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Research on Explosives Detection Technologies in Aviation Security Industry

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Abstract

The article provides practical knowledge about the explosives detection research. Also, the application characteristics of the device for the detection of explosive substances are defined. Currently, among the special means of ensuring aviation security, X-ray television intro scopes are most widespread due to their high speed of inspection and the ability to detect bladed weapons and firearms, as well as detect explosives and explosive devices. However, conventional X-ray inspection systems cannot separate explosives from harmless substances with decision to the operator. The latter circumstance leads to a significant dependence of the quality of inspection on the experience and qualifications of the operator.

Keywords: radiation analysis, explosive simulator, spectrogram, detector, electrometers.

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Aviasiya təhlükəsizliyi prosedurlarının tədqiqatında partlayıcı maddələrin aşkarlanması texnologiyaları

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Xülasə

Məqalədə partlayıcı maddələrin aşkarlanması üzrə tədqiqatlar haqqında praktiki biliklər verilir. Həmçinin, partlayıcı maddələrin aşkarlanması üçün qurğunun tətbiqi xüsusiyyətləri müəyyən edilmişdir. Hal-hazırda aviasiya təhlükəsizliyini təmin edən xüsusi vasitələr arasında rentgen televiziyasının introskopları yüksək yoxlama sürətinə və bıçaqlı silahları və odlu silahları aşkar etmək, həmçinin partlayıcı maddələri və partlayıcı qurğuları aşkar etmək qabiliyyətinə görə daha çox yayılmışdır. Bununla belə, adi rentgen yoxlama sistemləri partlayıcı maddələri oxşar sıxlıqlara və effektiv atom nömrələrinə malik olan zərərsiz maddələrdən ayıra bilməz. Ən yaxşı halda, bu parametrlər son qərarı operatorun ixtiyarına buraxaraq, baqajda şübhəli sahələri ayırmaqla yalnız göstərişlər verir. Sonuncu hal yoxlamanın keyfiyyətinin operatorun təcrübəsindən və ixtisasından əhəmiyyətli dərəcədə asılı olmasına səbəb olur.

Açar sözlər: radiasiya analizi, partlayıcı simulyator, spektroqram, detektor, elektrometrlər.

Технологии обнаружения взрывчатки в методах авиационной безопасности исследования

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Аннотация

В статье представлены практические знания об исследованиях по обнаружению взрывчатых веществ. Определены особенности применения устройства обнаружения взрывчатых веществ. В настоящее время среди специальных средств обеспечения авиационной безопасности наибольшее распространение получили рентгенотелевизионные интроскопы благодаря высокой скорости досмотра и способности обнаруживать холодное и огнестрельное оружие, а также обнаруживать взрывчатые вещества и взрывные устройства. Однако обычные системы рентгеновского контроля не могут отделить взрывчатые вещества от безвредных веществ с одинаковой плотностью и эффективными атомными номерами. В лучшем случае эти настройки дают лишь подсказки, обозначая подозрительные места в багаже, оставляя окончательное решение за оператором. Последнее обстоятельство приводит к существенной зависимости качества контроля от опыта и квалификации оператора.

Ключевые слова: радиационный анализ, имитатор взрывчатки, спектрограмма, детектор, электрометры.

Introduction

In addition, the use of such installations in practice, even with the tomographic principle of image acquisition, has shown that the number of false alarms remains very significant (20-30%) and requires the use of additional means to check objects suspected of the presence of explosives

The use of other explosive detection systems and methods, such as explosive vapor and particle analysis or trained dogs, have proven effective in practice, but if the explosive is contained in a sealed enclosure, then the use of such detection options becomes impractical.

The purpose of the work

A separate problem for ensuring aviation security has become the possibility of committing an act of sabotage and terrorism using liquid explosives, the detection of which is difficult by traditional means of screening hand luggage. The shortcomings of these methods have led to the general conclusion of aviation security experts around the world that success in detecting explosives is only possible through the use of a combination of different technologies. Therefore, the immediate prospects for improving technical means of ensuring aviation security will be associated with the introduction into practice of complex systems using devices operating on different physical principles.

The main advantages of devices based on neutron radiation analysis are the ability to use non-destructive analysis to determine with a high degree of probability the presence or absence of a non-shelled explosive substance and the ability to operate in a fully automatic mode, without operator participation, which ensures the absence of the “human” factor. However, the first samples of neutron radiation analysis devices showed a fairly high level of false alarms and low inspection productivity. The reason for the high rate of false alarms was the presence of a large amount of nitrogen-containing materials in baggage, not related to explosive substances, including in wool, leather goods and food [1-3].

The results obtained as part of this research article showed that these installations with a special data processing algorithm can be successfully used to create complex systems for detecting explosive substances in hand luggage and baggage, as well as in containers from air passengers.

Therefore, explosive substance detection installations using the neutron radiation analysis method could be used to solve a narrow range of security problems that did not require high speed when inspecting objects, and the objects themselves did not contain items with a high nitrogen content.

Advantages of the neutron radiation method analysis are as follows:

- detection of explosives in neutron radiation analysis facilities is carried out in an automatic mode, which does not require the participation of a qualified operator for visual recognition of camouflaged explosives;
- installations of neutron radiation analysis make it possible to check with a high degree of reliability any objects, including non-removable ones, for the purpose of stable detection of explosives;
- the possibility of detecting explosives located in a sealed housing, or with the introduction of special volatile components, which in many cases exclude the possibility of their detection using vapor and particle analysis units or specially trained dogs;

- more reliable detection of explosives, regardless of their type, shape, state of aggregation and possible camouflage measures, including explosives in liquid form;
- lower price compared to technical means that allow automatic detection of explosives;
- the possibility of combining the installation with other inspection means into a single automated inspection complex;
- the ability to quickly integrate the installation as part of the complex into existing airport inspection areas;
- the cost of installations based on neutron analysis and their maintenance in general is significantly less than the cost and maintenance of tomographs.

The operation of the device is based on the nonlinear dependence of the mobility of ions in an electric field on its strength. At the entrance to the analytical, as well as to the calibration reference channels of the product, ionization of the air flow occurs under the influence of radiation from the built-in radionuclide source. The resulting ions are separated under the influence of high-frequency alternating and direct electric fields. This separation is a consequence of the different dependence of ion mobility on the electric field strength. When a superposition of alternating and constant electric fields is determined for each type of ion, the average drift of ions is compensated, which creates conditions for passage through the analytical gap for a certain type of ions. The ions enter the electrometric amplifier, and thus their selection is carried out.

Ions for which the selection conditions are not met recombine on the walls of the analytical channel.

Vapors of an explosive simulator are constantly introduced into the air entering the reference channel during operation of the device. The spectrograms of the measuring and reference channels are compared, after which the position of the peak corresponding to the mobility of ions of the explosive simulator is determined, depending on the environmental conditions. Based on the data obtained, the device is automatically calibrated to determine the expected position of the shift of the peaks of the registered target substances on the iono gram. After amplification and processing by a digital computing unit, the product initiates sound and light alarms with information about the type of explosive.

We present a device that detects explosives using the neutron radiation method. The device has many advantages (fig. 1).

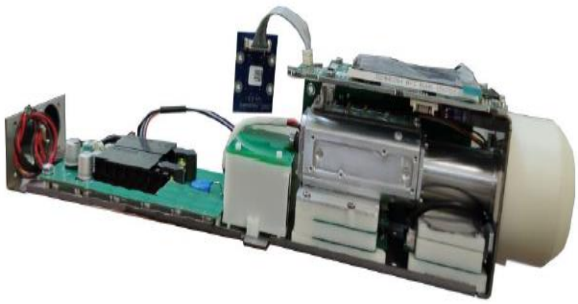


Figure 1 – Location of control buttons, indication and network adapter connector

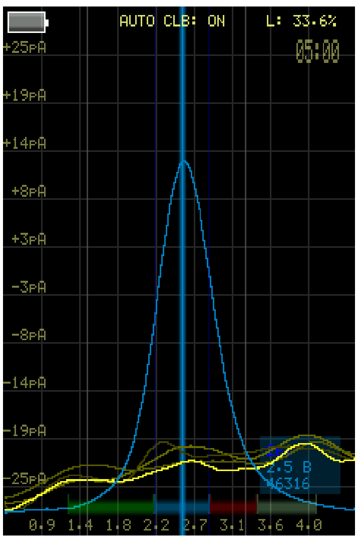
To turn on the device, you must hold the "Back/Enter" button for 3 seconds. Under this button on the handle of the device there is a corresponding switch symbol. This activates the which displays a hint on how to turn on the device. The device is turned off in the same way: by holding the button for 3 seconds. After turning on the product, the device self-test system will start

Decoding text messages on the device display: Starting the IVP - checking the operation of the secondary power source; Setting up the GAN – setting the parameters of the separating electric field of the asymmetric voltage generator; Caliber. IR – calibration of the measuring channel of the device; Caliber. RK – calibration of the reference channel of the device; Settings zone detection – setting the position of substance detection zones; Checking the pump – checking the functionality of the pump; Checking the GAN – checking the operability of the asymmetric voltage generator.

The time for self-diagnosis of the device, depending on environmental conditions and the internal temperature of the device, can range from 8 seconds to 10 minutes (at a temperature of less than 12 ° C).

The device display in the ionogram display mode is shown in the fig. 2 [4]. The yellow graph displays the spectrogram of the measuring channel. The blue graph on the screen corresponds to the reference channel, relative to which constant auto-calibration is performed. The horizontal scale shows the sweep of the compensating voltage. The vertical scale corresponds to the ionic current recorded by electrometers in picoamperes. At the bottom of the screen there are color bars corresponding to the confidence zones for detecting substances. When a peak falling within the confidence zone is detected, an inscription appears on the display indicating the type of explosive detected [2].

Depending on the environmental conditions, the reference channel graph is automatically adjusted so that the maximum of the spectrogram is in the center of the screen. At the same time, the detection zones for target substances shift [3]. Detection zones are conventionally indicated by stripes of different colors at the bottom of the display. The settings provide a search for six zones: TNT, RDX, HMX, PENT, and two user ones - SUB1 and SUB2. The iono gram simultaneously displays five measurement channel graphs corresponding to five successive display updates; At the same time, the lines of the graphs have decreasing intensity and are consistently updated (fig. 2).

a)


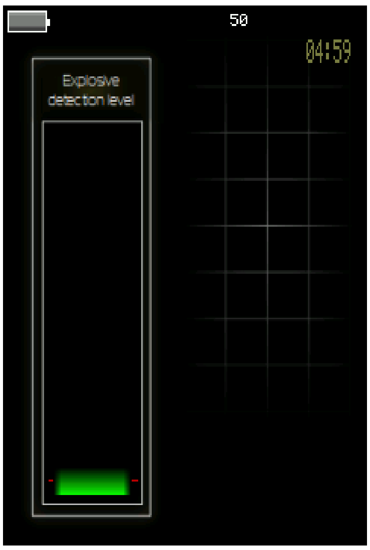
b)


Figure 2 – a) Device display in iono gram display mode; b) Device display in level scale mode

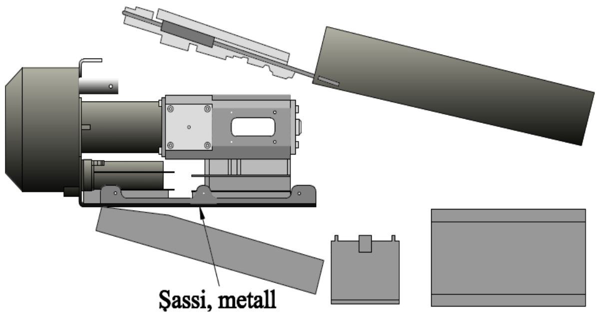


Figure 3 – Description of the product keyboard

In order to ensure aviation safety, we witnessed the prohibition of explosives and devices entering the airport area, and the possibility of detecting these items by various methods [5].

During the investigation of this research, in addition to the technical tools listed above, it is possible to use the spectrometer, which detects explosives, in airports (fig. 3). Let's take a closer look at this system.

Main features: Do not inspect people without contact, from head to toe; High productivity - inspection of 6 people in 1 minute; Fully automated system; Color sensitive screen.

The spectrometer is designed to eliminate the time-consuming manual search process. Detects and recognizes more than 40 substances in a few seconds. The operator controls the system with a color touch screen. The result of the analysis is written on the screen in an easy-to-understand manner. If a threat is detected, the color printer immediately prints the digital photos taken during the scan. Directly responding to consumer demands and based on multiple experiments, the new release of the explosive detection system uses low energy, has a modular frame design that allows the compressor to be placed inside the device, and takes up less space than previous models of the spectrometer system.

Conclusion

In addition, convenient design, excellent passenger interface and easy operating conditions further expand its capabilities. All these improvements have been made while maintaining the inherent sensitivity and reliability of the device.

It scans people to detect explosives and drugs. With its high productivity, it allows to scan many people in airports, customs, military bases, correctional labor camps, state-important facilities and mass events, performing head-to-toe inspection and detecting particles of dangerous substances.

Conflict of Interests

The authors declare there is no conflict of interests related to the publication of this article.

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