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THE ANALYSIS OF FOREIGN, NATIONAL REGULATORY DOCUMENTS AND RESEARCH ON THE DEVELOPMENT AND APPLICATION OF FOAMING AGENTS OF GENERAL PURPOSE FOR EXTINGUISHING FIRES

The aim of the article is to analyze normative documents, both national and foreign, patents, scientific works, dissertations, which are devoted to research on the development, application and improvement of general-purpose foaming agents used for firefighting. The analysis of research work related to the study of the properties of general-purpose foaming agents for fire extinguishing, showed that there was only the search and analysis of patent documentation compiled or published in the period up to 2010. Therefore, the aim of the article was to search and analyze patent documentation, research , documents on foaming agents for the subsequent period, namely 2010 - 2020. Taking into account the results of search and analysis of patent materials, we can conclude that fundamentally new approaches to the development of recipes and technologies for the production of foaming agents have not been created during this time. As before, foaming agents are produced both from raw materials of natural origin and from synthetic surfactants. In some cases, formulations of foaming agents made from natural raw materials contain additives of synthetic fluorine-containing surfactants. According to a patent search, synthetic foaming agents are used to extinguish non-polar combustible foams by supplying foam in both "hard" and "soft" ways. Foaming agents based on natural raw materials are used to extinguish them with the supply of foam mainly in "soft" way, "hard" method of its supply can be implemented in the presence of such foaming agents synthetic fluorine-containing surfactants, the presence of which reduces the intensity of foam destruction by hydrocarbons.. Foam generated from working solutions of any foaming agent of any type should be applied to extinguish polar flammable liquids only in a "soft" way. Analysis of scientific works (dissertations, research works, monographs) showed that during firefighting it is allowed to simultaneously use any biologically "soft" general-purpose foaming agents, any synthetic film-forming foaming agents, etc., provided that foam is generated by separate foam generators. If the possibility of mixing foaming agents is previously established, their simultaneous use is allowed, taking into account the concentrations of working solutions and foam generation by means of the same foam generators. It is not allowed to mix different types of foaming agents, even when extinguishing a fire. The necessity of developing a method of application of "One Seven" technology in Ukraine is substantiated.

Key words: *extinguishing agents, phlegmatization, cessation of combustion, efficiency***.**

Formulation of the problem. The first foaming agents began to be made from processed products of natural origin, but due to a number of shortcomings, work on their development on the basis of synthetic raw materials was started. The work made it possible to create relatively cheap foaming agents, which were made of synthetic surfactants, as well as equipment for generating foam of low, medium and high multiplicity.

The use of synthetic surfactants made it possible to extend the shelf life of foaming agents, increase the tactical capabilities of firefighting equipment and, ultimately, increase the fire-fighting efficiency of the foam itself. Later, fluorine-containing surfactants were synthesized, the introduction of which into the formulation of foaming agents made it possible to give them the ability to form aqueous films on the surface of nonpolar combustible liquids, primarily oil and petroleum products whose density is lower than water density. American foaming agents called "Light Water" (now called foaming agents because of their ability to form aqueous films on the surface of flammable liquids lighter than water) have proven to be much more effective at quenching oil and petroleum products than "traditional" concentrates. Today film-forming foaming agents are produced in many countries, and their use makes it possible to extinguish even the most

complex fires at refineries, oil tankers, and other cases where conventional foaming agents and other fire extinguishing agents do not provide the desired effect.

For a long time, the problem of extinguishing polar flammable liquids, such as alcohols, ketones or solvents for the paint and varnish industry, remained practically unsolved, but the introduction of water-soluble polymers additives into the foaming agents made it possible to extinguish such fires.

Continuous improvement of formulations of relatively cheap foaming agents based on natural raw materials has made it possible not to stop their production and to develop many fire extinguishing agents suitable for extinguishing non-polar and (in many cases) polar liquids and solid combustible materials. In addition, today the world produces a large number of foaming agents based on synthetic raw materials (both on the basis of only hydrocarbon surfactants and with the addition of fluorine-containing substances).

It should be noted that currently in some developed countries the use of relatively new technology for generating fire extinguishing foam and its supply to a significant height is increasingly developing, which can provide high efficiency of fire extinguishing while reducing the cost of building a protected structure. Therefore, research on the development and use of general-purpose foaming agents for firefighting is an urgent task.

Analysis of recent achievements andpublications. The analysis of the performed research works concerning the study of the properties of general-purpose foaming agents for fire extinguishing [1-4] showed that they were used to search and analyze patent documentation compiled or published in the period up to 2010. [5-10] . Based on its results, a classification of foaming agents was compiled (Figure 1), the existing approaches to the preparation of recipes and technologies for the production of foaming agents were identified, and an approximate list of surfactants suitable for their production was determined.

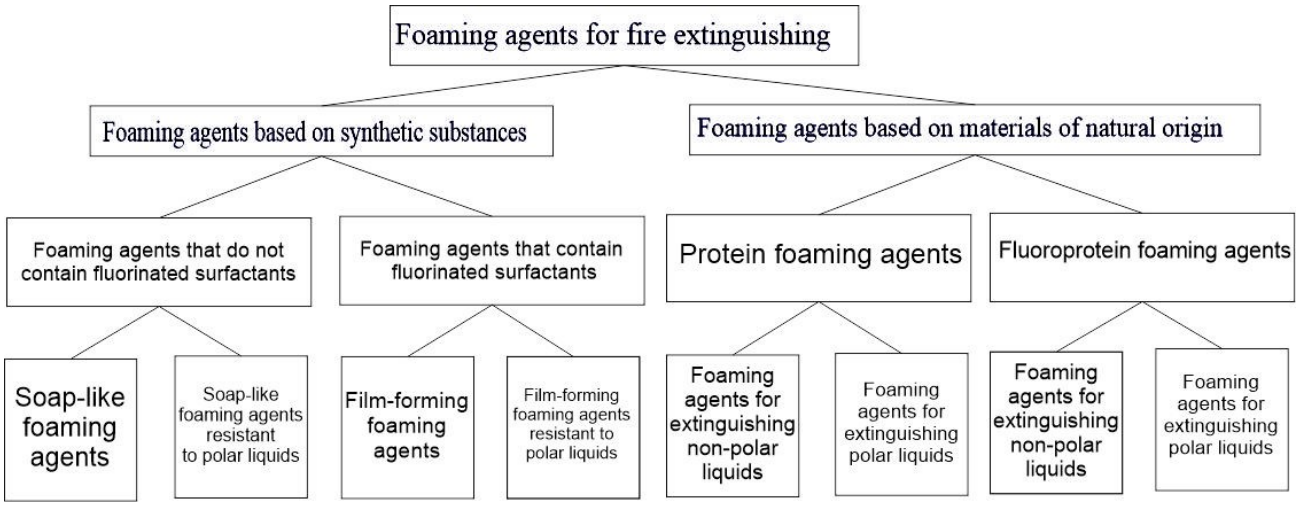

Figure 1 – Classification of Foaming Agents for Fire Extinguishing.

In particular, it is established that the main areas of improvement of foaming agents are to increase their shelf life by reducing corrosion activity and (or) inhibition of putrefactive bacteria (ie reducing the rate of contamination by corrosion products and surfactants), reducing the pour point to ensure homogeneity of foaming agents. low temperatures, increase of fire-extinguishing and insulating ability of foam, etc. However, all this is due to the complexity of recipes and technologies for the production of foaming agents and, as a consequence, increase their cost. Therefore, along with highly efficient "universal" foaming agents, relatively cheap "highly specialized" ones are also produced. When extinguishing many fires, the use of a cheaper and less efficient foaming agent is more economically feasible, while under certain conditions extinguishing can be achieved only with the use of the most expensive "universal" foaming agents.

Highlighting previously unsolved parts of the general problem to which the article is devoted. Given the above, the purpose of this article was to search and analyze patent documentation, research, documents on foaming agents for the subsequent period, namely 2010 - 2020.

Taking into account the results of search and analysis of patent materials [1-4], we can conclude that fundamentally new approaches to the development of recipes and technologies for the production of foaming agents have not been created during this time. As before, foaming agents are produced both from raw materials of natural origin and from synthetic surfactants. In some cases, formulations of foaming agents made from natural raw materials contain additives of synthetic fluorine-containing surfactants (such foaming agents are called fluoroprotein or fluoroprotein).

Problem statement and its solution. Patenting of foaming agents by their manufacturers is carried out mainly on the basis of the use of certain substances that are produced (used) by a particular enterprise. It is known that in recent years the volume of production and use of organosilicon surfactants has increased, which led to attempts to use them in the formulations of individual foaming agents. However, the analysis of patent documentation does not allow to draw a definite conclusion about the provision of foaming agents with special properties through the use of these compounds. Cases of foaming agents specially designed for extinguishing fires at radiation-hazardous objects, foaming agents with the addition of cultures of microorganisms etc are also not typical.

At present, the classification of foaming agents and their gradation according to fire extinguishing efficiency and insulating ability of foam is established by International [11-13], European [14-16] and national [17] standards.

Піноутворювачі для гасіння пожеж поділяють на такі групи:

- protein foaming agents (P - protein) are liquids obtained from hydrolyzed protein materials;
- fluoroprotein foaming agents (FP - fluoroprotein) are protein (protein) foaming agents with the addition of fluorine-containing surfactants;
- synthetic foaming agents (S - synthetic) are foaming agents based on a mixture of hydrocarbon surfactants, which may contain fluorine-containing surfactants and additional stabilizers;
- “alcohol resistant” foaming agents (AR) are foaming agents that may be suitable for extinguishing hydrocarbon fuels, and the foam generated from their working solutions is also resistant to decomposition when applied to the surface of water-soluble flammable liquids. Some "alcohol-resistant" foaming agents can form a polymer film on the surface of alcohol;
- aqueous film-forming foam (AFFF - aqueous film-forming foam) - are foaming agents, the basis of which is usually a mixture of hydrocarbons and fluorine-containing surfactants, they are able to form an aqueous film on the surface of some types of hydrocarbon fuel;
- film-forming fluoroprotein (fluoroprotein) foaming agents (FFFP - film-forming foam fluoroprotein) are fluoroprotein (fluoroprotein) foaming agents capable of forming an aqueous film on the surface of some types of hydrocarbon fuel.

Publications in scientific, technical and journalistic publications, monographs, as well as dissertations are devoted to the development of formulations of foaming agents, the study of the effectiveness of their various types in extinguishing certain flammable liquids, identifying the influence of chemical nature, fractional composition and additives to foaming agents, efficiency of the foam generated from its working solutions, research of the factors influencing results of their tests, and also definition of dependence of fire-extinguishing efficiency of the foam generated from working solutions of foaming agents of various types, on chemical nature of combustible liquids during their extinguishing.

Analysis of the information provided in these publications shows that a significant factor influencing the performance (including fire-fighting efficiency) and scope of the foaming agent is its chemical nature. Depending on it both the scope of the foaming agent and the normalized supply parameters of its aqueous solutions are determined.

According to the regulations, foaming agents for fire extinguishing are divided into two classification groups depending on their properties, as well as objects and conditions of use: general-purpose foaming agents and special-purpose foaming agents. According to the ability to decompose under the influence of microflora of reservoirs and soils, foaming agents are divided into biologically "soft" (biological ability to decompose is 80% or more) and biologically "hard" (biological ability to decompose is less than 80%).

In many cases, the names of foaming agents contain information about the recommended concentration of their working solutions.

As a rule, foaming agents are developed in such a way that the concentration of their working solutions is equal to 6% (vol.), 3% (vol.) Or 1% (vol.). Exceptions may be foaming agents intended for use in shipboard fire extinguishing systems, extinguishing solid combustible materials, forest fires, etc.

General purpose foaming agents ("S" type foaming agents) are made of synthetic hydrocarbon surfactants and additives, as a rule, they do not contain fluorine-containing substances. They are suitable for generating low, medium and high multiplicity foam from working solutions, as well as preparation of wetting solutions. Such foaming agents are intended for extinguishing fires of classes A and B, ie solid combustible substances and materials (except for those which enter into chemical interaction with water) and water-insoluble combustible liquids.

Requirements for foaming agents used for firefighting are established by standards, as well as technical conditions and other regulations on foaming agents, agreed in the prescribed manner. Extinguishing

of combustible liquids and solid combustible materials by foam occurs mainly due to the isolation of vapors coming from the burning surface from the oxidant (usually oxygen), with its simultaneous cooling. In the case of extinguishing solid combustible substances and materials with wetting solutions, the dominant factor is the cooling of their surface. The addition of surfactants to water makes it possible to increase the cooling efficiency of substances and materials that burn. The use of wetting solutions of foaming agents instead of water also contributes to more efficient cooling of substances, materials, structures and equipment that are close to the fire and are protected from ignition by irrigation.

Foam generator shafts, which are recommended for use in the prescribed manner, should be used to obtain low, medium and high multiplicity foam from working solutions of foaming agents of all types. In particular, it is allowed to use barrels-generators of foam of all types certified in Ukraine. Low-density foam is used to extinguish fires in a "sub-layer" or surface way. Medium-density foam is used to extinguish fires in both surface and three-dimensional ways. High-density foam is used to extinguish fires in a three-dimensional way.

There are two ways to apply low and medium multiplicity foam: "hard" supply and "soft" supply. "Hard" supply of foam involves its contact directly with the surface of the liquid or combustible material. This method of feeding foam is mostly used. The "soft" supply of foam involves its smooth flow on the surface of the liquid or combustible material from another surface. A typical example is the supply of foam to the wall of the tank for storing water-soluble combustible liquid. Under conditions of smooth flow of foam from the tank wall to the surface of the water-soluble combustible liquid, its destruction is slowed down, and the fire-fighting efficiency increases. High-density foam is supplied directly into the protected volume (room).

Wetting solutions of foaming agents can be supplied with the use of fire trunks designed for the formation and supply of compact and atomized water jets.

Preparation of solutions of a given concentration is carried out in advance (for example, in case of storage in tanks of stationary fire extinguishing systems) or during operation of technical fire extinguishing means (by means of dosing devices, for example, ejection type mixers, dosing pumps, wide range proporters, etc).

It is not allowed to use foaming agents (both in the case of extinguishing with foam and in the case of extinguishing with wetting solutions):

- for extinguishing substances and materials that enter into chemical interaction with water (for example, alkali and alkaline earth metals, carbides, metal nitrides, etc.);
- to extinguish live electrical equipment.

Low and medium multiplicity foam formed from working solutions of foaming agents is not effective in extinguishing Class C fires (combustion of gaseous substances). The possibility and conditions of application of high-density foam for extinguishing class C fires shall be established in a volumetric manner by normative documents in force in the relevant field, or determined separately in each case and agreed with the state fire supervision authorities in accordance with the established procedure.

General purpose foaming agents are suitable for use in all types of technical fire extinguishing equipment (water and water foam extinguishers, water systems with wetting and foam fire extinguishing, fire trucks, etc.). They are used to extinguish class B fires with low, medium and high multiplicity foam, as well as to extinguish class A fires with compact and sprayed jets of wetting solutions, and low and medium multiplicity foam.

Water used for the preparation of working solutions of foaming agents must not contain impurities of oil and oil products visible to the naked eye. The possibility of using circulating water of industrial enterprises for the preparation of working solutions of foaming agents should be determined in each case by organizations that have licenses and accredited for testing foaming agents, based on the results of special studies and subject to coordination with state fire authorities.

To ensure the greatest efficiency of the use of foaming agents and their aqueous solutions, measures should be taken to stabilize their quality, as well as compliance with the conditions of transportation and storage, which ensure the best preservation of quality indicators.

General-purpose foaming agents are used primarily for extinguishing fires in industrial, commercial enterprises, warehouses, vehicles, in the residential sector, etc. When extinguishing fires in tanks for storage of combustible liquids, including oil and oil products, as well as isolation and extinguishing spills of these liquids, special purpose foaming agents are more effective. In the case of general-purpose foaming agents, the main means of extinguishing oil and liquid petroleum products is medium-density foam. It is recommended to apply working solutions of foaming agents for receiving foam of average multiplicity under pressure from 0,5 MPas to 0,6 MPas. Medium-density foam formed from working solutions of foaming agents in the case of using GPS-type

foam generator barrels can usually be supplied only at short distances (several meters), which can significantly reduce the tactical capabilities of firefighting equipment and firefighters, as well as the safety of people who participate in firefighting. In order to increase the length of foam jets, it is allowed to use foam generator barrels of special designs that have been tested and recommended for use in the prescribed manner.

Low-density foam formed from working solutions of general-purpose foaming agents is less effective in extinguishing Class B fires than medium-density foam formed from them, especially in the case of extinguishing liquids with low blazing up points. However, low-density foam can be applied over long distances (several tens of meters). To generate it, SVP-type generator shafts and other types of equipment that have been tested and recommended for use in the prescribed manner are used. Fire extinguishing systems use low-density foam generators of the above types, foam sprinklers and other types of fire-fighting equipment that have been tested and recommended for use in the prescribed manner.

Low-density foam, formed from working solutions of general-purpose foaming agents, is recommended only for extinguishing oil and liquid petroleum products with a flash point above 1000C, eliminating the combustion of liquids in the embankment during firefighting in tanks for storage of oil and petroleum products, and extinguishing solid combustible materials. The fire-extinguishing efficiency of low-density foam, which is formed from the working solutions of general-purpose foaming agents, largely depends on the method of its supply and the design of the devices used to produce foam. Normative intensity of supply of working solutions of foaming agents of general purpose in case of extinguishing by foam of low multiplicity is defined by carrying out special researches.

The intensity and duration of the supply of working solutions of general-purpose foaming agents in the case of extinguishing fires with high-density foam should be taken in accordance with the regulations in force in the relevant field, agreed in the prescribed manner.

The foaming ability of aqueous solutions of general-purpose foaming agents, as well as the fire-extinguishing efficiency of the foam formed from them, may deteriorate with increasing hardness of the water used for their preparation. Deterioration of the foaming ability of aqueous solutions of foaming agents and fire-extinguishing efficiency of foam can also be observed in the case of using water that contains significant amounts of salts of other metals. In the case of general purpose technical water, artesian spring water or water from natural reservoirs with a total hardness of more than 15 mmol / dm3 (15 mg-eq./dm3) and containing more than 5 g / dm3 of mineral salts for the use of foaming agents for the preparation of working solutions, concentrations of working solutions of foaming agents should be determined by organizations that have licenses and accredited for testing foaming agents, based on the results of special studies, unless otherwise specified in the regulations on foaming agents, agreed in the prescribed manner.

The addition of foaming agents to water for the preparation of wetting solutions reduces its surface tension, improves the wetting of combustible materials of organic origin and facilitates the penetration of water to their pores. This reduces water consumption and increases the rate of quenching of hydrophobic materials (cotton wool, peat, cotton, fabric, paper, wood, etc.). In addition, wetting the pores of organic materials that are prone to decay reduces the likelihood of re-ignition. Increasing the hardness of water and the content of mineral salts in it does not affect the wetting ability of aqueous solutions.

For the preparation of wetting solutions general-purpose foaming agents that do not meet the established requirements for certain indicators (for example, foaming agents whose aqueous solutions have partially or completely lost foaming properties) are also suitable provided that they retain wetting properties. For their supply the fire trunks intended for formation and supply of compact and sprayed streams are used. The intensity of the supply of wetting solutions of foaming agents in the case of quenching of most solid combustible materials should be taken 0.05 ... 0.20 dm3 / (m2 * s).

Protein and fluoroprotein foaming agents are commonly used to quench water-insoluble flammable liquids with low-density foam. There are also protein and fluoroprotein foaming agents suitable for quenching water-soluble flammable liquids. Foams formed from working solutions of protein foaming agents are characterized by high resistance to dehydration and thermal resistance, which cause a sufficiently high fire-fighting efficiency and insulating ability. Feature of the foam formed from working solutions of the majority of protein foaming agents is low resistance to action of water-insoluble combustible liquids. Therefore, it should be submitted in such a way as to prevent immersion in the fuel ("soft" way). The addition of some fluorine-containing surfactants to protein foaming agents makes it possible to obtain fluoroprotein foaming agents. Foam formed from working solutions of fluoroprotein foaming agents has greater thermal stability and resistance to fuel than foam formed from working solutions of protein foaming agents.

In the absence of film-forming properties, the foam formed from the working solutions of fluoroprotein foaming agents ("FP") should also be applied to quench flammable liquids in a "soft" way. Fluoroprotein foaming

agents with film-forming properties should be used in accordance with the provisions relating to fluorosynthetic film-forming foaming agents. Foaming agents based on natural raw materials are destroyed under the action of microorganisms more intensively than synthetic foaming agents. The presence in their composition of fluorine-containing surfactants and (or) antiseptic additives increases the shelf life. The rate of destruction of the components of such foaming agents can be significantly increased if they are stored in the form of aqueous solutions. In addition, surfactant molecules of natural origin are large in size, due to which their aqueous solutions are prone to delamination. Therefore, it is generally not allowed to store protein and fluoroprotein foaming agents (including film-forming and those suitable for extinguishing water-soluble flammable liquids) in the form of working solutions in tanks of stationary fire extinguishing systems.

In the case of introduction into the composition of foaming agents made on the basis of natural or synthetic raw materials, of certain fluorine-containing surfactants, the surface tension of their aqueous solutions becomes lower than the surface tension of hydrocarbon liquids. As a rule, the surface tension of the working solutions of film-forming foaming agents is equal to 16 ... 18 mN / m, which determines the possibility of formation of an aqueous film on the surface of water-insoluble combustible liquids. In the case of the use of film-forming foaming agents, the insulation of the liquid surface occurs due to the formation of an aqueous film on it, which prevents the evaporation of the combustible liquid. Its presence provides not only rapid quenching of the liquid, but also high resistance to re-ignition from the action of hot metal surfaces. The foam practically does not lose fire-extinguishing and insulating efficiency during "hard" contact with water-insoluble combustible liquids and can be given directly on their surface.

Film-forming foaming agents are designed primarily for quenching oil and petroleum products with low-density foam. The medium multiplicity foam formed from their working solutions is usually inferior to the low multiplicity foam in terms of insulating ability, although the rate of flame quenching with medium multiplicity foam may be higher. Therefore in case of application of film-forming foaming agents extinguishing of oil and oil products it is most expedient to carry out foam of low multiplicity.

If the foaming agent is suitable for use with seawater, the concentration of working solutions in drinking water, water from fresh natural reservoirs, artesian springs and seawater should be the same. The suitability of the foaming agent for use with seawater means that the foam generated from its working solutions in drinking water and seawater model of the established composition must provide extinguishing of the same model fires under the same test conditions (same experimental equipment, intensity of working solution supply). etc). The suitability of the foaming agent for use with seawater must be confirmed experimentally.

If necessary (for example, in case of removal of the foaming agent stored at the facility from production) during storage it is allowed to mix biologically "soft" general purpose foaming agents made of surfactants of the same nature. If the nature of surfactants is unknown the possibility of mixing with each other during storage of foaming agents made on the basis of surfactants of different nature must be determined in each case.

During firefighting, the simultaneous use of any biologically "soft" general-purpose foaming agents, any synthetic film-forming foaming agents, etc is allowed, provided that the foam is generated by means of separate foam generators. If the possibility of mixing foaming agents is previously established, their simultaneous use is allowed, taking into account the concentrations of working solutions and foam generation by means of the same foam generators. It is not allowed to mix, even during firefighting, different types of foaming agents (for example, general-purpose foaming agents and synthetic film-forming foaming agents, synthetic raw material-forming foaming agents and foaming agents made of natural materials)..

In recent years, information about the development and application of firefighting technology called "One Seven" has emerged. This technology involves the implementation of a new method of generating foam, as well as the use of film-forming foaming agents, which have very low concentrations of working solutions (about 0.3… 0.4%). Unlike traditional methods of generating foam, when it is formed directly in the fire barrel, which is used to supply it to the fire, this technology involves obtaining foam with a multiplicity of about 7 by means of a barrel installed in front of a fire hose or pipeline, followed by its movement with the help of the fire hose (pipeline) to the combustion chamber. According to advertising data, the implementation of the technology "One Seven" provides a significant increase in the efficiency of extinguishing both combustible liquids and solid combustible materials. It can be used both in stationary fire extinguishing systems and for extinguishing fires using mobile firefighting equipment. In the first case, one of the main advantages is the ability to reduce the weight of the pipelines of the stationary fire extinguishing system, because in case of fire they will move not the working foam, but air-mechanical foam with a multiplicity of about 7, the density of which is about 7 times less than the density water (water foaming agent).

According to available data, "One Seven" technology is used for fire protection of high-rise buildings in a number of European countries, the United States, China and some other countries. Research of this technology for the purpose of development of regulatory documents is begun in the CIS countries, however in Ukraine at present there is no experience of its application, the corresponding researches also weren't carried out.

Conclusions. The results of the analysis of various sources show that in recent decades, fundamentally new approaches to the development and production of foaming agents for firefighting have not been created. As before, foaming agents are made from synthetic raw materials or substances obtained from the processing of raw materials of natural origin, and in some cases mixtures of these substances. These substances are mostly of a similar chemical nature, more specific are additives that are introduced into the formulations of foaming agents by different manufacturers or offered by researchers. Surfactants suitable for the development of foams for both general and special purposes for firefighting are not currently produced in Ukraine. The existing facilities at the enterprises of the state, suitable for the production of these substances, have been decommissioned. In this regard, the need for exploratory or applied research to develop formulations of foaming agents for firefighting based on raw materials produced in Ukraine, is currently absent.

The fire-fighting efficiency of the foam generated from the working solutions of foaming agents depends primarily not on their manufacturer, but on the chemical nature of the foaming agents and the applied fire-fighting technologies. Indicators of fire extinguishing efficiency and insulating capacity of foam generated from working solutions of a foaming agent can be determined using the relevant international, European or national standards. In recent years, Ukraine has been working to create and update the regulatory and technical framework governing the testing of foaming agents, as well as their application. [1-17]. All these documents provide for known methods of generating (using fire barrels-generators or nozzles, foam sprinklers) and feeding foam (hinged jets, overboard, through foam chambers, floating from a protective screen, under a layer of fuel, through an elastic sleeve on the surface of the liquid). However, in the scientific and technical literature, reference books and regulations there is not enough information on the normalized parameters of the foam generated from the working solutions of modern foaming agents for fire extinguishing, during the extinguishing of most flammable liquids and solid combustible materials. There are currently no normative documents or at least recommendations on the use of "One Seven" technology or other latest developments in Ukraine, which necessitates appropriate researches.

Types of foam (low, medium or high multiplicity), devices for its generation (barrels-generators of low, medium or high multiplicity foam, foam sprinklers, high-pressure foam generators, etc.) that can be used during foam fire extinguishing, as well as methods of foam supply (hinged jets, through the foam chambers, on top of the liquid surface, through the fuel layer, etc.) are determined primarily by the chemical nature of the foaming agents. The effectiveness of the foaming agent in the case of foam supply in one way or another depends on its chemical nature and fire-fighting equipment used in firefighting, as well as on the chemical nature of the combustible liquid or solid combustible material and the method of foam supply. In this regard, during studies to determine the fire-extinguishing efficiency of foam generated from working solutions of foaming agents of different types, when extinguishing a combustible liquid, it is necessary to study the dependence of fire-extinguishing efficiency of foam on the method and intensity of its supply, layer height and duration of free combustion of liquid, external factors, etc, ie to identify the conditions for the most effective use of foaming agents to extinguish this liquid.

Existing normative documents regulate the value of the normative intensity of supply of working solutions of foaming agents of different types in case of extinguishing of oil and oil products with low and medium multiplicity foam, however, the influence of additives of polar liquid detonators to motor fuel on the fire-fighting efficiency of foam generated from working solutions of foaming agents of different types has also been insufficiently studied. Therefore, appropriate analytical and experimental studies are required in the future

Prospects for further research. Thus, the promising areas of analytical and experimental research in the field of foam fire extinguishing in Ukraine at present are:

- detection of the influence of polar additives-detonators added to motor fuel on the fire-fighting efficiency of foam generated from working solutions of modern foaming agents for fire extinguishing, as well as determining the conditions (type of foaming agent, type of foam, intensity, method and duration of its supply, etc.) efficiency of their extinguishing (both in case of storage in tanks, and during extinguishing of spills);

- study of the influence of the chemical nature of non-polar and polar combustible liquids on the fire-fighting efficiency of foam generated from working solutions of modern foaming agents for fire extinguishing, as well as determining the conditions (type of foaming agent, type of foam, intensity, method

and duration of its supply, etc.) their extinguishing (both in case of storage in tanks, and during extinguishing of spills);

- study the effectiveness of "One Seven" technology and other new ways and develop recommendations for its use.

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АНАЛІЗ ЗАКОРДОННИХ, НАЦІОНАЛЬНИХ НОРМАТИВНИХ ДОКУМЕНТІВ І ДОСЛІДЖЕНЬ ЩОДО РОЗРОБКИ ТА ЗАСТОСУВАННЯ ПІНОУТВОРЮВАЧІВ ЗАГАЛЬНОГО ПРИЗНАЧЕННЯ ДЛЯ ГАСІННЯ ПОЖЕЖ

Метою статті є аналіз нормативних документів, як національних так і закордонних, патентів, наукових робі, дисертацій, які присвяченні дослідженням щодо розробки, застосування та покращення піноутворювачів загального призначення, які використовуються для гасіння пожеж. Аналіз виконаних науково-дослідних робіт, які стосуються дослідження властивостей піноутворювачів загального призначення для гасіння пожеж, показав, що проведений пошук та аналіз патентної документації, складеної або опублікованої у період до 2010 р. Тому ціллю статті було здійснення пошуку та аналізу патентної документації, наукових досліджень, документів стосовно піноутворювачів за подальший період, а саме 2010 – 2020 р. Беручи до уваги результати пошуку та аналізу патентних матеріалів, можна зробити висновок, що принципово нових підходів до розроблення рецептур і технологій виробництва піноутворювачів за цей час не створено. Як і раніше, піноутворювачі виробляють як із сировини природного походження, так і з синтетичних поверхнево-активних речовин (ПАР). В окремих випадках рецептури піноутворювачів, виготовлених з природної сировини, містять добавки синтетичних фторвмісних ПАР. З проведеного патентного пошуку встановлено, що піноутворювачі на основі синтетичної сировини застосовуються для гасіння неполярних горючих рідин з подавання піни як "жорстким" так і "м'яким" способом. Піноутворювачі на основі сировини природного походження застосовуються для їх гасіння з подаванням піни переважно "м'яким" способом, "жорсткий" спосіб її подавання допускається реалізовувати у разі наявності у складі таких піноутворювачів синтетичних фторвмісних ПАР, наявність яких знижує інтенсивність руйнування піни вуглеводнями. Подавання піни, генерованої з робочих розчинів будь-яких піноутворювачів будь-якого типу, на гасіння полярних горючих рідин, має здійснюватися тільки "м'яким" способом. Аналіз наукових робіт (дисертацій, науково-дослідних робіт, монографій) показав, що під час гасіння пожеж допускається одночасне застосування будь-яких біологічно "м'яких" піноутворювачів загального призначення, будь-яких синтетичних плівкоутворювальних піноутворювачів тощо за умови генерування піни за допомогою окремих піногенераторів. Якщо попередньо встановлено можливість змішування піноутворювачів, то допускається їх одночасне застосування з урахуванням концентрацій робочих розчинів і генерування піни за допомогою одних і тих самих піногенераторів. Не допускається змішувати між собою, навіть під час гасіння пожежі, піноутворювачі різних типів. Обґрунтовано необхідність розробки методики застосування технології "One Seven" в Україні.

Ключові слова: *вогнегасні речовини, флегматизація, припинення горіння, ефективність.*