The gas detector for revealing decay processes in storages

V.V. Boyko, G.I. Bulakh, G.I. Podpriatov, S.M. Gunko

The aim of this study is to develop a specialize gas detector that can record the volatile organic compounds (VOCs), which are released during spoilage of fruits and vegetables. The registration of total concentration of these substances using the developed device can help to determine the initial stage of decay and based on this information to make decisions about the need for sorting products stored, to remove infected (rotten) ones, which will help reduce losses during storage.

Potatoes - one of the staple foods. Many potato is laid on the storage and processing for realization. The main problem during storage is quite significant losses of potato tubers, which in some years up to 20-30%.

One way to prevent crop losses during storage of potatoes, other than preventive measures can be revealing the processes of decay in the early stages and disposal of their cells. Search for means of detection and localization of the initial stages of damage to agricultural production continues for many years, both abroad and in Ukraine.

One way to address this issue was the analysis of samples of air pumped from the mass of product through a special tubing. Analysis of selected samples of volatile components is carried out by determining the amount of ethylene. The results of this analysis assess the suitability of products for long-term storage (RF patent, в„–2143682).

Another promising means of control is the gas medium in storage of fruits and vegetables using gas-analyzing devices. It is known that the main cause of damage, such as potatoes, are putrid infection by bacteria such as Erwinia carotovora, Bacillus polymyxa, Arthrobacter sp., Fungi Phytophthora infestans, Fusarium coeruleum and others. Highly sensitive and valuable means of gas chromatography and mass spectrometry revealed that during the life of these harmful microorganisms released more than a hundred different volatile organic compounds (VOCs) [1-2]. Particularly in the case of infection by bacteria Erwinia carotovora recorded dozens of different volatile compounds from among alkanes (paraffins), alkenes (olefins), aldehydes, sulfides, ketones, alcohols, etc. The most intense and characteristic compounds are ethanol, methanol, acetone, butane-1-ol, which may serve as markers of decay processes at the initial stage [3]. However, the methods and devices of the gas analysis, used in scientific research, are not suitable for practical application in storages due to the high cost of equipment, duration of measurements, need for qualified personnel and as a long time did not go beyond the laboratory.

Powerful technology development of gas sensors in the end of the 20th century led to a significant improvement of sensitivity, efficiency, stability, performance and reduced size gas sensitive sensors [4]. The mass production of such sensors caused their wide availability and contributed significantly reduced cost to the level of several tens, and now to several dollars. Therefore, in recent

years in the UK, Canada and the United States began developing technical means of gas monitoring in storage environments that use modern gas sensors. The use of these inexpensive devices promises significant economic impact and improve the quality of products. For example, in the UK the annual economic effect of the introduction of such devices only for potatoes estimated within 5.7 million pounds. The purpose of this research - development of specific gas detector for detection of decay processes in storages. Therefore, this direction of research is relevant and promising.

Materials and methods of research. Studies conducted in the departments of physics and department of technology of storing, processing and product standardization at The National University of Life and Environmental Sciences of Ukraine.

The investigation of gas detector for detection of decay processes in storages performed using special glass box with app. 80 liters volume.

Box made of transparent organic glass thickness 6 mm, with a top cover lid, cylindrical side airlocks, which is closed with a lid tightened clamping mechanism for easy opening-closing, several screw plugs for input samples inside. To enter the signal cable and power cord of device, the airlock was mounted with sealing gland. Inside the chamber the test gas detector and plastic mesh box with fresh or rotten tuber samples were placed. The output of the gas sensor detector was applied to the analog input recording device. It provides a standalone recording to internal memory analog signal in the range 0 - 2 V with intervals of 1 min to 255 min.

Results. The development of gas detector for detection of decay processes in storages started in The National University of Life and Environmental Sciences of Ukraine some years ago [5].

As a result of this work is the experimental gas detector. The main element of the device is a semiconductor gas sensor based on metal oxides, which is sensitive to the concentration of VOCs for a wide range of substances (including VOCs, which are the substances released during the decay of fruits and vegetables). The sensor is connected to the measuring system, which processes the signal and normalize and directs it to connector for control. Display console provides setting the threshold level for signal from the sensor and switches indication (signaling) in excess of this concentration threshold. The detector is equipped with a relative humidity sensor, temperature sensor and electronic unit that provides signal processing.

For recording the results of measurements, the detector equipped with analog-to-digital converter, internal memory and real-time clock. It can simultaneously record up to four digitized signals from the sensors for a long time. The interface unit is designed for connecting the device to external computer to read data from memory and program detector's performance. Thus, the value of the output of the device indicates the magnitude of the concentration of volatile compounds in the atmosphere in storage and thus can be quantitative measure of the process of decay.

When used as a vegetable store detector registers the total concentration of VOCs, which are markers of decay processes, which allows certain conclusions

about the depth of the processes of decay products during storage. Simultaneous recording of VOC concentrations and atmospheric storage parameters (temperature and relative humidity) allows more accurate estimate of the degree of threat spoilage of fruits and vegetables, as fluctuations in temperature and humidity can significantly change the value of the device's output and thus affect the reliability of analysis. The presence of the device's own memory, which recorded measurement results enables document confirming the storage conditions.

Tests of the device in the laboratory in a sealed box shown its high ability to recognize healthy and infected (rotten) products, including potato tubers. Signal device from infected tubers more than 8 times higher than the signal from healthy and showed its high sensitivity to VOCs are released during decay.

Conclusions.

1. The gas detector for detection of decay processes in storages is developed and studied.
2. Testing of the detector in laboratory in a sealed box shown its high ability to recognize healthy and infected (rotten) products.

References:

- 1. The perspectives of using modern gas sensors in a technology of storage of agricultural products. V.V. Boyko, G.I. Bulakh, G.I. Podpriatov, S.M. Gunko // Research Bulletin of NAU. вЂ“ 2007. вЂ“ в„–105. С. 237вЂ“ 341. (In Ukrainian)
- 2.Varns J. L., Glynn V. Detection of disease in stored potatoes by volatile monitoring. American Potato Journal. 56, 1979, 185-197.
- 3.Waterer D.R., Pritchard M.K. Monitoring of volatiles: A technique for detection of soft rot (Erwinia carotovora) in potato tubers. Canadian Journal of Plant Pathology. 6, 1984, 165-171.
- 4.de Lacy Costello B. P. J., Evans P., Ewen R. J., Gunson H. E., Ratcliffe N., Spencer-Phillips M. P. T. N. Identification of volatiles generated by potato tubers (Solanum tuberosum CV:Maris Piper) infected by Erwinia carotovora, Bacillus polymyxa and Arthrobacter sp. Plant Pathology. 48, 1999, 345-351.
- 5.Fine G.F., Cavandagh L.M., Afonja A., Binions R. Metal Oxide Semi-Conductor Gas Sensors in Environmental Monitoring. Sensors. 10, 2010, 5469-5502.