SPEAKER

DR. LIU FENGSHAN

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Date
31 October 2008
Friday

Time
6.30 – 9.30 pm

Venue
Room Y303
The Hong Kong Polytechnic University

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[Ref: Non-grey Gas Radiation Modelling and Soot Related Studies]

☐ I enclose a cheque of HK$300 for the registration for the lecture course on 31 October 2008

☐ I am an SFPE/IFE* member. I enclose a cheque of HK$150 for the registration for the lecture course on 31 October 2008

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* Please delete as appropriate

THE HONG KONG POLYTECHNIC UNIVERSITY

C P D L E C T U R E

Non-grey Gas Radiation Modelling and Soot Related Studies

Organized by

Professor W.K. Chow
Director, Research Centre for Fire Engineering
Acting Head, Department of Building Services Engineering
Leader, Area of Strength: Fire Safety Engineering
The Hong Kong Polytechnic University

Program schedule

6.30 – 6.40 pm .... Registration

6.40 – 6.45 pm .... Welcome and Introduction by Professor W.K. Chow

6.45 – 7.45 pm .... Part 1: Non-Grey Gas Radiation Modelling Using the Statistical Narrow-Band Model and Soot Formation Modelling in Laminar Diffusion Flames

7.45 – 8.15 pm .... Coffee break

8:15 – 9:15 pm .... Part 2: Theory of Laser-Induced Incandescence: current status and remaining issues

9.15 – 9.30 pm .... Questions and answers

Abstracts

Part 1

Thermal radiation plays an important role to transfer heat in large scale combustion systems and fire spread. Accurate modelling of non-grey gas and soot radiation is essential for the overall accuracy of a flame or fire model. Various levels of approximations to arrive at the radiative properties (absorption coefficients) of CO, CO_2, and H_2O based on the statistical narrow-band (SNB) model were developed and discussed in some details. Since the SNB model only provides the gas transmissivity, it can only be incorporated into a ray-tracing type of solution technique of the radiative transfer equation (RTE). The methodology employed for such purposes is the correlated-k approach, which provides the absorption coefficients so that the SNB model can be used in any RTE solver. Applications of these SNBCK based models to calculate non-grey gas radiation in several problems are also demonstrated.

The second part of this presentation focuses on the modelling of soot formation in laminar diffusion flames. Modelling soot formation in hydrocarbon fuelled flames is a formidable task. Two soot models were used in our numerical studies: a semi-empirical model which assumes acetylene (C_2H_2) is the only species responsible for soot nucleation and surface growth and a more detailed model which assumes pyrene ($C_{16}H_{10}$) is the soot nucleation and surface condensation PAH species and acetylene is responsible for surface growth (HACA mechanism). The advantages and drawbacks of these two types of soot model are discussed through analysis of numerical results of soot field predicted in several laminar diffusion flames.

Part 2

Laser-induced incandescence (LII) has been utilized to develop laser based diagnostic tools for soot measurements (concentration and particle size). The principle of LII is the rapid heating of nano-sized soot particles by a high power pulsed laser of about 20 ns duration to temperatures in the neighbourhood of 3500 to 4000 K. Detection and subsequent analysis of the incandescence signals from excited soot particles yield information of the soot particle concentration. Time-resolved LII has been employed to arrive at the particle size information, because smaller particles cool faster than larger ones after the laser heating.

The current theory of LII is based on energy and mass balance for a single spherical particle. This theory has been demonstrated to be useful for extracting particle size information from time-resolved LII signal or the soot temperature temporal decay curve. In reality, however, soot appears as fractal aggregates, but not individual isolated particles. The aggregation of soot particles has significant effects on the soot particle laser energy absorption rate and its heat conduction heat loss rate to the surrounding gas. Some efforts to account for the effect of soot particle aggregation have been recently made for LII modelling. Unresolved issues in LII, such as the thermal accommodation coefficient of soot, soot particle sublimation process, and the aggregation effect, are also discussed.