Using of Laser Fluorescence Method Based on Copper-Vapor Laser (578.2 nm) for Molecular Iodine Detecting in Gaseous Media

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The problem of developing high-sensitive selective express-methods of molecular iodine detecting (first of all, of long-lived iodine-129 radionuclide) in various environmental objects is of high importance nowadays. These methods of real-time iodine-129 detecting in gaseous technological media generated during spent nuclear fuel (SNF) reprocessing in radiochemical plants and in the atmospheric air will help to solve a number of important tasks connected with increasing of environmental security in these plants, with developing new power-efficient and environmental-friendly technologies of SNF reprocessing (in particular, of solid SNF, generated in fast reactors), and with environmental monitoring of the atmosphere.

This paper is devoted to the developing of the laser-fluorescent method of simultaneous selective measurement of molecular iodine isotopologues \(^{127}\text{I}_2\), \(^{127}\text{I}^{129}\text{I}\) and \(^{129}\text{I}_2\) content in gaseous media. This method is based on using a laser with a fixed wavelength as a radiation source. This laser excites fluorescence of all isotopologues present in the analysed mixture. The selectivity of their detecting is provided by registration of intensities of separate spectrally resolved fluorescence lines.

As a laser source, we take a copper-vapour laser with radiation wavelength 578.2 nm. It was done due to the fact that the results obtained previously in the papers [1,2] concerning the fluorescence of \(^{127}\text{I}_2\), \(^{127}\text{I}^{129}\text{I}\) and \(^{129}\text{I}_2\), excited by radiation of this laser, show that close to this wavelength each of these isotopologues has a big number of closely spaced absorption lines. The excited fluorescence spectra are quite intensive due to this fact and also to the big value of absorption cross-sections.

Thus the mentioned laser is considered to be a promising source of molecular iodine isotopologues fluorescence exciting for developing a high-sensitive method of detecting them in the gaseous media. The calculated and experimental research show that the value of boundary relation of \(^{127}\text{I}^{129}\text{I}\) concentration to that of \(^{127}\text{I}_2\) in the atmospheric air (the minimum relative concentration of \(^{127}\text{I}^{129}\text{I}\), measurable in the presence of really higher concentrations of \(^{127}\text{I}_2\)) is approximately \(10^{-6}\), that is in the row of the best results achieved nowadays. The estimated sensitivity of molecular isotopologues detecting during the exciting of their fluorescence with copper-vapour laser is approximately 0.05 ppb.

Applying of this method makes it possible to perform molecular iodine monitoring, particularly in technological processes of SNF reprocessing, in gaseous emission on radiochemical plants and in the atmospheric air.

References
