Experimental and mathematical investigation into the heat-transfer processes within the heat exchangers of an α type Stirling engine

Abstract

Mathematical modelling of Stirling engines has been a widely researched topic over the course of the last few decades. Amongst different approaches, many zero-dimensional models based on solving differential mass and energy balances have been proposed by different authors. As some of these models necessitate the use of heat transfer coefficients characterizing the convective processes in the heat exchangers, the method by which those are calculated demands close attention. The aim of this work is to investigate how the quality of heat transfer coefficients formulas influences the quality of zero-dimensional mathematical, Stirling engine models. This was done by validating different heat transfer correlations within the framework of a zero-dimensional model created by the author. The work presents a comprehensive review of heat transfer correlations adequate for Stirling engine calculations. Experimental results are obtained from a rig based on a Genoastirling ML3000 engine. These results are compared with model results utilizing different heat transfer models, narrowing the selection to the heat transfer correlations of Anannd and Pinfold (1980), Toda (1994) and Kanzaka and Iwabuchi (1992). For the best performing models further refinement to the equations is proposed and evaluated showing an improved quality of model prediction in terms of indicated power.}

The presented dissertation is organized into six Chapters, expanding on content which was in part already published by the author in several publications in the course of performing PhD studies. Chapter I outlines the problem in question and the state of the art. Chapter II concerns Stirling engine modelling, the outline of the author's model described within it. Chapter III deals with the construction of the experimental stand. Chapters IV and V describe the validation of the aforementioned model and the work concerning the fine-tuning of the selected heat transfer correlations. Chapter VI are the overall conclusions from the work.