Heat Transfer During the Piston-Cylinder Expansion of a Gas

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Abstract

The expansion of a gas within a piston-cylinder arrangement was studied in order to obtain a better understanding of the heat transfer which occurs during this process. While the situation of heat transfer during the expansion of a gas has received considerable attention, the time dependence of heat transfer has not been well studied, with many researchers instead focused on modeling average heat transfer rates. These models generally assume pseudo-steady state behavior, which ignores important transient aspects of the process. Additionally, many of the proposed models are very sensitive to experimentally determined coefficients which have been found to vary widely between test geometries and operating conditions.

The process of gas expansion was analyzed in order to develop a model for the transient heat transfer. An analytical model was developed without assuming pseudo-steady state behavior by characterizing the heat transfer in terms of a polytropic exponent describing the expansion. This model was tested by experimentally determining the heat transfer during the piston-cylinder expansion of a gas. The data collected from these experiments validated the analytical heat transfer model, showing good agreement between experimental and predicted heat transfer characteristics. The proposed model also accurately handles variations in the heat transfer characteristics due to the different test conditions studied. By capturing the transient effects of heat transfer during the expansion process, the proposed model should be a more accurate tool in determining heat loss during the expansion of a gas than previously developed models.

Thursday, June 5
11:00AM, Rogers 226

School of Mechanical, Industrial, and Manufacturing Engineering