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DETERMINATION OF THE GEOMETRIC PARAMETERS OF POWDER (PFPA) AND SOLID FUEL PRESSURE ACCUMULATORS (SFPA) FOR APPLICATIONS IN AUTOMATIC FIRE EXTINGUISHING SYSTEMS

The article presents an algorithm for solving the problem and calculating the use of PFPA (SFPA) in automatic fire extinguishing systems. For given parameters P and V of the automatic fire extinguishing system, the geometrical parameters of PFPA (SFPA) are calculated, which allows to choose standard products for the system of AFTS with a powder (solid fuel) pressure accumulator taking into consideration length and area of combustion of charge.

Keywords: fire extinguishing units, powder and solid fuel pressure accumulator.

Problem formulation. Cases of destructive fires in the warehouses of ammunition and explosive substances indicate the urgency of their fire safety. One of the areas of warehouse protection is the use of efficient and high-speed automatic fire extinguishing units. Ensuring the units working condition and the reliability of their operation remains a problem.

Analysis of recent research and publications. Publications examining the protection of ammunition and explosive ordinance warehouses with automatic fire extinguishing systems offer the use of generally accepted systems that have a high degree of inertia and need for rigorous maintenance. The article [1] considers the possibility of using standard products of rocket armament of PFPA and SFPA to create pressure in the storage tanks of the extinguishing agent, which enables the maintenance of fire extinguishing systems without devices operating under high pressure (such as gas cylinders and pressure vessels). This ensures an increase in the reliability of the unit and facilitates maintenance in an operational condition. In the papers [2, 3] the issues of obtaining volumes of combustion products during the operation of PFPA and SFPA are considered. The above-mentioned works do not consider the possibility of choosing the geometric parameters of PFPA (SFPA) under the specific conditions of application.

Statement of the problem and its solution. The purpose of the work is to construct an algorithm and solve the problem of choosing the geometric parameters of PFPA (SFPA) for their use as sources of obtaining working pressure in the equipment of automatic fire extinguishing systems of ammunition and explosive substances.

The analysis of the main indicators of systems operation was carried out. Taking into account the possibility of accumulation of the necessary stock and the effect of use, it is proposed to use water as a fire-extinguishing agent. To ensure a sufficient efficiency of quenching with a spraying water jet, we accepted the working pressure in the system reservoir P_{rob} = 0.7 ... 0.9 MPa. Normative intensity of water supply to the surface of a stack of ammunition was I = 0.4 l / s · m^2 [4]. The conducted experiments showed that for humidifying the stack surface, the operating time of the system can be taken 60 s. at the standard intensity of water supply. The volume of the reservoir must be filled with a fire extinguishing agent to no more than 85%.

Adoption of these data allows determining the required geometric parameters of PFPA (SFPA) for use in automatic fire extinguishing systems.

The algorithm for solving the problem is shown in Fig.1

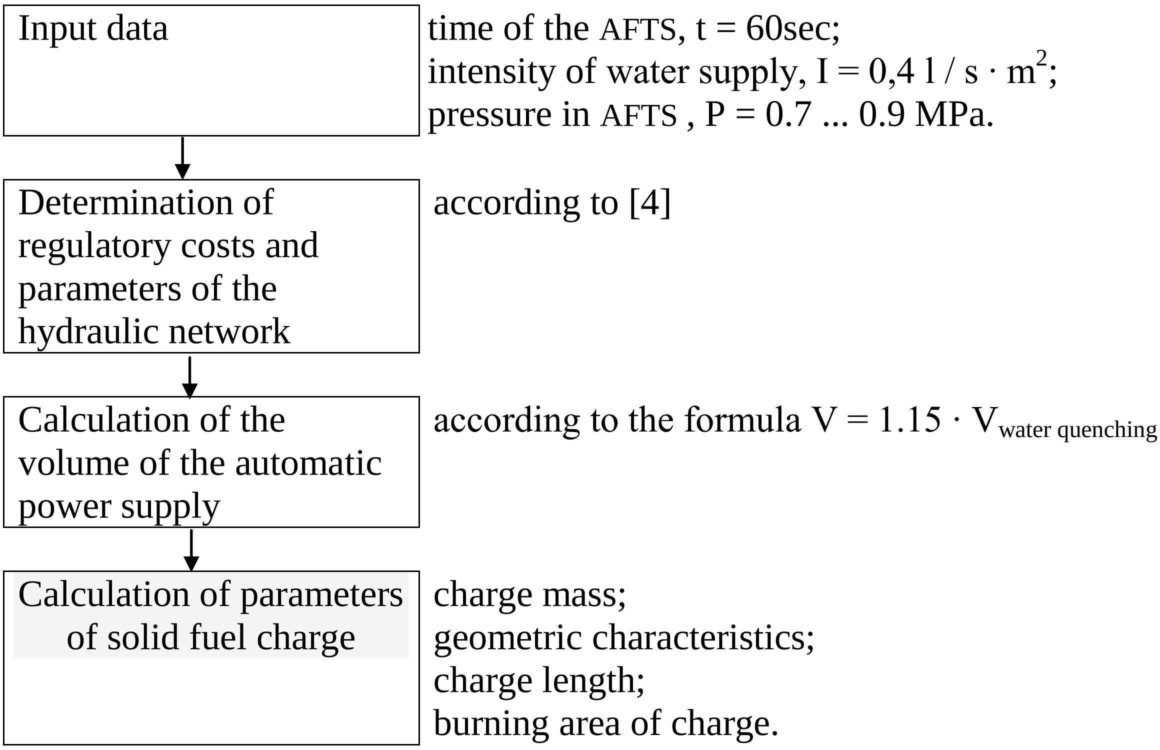

Fig. 1. Algorithm for solving the problem of determining the parameters of PFPA (SFPA) for AFTS

For the initial stage of the calculation, from the equation of the ideal gas state we determine the required mass of gas at given parameters for automatic fire extinguishing (P, V, R, and T = 800 ° C).

$$m = \frac{PV}{RT}. \qquad (1)$$

Using equation (1) and knowing the operating time of the system, we determine the required massive gas spending per second

$$m_{\Gamma} = \frac{m}{\tau} = \frac{PV}{RT}. \qquad (2)$$

Equation (2) does not allow us to calculate directly those values (working parameters) PFPA (SFPA). Thus, we use the equation of gas production of solid fuel charge [2,3] and define

$$m_{(+)} = \rho_{г} u S_{г} \ . \tag{3}$$

where $m_{(+)}$ - gas production charge, $\rho_{г}$ - gas density, u - burning rate of charge, $S_{г}$ - area of burning charge.

A separate issue is to calculate the rate of charge combustion, as it depends on many factors (components PFPA (SFPA) and combustion phase (initial, final, or other)).

Additionally, the operating time of an automatic system will be decisive to determine the burning speed since these systems may be effectively applied only in the initial stage of the fire, and then tanks. Therefore, given the relatively short working time of this system (up to 1 minute), we assume charge burning rate value to be constant, that is, u = const.

At the combustion of solid fuel charge PFPA (SFPA), the process in the first approximation can be considered adiabatic, since gas does not go anywhere but enters the capacity, which makes it possible to obtain (4) from (2) and (3)

$$m_{г} = m_{(+)} . \tag{4}$$

We substitute the value of massive gas consumption per second and gas production of a charge in equation (5) and we obtain

$$\rho_{г} u S_{г} = \frac{PV}{\tau RT} . \tag{5}$$

From equation (5) determine the burning area of charge

$$S_{г} = \frac{PV}{\tau RT \rho_{г} u} . \tag{6}$$

Knowing the length of the charge [2, 3] we will write down

$$l_{з} = u\tau . \tag{7}$$

Then the formula for the burning area will be written down

$$S_{г} = \frac{PV}{RT\rho_{г} l_{з}}. \quad (8)$$

Conclusions. Given the pressure parameters in the system, the volume of the tank of the automatic fire extinguishing system and the estimated time of its operation, it is possible to determine the geometrical parameters of the PFPA (SFPA), which enables, according to the length and area of the charge combustion, to select standard products for the system of AFTS with a powder or solid fuel pressure accumulator.

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Визначення геометричних параметрів порохових (ПАТ) і твердопаливних акумуляторів тиску (ТАТ) для застосування в автоматичних установках пожежогасіння

У статті наведений алгоритм рішення задачі та розрахунок використання ПАТ (ТАТ) в установках автоматичного пожежогасіння. При заданих параметрах Р і V автоматичної установки пожежогасіння розраховуються геометричні параметри ПАТ (ТАТ), що дає змогу по величинам довжини та площі горіння заряду підібрати стандартні вироби для монтажу АУПГ з пороховим (твердопаливним) акумулятором тиску.

Ключові слова: установки пожежогасіння, пороховий і твердопаливний акумулятор тиску.

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Определение геометрических параметров пороховых (ПАД) и твердотопливных аккумуляторов давления (ТАД) для применения в автоматических установках пожаротушения.

В статье приведен алгоритм решения задачи и расчет использования ПАД (ТАД) в установках автоматического пожаротушения. При заданных параметрах Р и V автоматической установки пожаротушения рассчитываются геометрические параметры ПАД (ТАД), что позволяет по величинам длины и площади горения заряда подобрать стандартные изделия для монтажа АУПГ с пороховым (твердотопливным) аккумулятором давления.

Ключевые слова: установки пожаротушения, пороховой и твердотопливный аккумулятор давления.