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Shape optimization on constrained linearly expanded tubes by using genetic algorithm

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One of the most important practical considerations in muffler design is the constrain problems in a confined place. In addition, to release the pressure drop in a muffler system, a new silencer of linearly expanded tube is proposed and investigated in this paper. The genetic algorithm (GA), a stochastic algorithm, is used as an optimizer by mimicking the genetic drift and Darwinian strife for survival.

To approach this study effectively, the linearly inclined tube is divided into several segments of straight tube with different diameters. Four-pole transfer matrix is then in use, accordingly. Not only the theoretical derivation in sound transmission loss (STL) but also the GA searching technique is discussed. Additionally, a numerical case on the expanded tube is introduced. To achieve the best optimization in terms of STL of a muffler, the GA parameters are on trial in various values.

Results show that when the divided elements of the tube are more than sixteen segments, the modeled segmental tube is similar to the linearly expanded tube. In addition, the STL in muffler becomes to be stable.

Keywords: shape optimization; linearly expanded tube; muffler; transfer matrix method; space constraints; genetic algorithm

1. INTRODUCTION

As the report by America Petroleum Institute (API) [1] shown that reactive silencers, accessory of a gas venting system, are particularly effective in eliminating the noise wave whose spectrum characteristics is either at low frequency or limited bandwidth. Whilst most of the electric machines almost belong to this kind of low frequency type [2], the muffler system is thus adopted in the gas venting system in which the space volume is constrained in usual.

In practical engineering design, the shape optimization to maximize the muffler’s performance is essential when the space volume of mufflers in a venting system is constrained inside a building. In the previous study [3], the graphical analysis of optimal shape design to improve the performance of STL on a constrained single expansion muffler was discussed. However, the abrupt shape of a muffler often increases the pressure drop [4] and results in the fact that the performance of machine such as engine will more or less be influenced. Therefore, the interest in developing a high performance of muffler with lower pressure drop under space constraints is thus arising in the field.

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