

## Development of the installation for the binary feed of gelling formulations to extinguishing facilities

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Paper received 14.03.17; Revised 20.03.17; Accepted for publication 22.03.17.

**Abstract.** In this paper, we solve the problem of increasing the efficiency of usage gel-forming compounds (GFC) during extinguishing fires, which is carried out by a dedicated remote (about 10 meters) supply of compact or spray GFC jets with trunks spray into the space above/before the hearth fire so that moving on pre-calculated the trajectories of the drops of compact or atomized jets constituting GFC initially not in contact with each other, and a spent (at the time they reach the space above/before the fire hearth) are mixed, there is a mechanical and chemical interaction between them, in which they are being deposited in layers, liberally coat the surface of the burning objects, locating and stopping combustion.

**Keywords:** *gel-forming compositions, pilot plant, fire fighting, remotely.*

**Introduction.** Over the past decade the number of fires in Ukraine was not reduced and for the current period it is about 70 thousand fires per year. In this regard, the development and introduction of new methods of extinguishing agents and their delivery remains relevant. Currently, the most common extinguishing agent is water. [1] It is available, relatively inexpensive and versatile. However, there is a significant disadvantage in relatively large losses due to runoff from the slope (vertical) surfaces of burning objects, which significantly reduces its fire-extinguishing efficiency and leads to additional costs from the water damage to the floors below it. Significantly reduce the loss of fire extinguishing agent, incidental or consequential damages, it allows the usage of gel-forming compounds (GFC) [2, 3], which are firmly good on inclined and vertical surfaces, which in comparison with using only water, significantly reduces the loss of quenching substances related with their runoff.

**Analysis of recent research and publications.** Modern GFC consists mainly of two separately stored components and simultaneously supplied. One of them is a gelling solution of alkali metal silicate. Other - solution substances that interact with silicates to form a stable non-sag gel. The gel on the surface of the object creates an extinguishing flame retardant layer, which prevents the spread of combustion. This feature of the GFC necessitates the usage of nonstandard means of storage and supply, in particular installations like AUTGOS and AUTGOS-P [4]. They are used as a framework ready frame of insulating mask "Drager" company. For frame mounted two plastic containers with 8 liters and can of compressed air. To install AUTGOS used cylinder capacity of 2 liters, and for installation AUTGOS-P cylinder (ICH 6.8 -139-300) with 6.8 liters. In order to ensure constant pressure in the containers with the components of GFC equal to 0.3 MPa, using reducer direct action. The apparatus AUTGOS-P, compressed air is supplied to the same dispensers pressure of 0.3 MPa. It is in both plants by flexible hose with an internal diameter of the system (5-8) mm.

Developing the idea of studies [2, 3, 4] in terms of extinguishing fires using GFC AUTGOS type structures, it can be stated that they do not always provide the localization and liquidation of fires in distance (about 10 meters) fire fighting. [5] Disadvantages AUTGOS installations and AUTGOS-P arise from the fact that their usage is not regulated data ballistics two jets of water solutions of GFC components [6, 7], which a priori related to the

synergistic effect of mixing jets constituting the GFC. Moreover, their mixing is carried out by spray-hold barrel in manual mode, ie, "By eye" estimated the spatial position of the trunks of spraying, which aim at the seat of fire approximately to the same orientation arbitrarily implemented jointly filing streams CRP components fire-fighting facility.

In other words, the use of plants and AUTGOS AUTGOS-P without proper tactical and technical provision does not exclude the error of premature gel formation of drops in motion bitstream GOS to the fire. As a result of untimely drops to form the mixture is not frozen gel will fall "precipitated" the approaches closer to the fire fighting project, and the effectiveness of supply GFC with these plants will decrease.

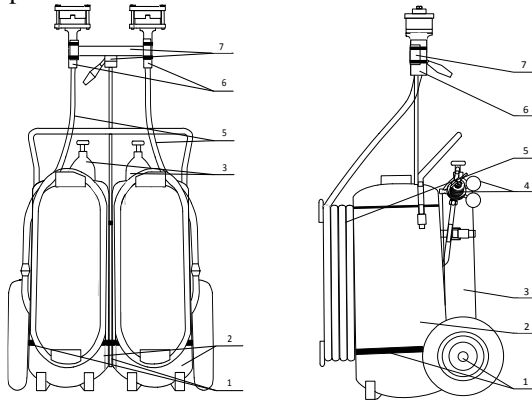
**Goal.** In connection with the above stated, the purpose is to improve the efficiency of the usage of GFC in distance (about 10 meters) fire fighting. Through constructive ensure targeted remote supply of compact or spray jets GFC trunks spray into the space above/before the hearth fire so that moving on pre-calculated trajectories drop GFC components initially not in contact with each other, and on the decline (at the time they reach the space above / front of the hearth fire) are mixed, between them there is a mechanical and chemical interaction in which they are being deposited in layers, abundantly cover the surface of the hearth burning objects, locating and stopping combustion.

**Materials and methods.** The problem is solved with the help of which we developed installation AUTGOS-M, which is designed to extinguish fires and protect neighboring hearth fire facilities with liquid phase fire extinguishing agents, in particular - aqueous solutions of GFC, and can be used for research purposes when creating instructions to users of autonomous remote fire extinguishing installations (tactical and technical support).

AUTGOS-M comprises a base frame, where installed: two containers with components of GFC, compressed air cylinders with visual indicators of pressure control in tanks, which are combined reducer of direct action. With that, contained in tanks, pressurized air, each GFC component, thanks to the connection of flexible hose system is supplied to the fire-fighting facility with two-spray trunks with one tap for their opening and closing, which is associated with a single or joint submission GFC components. In addition to the support the frame is set to spray-guided device trunks on fire fighting facility with verification at

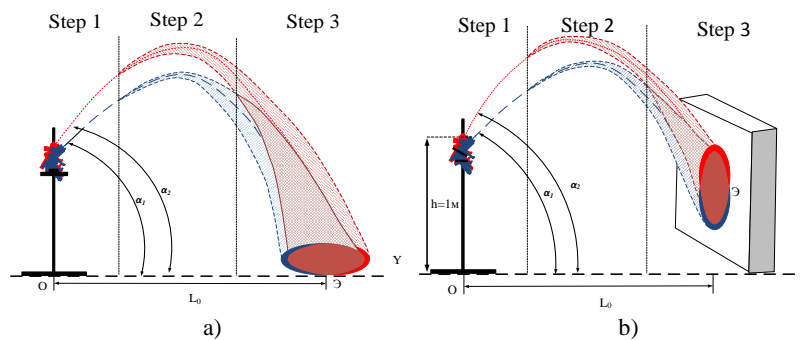
the corners of the elevation, yaw angles, height and width of the base of a symmetric placement and fixation spray-trunks.

Figure 1 shows a plant designed AUTGOS-M static components with its elements:



**Fig. 1.** General view of the installation AUTGOS-M: 1 - frame installation carts; 2 - The tank with the aqueous compounds of the GFC; 3. - compressed air cylinders; 4. - reducer with pressure indicators (gauges); 5. - system of connecting flexible hoses; 6. - Two spray trunk; 7. - Device for putting trunks on fire-fighting facility.

One use of tactics installation AUTGOS-M as outlined in Scheme example (Figure 2) and determines a focus feeding fire sputtered bitstream GFC component of one point two-gun barrels aimed at the hearth elevation at different angles  $\alpha_1$  and  $\alpha_2$  by pre-calculated trajectories of their movement. Whence it follows that the process of moving undrowned jets (GFC components) is naturally divided into three stages: Stage 1 - injection of compact parts make up the GFC in the atmosphere; Stage 2 - the free movement of dividing jets; Step 3 - Contact with object extinguishing sprayed jets of GFC.



**Fig. 2.** supply schemes in the hearth fire of two mutually independent sprayed jets bitstream GFC-gun barrels aimed to focus on the independent motion paths for extinguishing burning objects: a) arranged on a horizontal surface; b) arranged perpendicularly or obliquely towards the binary stream jets

It is understood that step 3 is characterized by the fact that there comes a time when the translational velocity of the particles (droplets) of binary stream along the coordinate axes OY become close to zero values. Then their movement is carried out either by the free-fall path to the location on a horizontal surface firefighting objects or stops when a binary stream meets on its way obliquely arranged burning objects. It is in this third step solutions both GFC components expedient form on/before the hearth fire as a gel drops mixture of two components.

Nevertheless, all three phases are external ballistics compact or atomized jets of aqueous solutions and therefore allow prediction of its movement in space by computational methods [8].

Obviously, in both variants of this problem is easy to find the optimal (rational)  $L_0$  distance, and the corresponding pair of angles  $\alpha_1$  and  $\alpha_2$  at which elevation extinguishing efficiency will be achieved well. In some cases (Figure 2a) mixing the components of GFC, it is desirable to carry out at the end of the third stage of the flow path; other (Figure 2b) - the second end (at the beginning of the third) stage [9].

**Results and discussion.** Tactical and technical support activities and fire-rescue in these cases is as follows:

1) Determine the extinguishing facility with located at a level (above/below) the cutoff type AUTGOS-M installation shafts;

2) Same trunks spray installation "AUTGOS"-M placed and fixed using a special installation device to the starting position with distance  $L_0$  from the epicenter of the fire;

3) Exhibit according to the calculation of the elevation angles  $\alpha_1$  and  $\alpha_2$  trunks in relation to the horizon;

4) Simultaneous opening of cranes barrels of spray given the same initial exhaust velocity  $V_0$  jets were both GFC, which to a certain pressure flow of these trunks.

As already mentioned setting can be used in the development of tactical and technical provision ("firing" of the table) by examining the tactical and technical characteristics of processes of remote supply of water and gelling binary formulations (trajectory, area lesions and others.) Under different operational conditions means the verifying the location of parameters and fixing the trunks of spray due to the presence in the installation of a special device. Then, using the derived table "firing" setting is used to extinguish fires in practice.

This unit has been tested (Figure 3) in conducting numerous experiments, including the extinguishing of model fires of Class A, allowing gain sufficient experimental material for constructing the corresponding mathematical models and develop them tactical and technical support. Some of the design decisions AUTGOS-M is already protected by patents of Ukraine, and the plant itself is adopted for usage in the educational process.



Fig. 3. Tests of elements, components installation AUTGOS-M

**Conclusions.** 1. A pilot installation AUTGOS-M remote binary extinguishing gel-forming compositions.

2. Proven order of operations regulated in creating tactical and technical maintenance of the new installations AUTGOS-M

3. The basic tactical and technical characteristics of the extinguishing solid flammable materials with the use of a pilot plant AUTGOS-M remote firefighting gel-forming compositions.

4. Proposed tactical techniques filing GFC on fire fighting, using the type "AUTGOS" installations

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#### Разработка установки для бинарной подачи гелеобразующих составов на объекты пожаротушения

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**Аннотация.** В данной статье решается задача повышения эффективности использования гелеобразующих составляющих (ГОС) при пожаротушении, которое осуществляется за счет целенаправленной дистанционной (порядка 10 метров) подачи компактных или распыленных струй ГОС стволами-распылителями в пространство над/перед очагом пожара так, что движущиеся по заранее рассчитанным траекториям капли компактных или распыленных струй составляющих ГОС вначале не контактируют друг с другом, а на излете (в момент достижения ими пространства над/перед очагом пожара) смешиваются, между ними происходит механическое и химическое взаимодействие, в результате которого они, осаждаваясь в виде слоев, обильно покрывают поверхность горящих объектов, локализуя и прекращая горение.

**Ключевые слов:** гелеобразующие составы, опытная установка, пожаротушение, дистанционно.