AN EXAMINATION OF VEHICLE FIRES ACCORDING TO SCALING RULES - PART II. FURTHER APPRAISAL OF THE RESULTS

J.C. Jones
School of Engineering, University of Aberdeen, Aberdeen AB24 3UE, UK

(Received 23 December 2008; Accepted 4 July 2009)

ABSTRACT

The approach taken in part I in this series [1] whereby flame temperatures are converted to heat fluxes by simple calculation is examined against independent work using scale model vehicles [2] in which heat fluxes are actually measured as well as temperatures. The comparison augurs well for the reliability of the simpler approach.

A recent contribution to this journal [1] describes experiments in which scale model cars are burnt and the results scaled up to full size. The only 'results' were thermocouple temperature measurements, and these were converted by heat fluxes by use of the equation:

heat flux from the model (q, units W m^{-2}) = σT^4

where σ is the Stefan-Boltzmann constant (5.7×10^{-8} W $m^{-2}K^{-4}$) and T the measured temperature (K).

Recent work by Ingason [2] takes a similar approach with 1/10 scale model railcars, but uses cone calorimetry as well as thermocouples. Referring to Table 5 in [2], the peak radiation levels across five tests are in the range 74.2 to 63.4 kW m^{-2}. We focus in this discussion on test 4, for which the maximum heat-release rate was 68.1 kW m^{-2}. On the basis of the equation above, this corresponds to a temperature of:

$(68.1 \times 10^3/5.7 \times 10^{-8}$ W $m^{-2}K^{-4})^{1/4}$ K = 1045 K = 795°C.

This test was chosen for the discussion because temperature histories for this test are given, as Fig. 11 in [2]. Traces for five thermocouples are shown, and at about five minutes into the test, where peak temperatures are observed, most of them are reading about 800°. Some of them rise to a little over 900°C over the next two to three minutes.

The relatively basic assumption in [1] that flame temperatures can be converted to heat fluxes on the basis that the flame show black body behaviour is therefore supported by examination of similar work in which both temperature and heat flux measurements were made.

REFERENCES

1. J.C. Jones, T. Noonan and M.C. Riordan, "An examination of vehicle fires according to scaling rules", International Journal on Engineering Performance-Based Fire Codes, Vol. 9, No. 3, pp. 111-117 (2007).
2. H. Ingason, "Model scale railcar fire tests", Fire Safety Journal, Vol. 42, pp. 271-282 (2007).