THERMAL DeNO$_x$ EFFECTIVENESS DEMONSTRATED IN A WOOD-FIRED BOILER

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In the abstract, the author advises he will describe the facilities, assess performance, and assess the cost-effectiveness of the DeNO$_x$ installation. The paper was based on the actual test data obtained at the Pacific-Ultra Power Chinese station wood-fired facility. However, the paper as presented is a discussion of the modeling, rather than a discussion of actual data.

In describing the facilities, the author provides some information in addition to a schematic of the facilities. However, other information which would have been quite useful to the reader concerning the actual residence time in the reactor and at what temperature this residence time occurred was omitted. Later in the paper, the author describes variations in DeNO$_x$ performance due to increasing or decreasing flue gas temperatures, and again there is no data on the temperatures, and in fact we don't even know which case had the higher flue gas temperatures. Was it case 3 or case 4? And how were the temperatures varied? Was it by increasing the excess air?

The paper would have been much more informative had more on-line test data been reported and less time spent discussing the kinetic model on the facility.

The conclusions reached by the author show the Thermal DeNO$_x$ to be a very cost-effective method for controlling of NO$_x$. In the light of numbers utilized by various air districts in California to determine cost-effectiveness of NO$_x$ control, I agree with the author's summary in which NO$_x$ reductions were achieved in a very cost-effective manner. However, it becomes somewhat difficult to arrive at other conclusions made by the author when most of the data needed is not included as part of the paper. I would suggest that the information obtained during the testing of this facility be condensed and presented in a form which shows actual test numbers on NO$_x$ before and after ammonia injection, either by sampling ports upstream and downstream of the ammonia injection points or by running the facility with and without ammonia injection. Similar data should also have been generated showing the variations in particulate emissions with and without ammonia injection so that the author could then show data substantiating the statement that there was no impact on the operation of other flue gas cleanup equipment, in particular the electrostatic precipitators. The conclusions the author discusses in which he refers to Fig. 3 and Table 4 are not all conclusions based on test data, but in the case of the first two items are conclusions based on his kinetic model.

In assessing the cost-effectiveness the author has taken the most effective test point as the condition about which to draw his conclusions on cost-effectiveness. Specifically he has taken Test No. 5 which achieved, according to data, an 80% reduction at an NH_3/NO_x mole ratio of 4 to 1. At the same mole ratios, and with just slightly lower temperature conditions, the data shows 64% and 66% effectiveness of the $DeNO_x$ system, and if we look at the author's curve on Fig. 3, the slope of the Case 1 curve and the resulting changes in $DeNO_x$ effectiveness we find that the total change predicted by the model over a temperature change of 1746 to 1764 is less than 3%. Therefore, the assumption of 80% as representative of what $DeNO_x$ can do, I think, is arbitrarily high, and it might be more appropriate to have used a more conservative number, such as 60%.

AUTHORS' REPLY

It is stated that the paper is a discussion of modeling, rather than a discussion of actual data. The modeling is used in this paper to put the field data in perspective. Field data can often be very misleading, since it is extremely difficult to obtain sufficient data at a given operating condition to make the data statistically significant. Also, measurement accuracy cannot always be verified with field instrumentation. Therefore, use of field-proven calculation tools is a method which we find valuable to check and analyze field data, especially when only a limited amount of data are available.

It is stated that a discussion of the effect of temperature on performance lacks data on the flue gas temperature and that no residence time data are supplied. Flue gas temperature data are clearly stated in Table 2 for design cases 1, 2, 3, and 4, along with other pertinent data. Residence time in the reaction zone is on the order of 1 sec as stated in the "Background" section and implied in our calculation results for Fig. 3.

As stated by the reviewer, we agree that only a limited amount of data are available for presentation in this paper. With that thought in mind, we attempted to expand the reader's understanding of these data by a qualitative analysis using our fundamental kinetic model. The purpose of this analysis, as stated in the paper, was for comparison purposes to illustrate trends in the data and to show why the actual operating conditions gave different results than the design conditions. We do not state or imply that the absolute values given in this analysis are representative of what can be achieved in the unit. In fact, we state that mixing has not been considered in this analysis.

To reiterate, for calculation purposes of Fig. 3, we have taken Case 2 from Table 2 (Design case 2) and compared this with a representative case of the field data which we called Case 1. We have accepted the measured temperature range, even though we feel that significant error exists with these temperatures, since they were taken by bare thermocouples. The results shown are qualitatively consistent with the field data, and therefore satisfy the purpose for which they were intended.

In regard to our choice of 80% $deNO_x$ as the basis on which to calculate cost effectiveness, we feel entirely justified in the use of this number. However, we have supplied in the paper all of the cost data which were used in the calculation. The reviewer is invited to make any performance adjustment that he may deem appropriate for his purposes and recalculate the cost effectiveness for his personal use.