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Design and optimization of an elliptical multipass cell for laser absorption spectroscopy

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Abstract

An annular cell with an elliptical cross section and a small physical size is introduced and simulated for increasing the absorption length in the spectroscopy. In this investigation, by changing the geometrical radius of the ellipse, an absorption length of 15.50 m is obtained. By the optimization of the cell and including the sagittal and tangential radius of the ellipse that can reflect the beam, it is shown that at the obtained absorption length, it is possible to reduce the divergence of the beam down to 54 μm . Then, the signal-to-noise ratio (SNR) is calculated for the R(16) CO₂ absorption line by assuming that the cell is filled by the gas. The results of this calculation indicate that under the optimum conditions, the SNR can be increased up to 310. Finally, the cell is optimized using the Genetic algorithm by including all the effective parameters which can affect the efficiency of the cell. We find that in the best case, an absorption length of 8.24 m with the SNR of 107 can be achieved when the geometrical radius of the cell is fixed at 5.95 and 4.59 cm.

Keywords: absorption spectroscopy, annular multipass absorption cell

For full article, refer to the Persian section