PROGRESS REPORT ON FIRE AND SMOKE PHYSICS IN JAPAN

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A short review on progress in fire and smoke physics after the last UJNR meeting is given. However, since considerable part of the progress will be reported by the authors of original papers, the review will introduce mostly studies which will not be presented at this meeting. Following journals and preprints are reviewed for this purpose.

a) Proceedings of the Annual Meeting of the Architectural Institute of Japan(AIJ), 1989.

b) Proceedings of the Annual Meeting of the Japanese Association for Fire Science and Engineering, 1989.

c) Proceedings of the 26th Combustion Symposium, 1988.

Diffusion Flames

Extensive studies have been made on the modeling of such engineering properties of turbulent diffusion flames as extinction limit, radiation and flame height.

Tatsuta and Ito investigated into the influence of water addition on the behavior and extinction limit of methanol fires by experiments. They found considerable decrease of heat release rate due to water addition with extinction at water concentration=90%, and attributed this reduction to the combustion heat to latent heat ratio. They suggest that suppression of alcohol fires by water should be made with cold water while the fuel temperature is still low.

Hayasaka and Koseki proposed an engineering calculation method of properties of diffusion flames from tank fires. The model is based on the heat balance around the flame, and includes a radiation model with the concept of the mean beam length. Calculation on fires from large tanks shows good agreement with previous experiments.

Nohara, Hasemi and Nishihata reported flame height correlations for low Q^* region ($Q^* < 0.1$)using hydrocarbon-hydrogen mixtures as the fuel. They found that flame height for a given Q^* is larger for propane than for methane. It is also found that propane-hydrogen mixture generates larger flame than methane -hydrogen mixture of the same equivalent molecular weight. These results are unexpected from theories on which Q^* or Froude number analysis depends.

Flame Spread

Typical problems of flame spread along combustible surfaces in fire safety may relate to upward horizontal surface, liquid fuel or ground soaked with liquid fuel, or vertical or downward surface in building fires. This report will mention only on the former situation.

Masuda and Ito reported observations of "pulsating flame propagation" along alcoholic fuels. From careful observation of aluminum powders, they attributed this characteristic phenomenon to the alternate appearence of flame spread governed by the convection beneath the fuel surface and that caused by the combustible gas mixture formed intermittently beyond the flame.

Ishida reported a model experiment on the effectiveness of a vertical barrier for the suppression of flame spread along ground soaked with liquid fuels. The barrier height to the height of flammable mixture layer ratio is found to be the dominant factor on this effectiveness.

Takeno and Hirano reported experiments and analysis on the flame spread along the surface of solid-liquid mixtures. This study seems to be enforcement of their previous works on flame spread along glass beads soaked with liquid fuels: in its analysis they have pointed out the significance of the size of beads, and have shown that flame spread for large beads is governed by the convection in the liquid phase.

Field Models

Development of large capacity computers during the last decade has made the field modeling possible to serve for engineering purposes in fire safety problems. Considerable part of the recent works in the field modeling are related to the application of the models to specific problems or modification of models for engineering purposes.

Morita and Hirota examined the economy of computer time by the use of irregular cells, and found that computer time can be reduced to approximately 1/4 the case using square cells without significant difference in the calculation result.

Satoh, Miyazaki and Kawasaki reported calculation of air movement in a tunnel fire. They compared the result with experiments, and found that the models of turbulence still need modification for such strongly turbulent and high temperature environment.

[REFERENCES]

Ishida,H.: Influence of barrier on the flame spread on the ground, (c).
Masuda,D., and Ito,A.: On the flame spread on liquid fuels, Part2, mechanism of

pulsating flame spread, (c).

Morita,M., and Hirota,M.: Numerical calculation of hot gas movement using irregular size and shape cells, (b).

Nohara,M., Hasemi,Y., and Nishihata,M.: Influence of fuel composition on the properties of turbulent diffusion flames in low Q^* region, (b).

Satoh,K., Miyazaki,S. and Kawasaki,M.: Numerical calculation of hot gas movement caused by liquid fire in a tunnel, (b).

Takeno,K., and Hirano,T.: Influence of liquid properties on the flame spread along the surface of solid-liquid mixture, (c).

Tatsuta,S., and Ito,K.: Influence of water addition on the burning behavior of methanol, (c).

Hayasaka,H., and Koseki,H.: Studies on the combustion and radiative heat transfer in tank fires, (c).