling the CO inside the Hagerstown spreader stoker equipped boilers firing a mixture of coal and dRDF in 1976, we went to great lengths to make sure that the cooling water inlet discharged near the tip of the probe and the gas suction point was ground smooth with the cooling jacket. We had been told by Argo Krauss (then 74 and long retired from Detroit Stoker) that when he was profiling boilers in the early 1920s the conversion of CO to CO_2 was catalized by steel probe tips operating near furnace temperatures and stainless steel exacerbated this phenomena. Would the authors please describe their furnace probe including tip details, metallurgy and cooling water temperature, path and flow rate?

The authors traversed the furnace along the bed length. Both at Hagerstown and while temperature profiling the furnaces in Long Beach California (SERRF), a "bonfire" type convective profile was observed over the outer 10–20% of the furnace width even though the fire's profile appeared square to the eye. Have the authors done any traverse profiling to establish the presence of such a zone?

The authors point out that tars may have deposited in the water-cooled probe or removed in the condenser. Were the tars extracted and the probe wash and the impinger catch analyzed? Is the quantity or energy content of these organics significant compared to the other sources of uncertainty based on the propagation of errors analysis?

Regarding the simplifying assumptions used to back-calculate the fuel ultimate analysis, the authors are to be commended for carrying as many variables as long as they could and only using simplifying assumptions when further progress was impossible without simplification — use simplifying assumptions too early and the problem can be defined away.

Given this attention to detail, I wonder why the authors did not calculate excess air directly from the measured flue gas oxygen and carbon dioxide and use this value to check their results? I also noticed that the paper does not verify the internal consistency of the estimated heating value and the calculated composition using formulas like the Von Draek equation (applies to high oxygen fuels like solid waste). Such checks are routinely used to validate the plausibility of field and laboratory analyses. The reported approach of comparing the calculated and published results provides confirmation only if the published waste compositions are similar to those burned at the facility. Since a major outcome of this approach is to be able to estimate elemental composition without extensive sorting and laboratory work, a simultaneous method validation study is indicated.

The authors are to be congratulated for using engineering theory and experimentation to produce such a thought-provoking piece of work. I am looking forward to reading and using their future papers.

AUTHORS' REPLY

We thank Dr. Rigo for taking his time to read our paper carfully and suggesting ways of improving it. We did not, in fact, think of the catalization of CO to CO_2. We suspect that it is of a small magnitude. We have not come across any references on the subject. Unfortunately, our main concern was keeping the probe from overheating due to the fact that it was almost 10 m of stainless-steel pipe inside a hot furnace!

We did not make transverse measurements, but we believe the point made is very interesting to pursue. It so happens we took the same types of measurements over a wood chips-fired boiler of a similar grate design. The measurements were made at three points aligned in the transverse direction. When we inspect the results I will certainly look for this "bonfire" phenomena. This seeming interesting, we will publish these data as well. Going deeper into the analysis of the data will reveal what is happening on the grate itself.

The tars were not extracted nor analysed. Even though the quantities might be small and their calorific contribution low, I think this matter should be pursued. Perhaps we can take a few extra measurements, to at least get an idea of the magnitude of tars and pyrolysis oils. From a theoretical point of view, analysing this tar will give further clues to the decomposition processes occurring in the bed.

The co-worker who has done the physical flow modeling did calculate excess air from the measured flue gas composition. This results in

$$EA = 20.9/(20.9 - 5.57)*100 - 100 = 56.8$$

This compares very favorably with the value in the paper calculated by the given method of 56.6%

We calculate now the waste heating value by the Vondracek formula. Please consider that we have not accounted for Cl, N, or S. The Table below gives the results using two different ash fractions: the one derived in the study and a higher one. Recall that the uncertainty on this value is very high, as we have not measured the ash output.

This would indicate that the ash fraction used in the study was too low. For 20% ash content, there is an acceptable agreement between the two higher heating values.

Ash	12.4 wt %	20 wt %
HHV, measured	10,700 kJ/kg	–
HHV, Vondracek	12,745 kJ/kg	11,087 kJ/kg