Entropy and Exergy Analysis of Syngas Premixed Flames with a Detailed Mechanism

Luigi Acampora, Francesco Saverio Marra
Istituto di ricerche sulla Combustione - CNR
Napoli, Italy

The entropy production (second law-based) and exergy loss analysis, from historical point of view, were developed to evaluate and optimize the performance of energy conversion systems [1]. For those systems involving a combustion process, it has been concluded that the major part of the exergy loss is due exactly to the combustion process [1]. Therefore, entropy production has been investigated in several combustion processes, for example: droplet combustion [2]; spray combustion [3]; coal/carbon combustion [4]; laminar premixed flames [5, 6]; diffusion flames [7].

Four irreversible processes are responsible for entropy production during combustion: viscous dissipation, heat conduction, mass diffusion, and chemical reaction [6]. The scope of this work is to study the local entropy production due to these processes in premixed syngas laminar flames taking into account detailed chemical kinetics and transport data. The effects of unburnt fuel mixture composition, equivalence ratio, and inlet fluid temperature on local entropy generation are analyzed. Finally, the exergy loss ratio of each process is evaluated with respect the exergy of the reactant fuel mixture.

References

[1] S. Som and A. Datta, "Thermodynamic irreversibilities and exergy balance in combustion processes," *Progress in Energy and Combustion Science*, vol. 34, no. 3, pp. 351–376, 2008.

[2] S. K. Dash and S. K. Som, "Transport processes and associated irreversibilities in droplet combustion in a convective medium," *International Journal of Energy Research*, vol. 15, no. 7, pp. 603–619, 1991.

[3] A. Datta and S. Som, "Thermodynamic Irreversibilities and Second Law Analysis in a Spray Combustion Process," *Combustion Science and Technology*, vol. 142, no. 1-6, pp. 29–54, 1999.

[4] S. K. Som, S. S. Mondal, and S. K. Dash, "Energy and Exergy Balance in the Process of Pulverized Coal Combustion in a Tubular Combustor," *Journal of Heat Transfer*, vol. 127, no. 12, p. 1322, 2005.

[5] V. S. Arpaci and A. Selamet, "Entropy production in flames," *Combustion and Flame*, vol. 73, no. 3, pp. 251–259, 1988.

[6] K. Nishida, T. Takagi, and S. Kinoshita, "Analysis of entropy generation and exergy loss during combustion," *Proceedings of the Combustion Institute*, vol. 29, no. 1, pp. 869–874, 2002.

[7] A. Datta, "Entropy Generation in a Confined Laminar Diffusion Flame," *Combustion Science and Technology*, vol. 159, no. 1, pp. 39–56, 2000.

Correspondence to: marra@irc.cnr.it