**Trace gases analysis in pulsed photoacoustics based on** **swarm intelligence optimization**

M. Lukić1, Ž. Ćojbašić2, D. D. Markushev3

*1Faculty of Occupational Safety, University of Niš, Čarnojevića 10a, Niš 18000, Serbia.*

*2Mechanical Engineering Faculty, University of Niš, Aleksandra Medvedeva 14, Niš 18000,Serbia.*

*3Institute of Physics, University of Belgrade, Pregrevica 118, Belgrade-Zemun 11080, Serbia.*

e-mail:mladena.lukic@znrfak.ni.ac.rs

The application of pulsed photoacoustic spectroscopy (PAS) in in-situ measurements of trace gases with variable spatial and temporal distribution of concentrations requires high sensitivity, selectivity, as well as a simple, easily portable apparatus. In order to improve PAS characteristics in trace gases measurements, we have applied artificial intelligence techniques [1,2] which can not only increase the efficiency and precision of measurements but also enable the interaction of the system with its environment, through online training. The swarm intelligence optimization techniques simultaneously determined the unknown parameters of the photoacoustic (PA) signal: radius of the laser beam spatial profile ($r\_{L}$) and vibrational-to-translational relaxation time ($τ\_{V – T}$). Experimental PA signals were generated in the SF6+Ar mixture in the multiphoton regime. Two swarm intelligence algorithms were applied: particle swarm optimization (PSO) [3] and artificial bee colony optimization (ABC) [4]. Selected algorithms differ in terms of space being searched, the operators who use them, etc. [2-4]. Due to the convenience in calculations, the dimensionless parameters ε$ $ ($ε∝\frac{1}{τ\_{V – T}}$) and $r^{\*}$ ($r^{\*}∝\frac{1}{r\_{L}})$, were used, where $r\_{L}$ is the radius of Gaussian, top-hat or Lorentzian spatial profile of the laser beam. The parameter $r^{\*}$ is selected from the interval [10, 50], and ε from the interval [0.2, 5]. The lower and the upper bounds of the interval values of the selected parameters are the smallest and highest values of the parameters ε and $r^{\*}$, which can be expected in the experiment. The performances of the applied algorithms are based on the criteria: the precision of the result (%) and the number of function evaluations. The number of evaluations of PSO and ABC algorithm functions is similar. PSO algorithm precisely defines the unknown parameters of photoacoustic (PA) signal with a small number of function evaluations, while the ABC algorithm determines the least number of parameters to be set. A small number of function evaluations and a relatively simple implementation make swarm intelligence algorithms an efficient and extremely perspective tool for in-situ measurements.

[1] M. Lukić, Ž. Ćojbašić, M.D. Rabasović, D.D. Markushev, Meas. Sci. Technol. 25 (12), 125203 (2014)

[2] A.P. Engelbrecht, Computational Intelligence, 2nd edn. (John Wiley and Sons 2007)

[3] К. Parsopoulos, M.Vrahatis, Particle swarm optimization and intelligence: Advances and applications,

(IGI Global Joanina, Greece 2010)

[4] D.Karaboga, B. Gorkemli, C. Ozturk, N. Karaboga, Artif. Intell. Rev. 42(1), 21-57 (2014)