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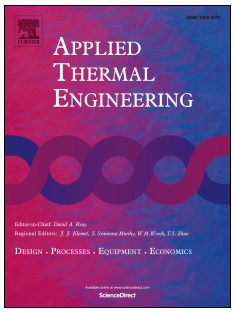

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Prediction of Film-cooling Effectiveness based on Support Vector Machine

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Abstract: Least square support vector machine (LS-SVM) model is applied to predict the lateral averaged adiabatic film-cooling effectiveness on a flat plate surface downstream of a row of cylindrical holes. The dataset used to develop and validate the presented model is obtained from the public literatures. The input parameters of LS-SVM include dimensionless downstream distance, pitch-to-diameter ratio, hole incline angle, hole compound angle, length-to-diameter ratio, blowing ratio, density ratio, and mainstream turbulence intensity. The predicted results are found to be in good agreement with the experimental results (the mean relative error is about 17.5%). The comparison between LS-SVM model and existing semi-empirical correlations is carried out, and the prediction performance of LS-SVM model is much better. Moreover, the effects of LS-SVM input parameters on film-cooling effectiveness are discussed in detail. LS-SVM is a promising model to predict the film-cooling effectiveness.

Keywords: Turbine; Film-cooling effectiveness; support vector machine; chaos optimization algorithm.

1 Introduction

The gas turbine industry continually seeks to improve the efficiency of the engine by increasing turbine inlet temperature. Current gas turbine blades rely significantly on cooling technologies in preventing failure owing to high temperatures and excessive thermal stresses. Film cooling scheme is a commonly used external cooling technology. Cooler air (ducted through internal passages of the blade from the compressor) is ejected through the blade surface into the external boundary layer, and forms a relatively cool insulating film on the blade surface, which protects the blade surface coming in contact with high gas temperature effectively[1,2].

The most commonly used parameter to characterize the performance of film cooling is adiabatic film-cooling effectiveness, η which is defined as:

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