Calibration Method for Ion Mobility Spectrometer

Valery VASILIEV
National Nuclear University "MEPhI", Moscow, Russia
vasilievvk@yandex.ru

Abstract **–The new method for the calibration of the ion mobility spectrometer has been developed. This article describes the working principle, advantages and disadvantages of the calibration method operating in the mode of explosives detection. This method is most suitable for use in portable detectors, due to the small weight, small size parameters and low power consumption.**

Key words **– ion mobility spectrometry, IMS, calibration, detection of explosives, corona discharge**

I. INTRODUCTION

Ion mobility spectrometry is a widely recognized global standard in detecting trace quantities of substances [1]. Devices based on the ion mobility spectrometry principles used in international airports and customs for detection of narcotics, explosives and warfare agents.

The principle of operation is the selection of samples from the surface or from the air, ionization and drift of ions through a constant electric field in the drift tube.

Output spectrum characterizes the composition of the sample. Ion of each substance has a definite mobility, therefore the measurement time-of-flight characteristics of the ions to determine their type.

As a result of changes in ambient temperature, humidity and pressure the output spectrum is changed. This fact requires periodic calibration of the spectrometer, so that the influence of external factors did not affect the results of the analysis. Calibration is carried out using previously known substances, which are periodically introduced into the ionization chamber.

The new calibration method by using the reaction products of corona discharge (nitrogen oxides) described in this paper. This method is most suitable for use in portable detectors, due to the small weight, small size parameters and low power consumption. It has a very good opportunities for constructive integration in the portable IMS device [2].

II. CALIBRATION METHOD USING A CORONA DISCHARGE

The possibility of chemical transformations under the influence of an electric discharge was discovered almost a hundred years ago . Since then, detailed studies of the processes occurring during combustion of corona discharge in air [3-5].

Chemical products resulting from combustion of corona discharge, such as nitrogen oxides, compete with analyte in electron capture reactions. The concentration of nitrogen oxides can be quite large and must be taken into account when dealing with the corona discharge ionization sources. These substances have a high oxidative properties and impede the detection of explosives. However, due to the stability of a corona discharge nitrogen oxides can be used as calibration substances.

Investigation of the reaction products of corona discharge was carried out on a specially designed layout. Layout consists of two electrodes made of stainless steel with a thickness of 0.5 mm using the technology of laser cutting. Tip electrodes are placed at a distance of 2mm. Burning source of corona discharge is shown in Figure 1.

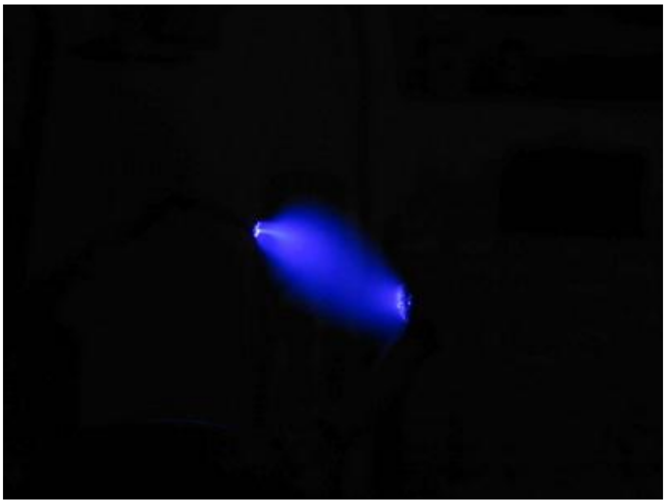

Fig.1. Corona discharge

In the transition from the regime of detection into the calibration mode, the device suspends the detection of explosives. The combustion products of corona discharge inputed into ionization chamber. Spectrum changes as shown in Figure 2.

The system detects the peak of the calibration substance and on the basis of known data on the time-of-flight characteristics of detected explosives builds markers of these substances relative to the calibration peak.

Analysis of the calibration peak showed that the experimental data given in [6], the gauge corresponds to the substance nitrogen oxide. Spectrograms show the presence in a sample of large amounts of information generated during the discharge of the substance.

By varying the voltage applied to the electrodes can change the amount generated by the combustion products, as illustrated in Fig. 3.

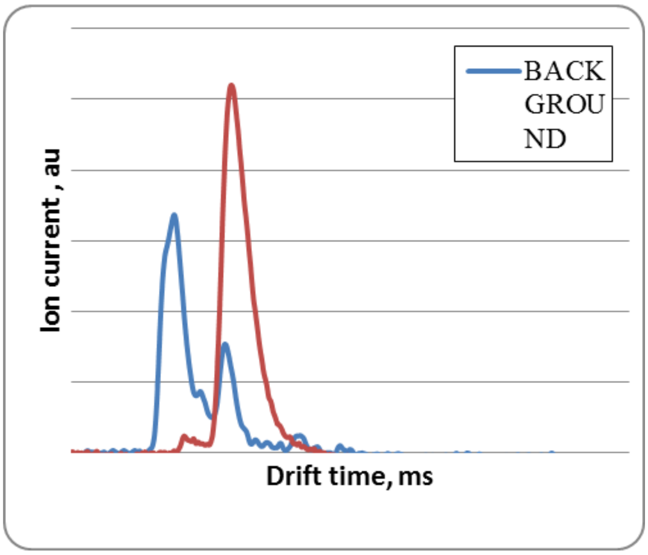

Fig. 2. Change in the spectrum in the calibration mode

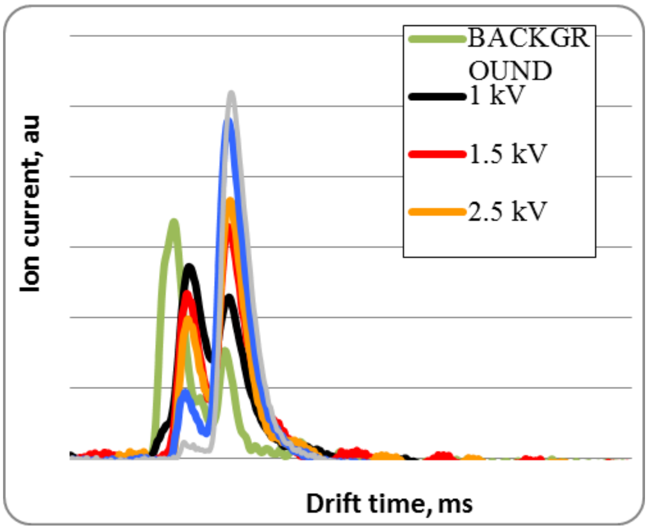

Fig. 3. Calibration spectrum for different discharge voltages

The figure shows that the number of outgoing material is directly proportional to the corona discharge voltage. However, from a certain level the spectrum changes only slightly.

At high voltages applied to the source of the corona discharge, the calibration substance pulls all the charge from the peaks of background signal. This suggests that the calibration material has strong oxidizing properties. This corresponds to the theoretical data [7].

In most cases, the electron affinity is less then 1 eV, but in the case of NO2 value exceeds 3 eV. In turn, the group OH (intermediate reactant ion in the negative mode ion mobility spectrometer), this value is 2 eV,which confirms the observed during the experiment, the charge transfer.

By varying the voltage applied to the electrodes, the configuration of needles and the distance between them, we can achieve stable combustion of corona discharge, provide the required burning time of the corona. The developed system allows to change the amount of combustion products generated by varying the voltage applied to the electrodes. In addition, the pulsed nature of the corona discharge provides the kalibrant reliability and extends the lifetime of needles.

The proposed calibration method was successfully used in a portable ion mobility spectrometer, which weight is a 2.9kg (without battery). Designed built-in ion mobility spectrometer calibration system based on corona discharge. It’s control system integrated into the control system of the spectrometer.

III. CONCLUSION

Calibration technique using a corona discharge is a very suitable for use in portable detectors, due to the small weight, small size parameters and low power consumption. It has several advantages, allowing to embed kalibrant in a portable ion mobility spectrometer. The developed ionization source control system implements the possibility of changing the parameters of corona discharge combustion (duration of burning and discharge voltage).

Further research is needed in the area of embedded kalibrant for positive mode of the IMS (detection of narcotics).

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