ABSTRACT

PRESSURE AND ACOUSTIC VELOCITY DYNAMICS ON H-TYPE RESONATOR: THEORETICAL STUDY OF SINGULARITY OF EDGE EFFECTS ON DUCT DISCONTINUITY AND OPTIMIZATION DESIGN USING GENETIC ALGORITHMS (GA)

Optimization of the resonator geometry is very important to maximize the photoacoustic signal, which is generally weak. The most frequently used configuration of the resonator is cylindrical because of its simple symmetry, which coincides with the laser beam propagating along the axis of the cylinder or one of its axes. In this H-type cylindrical resonator, acoustic propagation in a cylinder whose cross-sectional area changes suddenly (called duct discontinuity) becomes the main problem in this study. The purpose of this study was to determine the extent of the effect of edge effect singularity to obtain an optimal H-type cylindrical resonator design, resonant frequency (f), transmission loss (TL), quality factor (Q_j), and cell constant (C_j) for gas biomarkers: ethylene, SF_6, acetone, and ammonia. The method used in this optimization is a simulation through the transmission matrix method (TMM) and a genetic algorithm (GA) related to the pressure and volume velocity of the acoustic. The shape of this matrix corresponds to the lowest longitudinal normal mode $[kmn] = [100]$. The results obtained as a result of this duct discontinuity are the optimal design of the H-type cylindrical resonator in the form of buffer length $(l_{\mathrm{buf}}) = 48{,}8\ \mathrm{mm}$, buffer radius $(r_{\mathrm{buf}}) = 9{,}2\ \mathrm{mm}$, resonator length $(l_{\mathrm{res}}) = 102{,}5\ \mathrm{mm}$, and resonator radius $(r_{\mathrm{res}}) = 2{,}9\ \mathrm{mm}$, which raises the edge effect singularity affecting the resonant frequency, transmission loss, quality factor, and cell constant, as well as the location of the maximum signal in the resonator for all gases.