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Investigation of the velocity profiles in a ninety-degree curved standing wave resonator with Particle Image Velocimetry

Abstract

Travelling wave thermoacoustic heat engines have been reported to have a higher efficiency than the standing wave ones. The former are generally large systems which consist of toroidal shape resonators. While standing wave heat engines are inherently smaller, a reduction in size could be considered which may involve curvatures as compared to the straight tube conventional systems. However, as with the streaming losses in the travelling wave resonators, losses due to the curvature may be generated. This study involves preliminary experimental measurements using the Particle Image Velocimetry (PIV) method to analyze the velocity profiles in a standing wave resonator before and after a ninety degree curvature. This design can reduce the space generally occupied by the straight standing wave resonator. The overall length of the resonator fits a quarter wavelength wave based on the straight closed-end tube type. The working gas is air at 1 atmospheric pressure. Results have shown that the velocity profiles after the stack but before the curvature exhibit clear straight paths up just as reported elsewhere. Signs of disordered motion could be observed just before the bend and the pattern continues until after the curvature. The results are obtained before one periodic cycle and before the acoustic wave front hit the tube end. The trend is expected to affect the overall thermoacoustic performance of the engine as returning gas particles interact with the oncoming particles that pass by the curvature.

Keywords

Curvature; Particle Image Velocimetry; Standing wave resonator; Thermoacoustic heat engines