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**THE ORIGIN, DEVELOPMENT AND PROSPECTS OF FOAM  
EXTINGUISHING IN FACTURES OF FUEL AND ENERGY COMPLEX**

**ПРОИСХОЖДЕНИЕ, РАЗВИТИЕ И ПЕРСПЕКТИВЫ  
ПЕННОГО ПОЖАРОТУШЕНИЯ НА ПРЕДПРИЯТИЯХ  
ТОПЛИВНО-ЭНЕРГЕТИЧЕСКОГО КОМПЛЕКСА**

I.F. Hafizov, I.A. Khairetdinov,  
FSBEI NPE “Ufa State Petroleum Technological University”,  
Ufa, the Russian Federation

Хафизов И.Ф., Хайретдинов И. А.,  
ФБГОУ ВПО «Уфимский государственный нефтяной технический  
университет», г. Уфа, Российская Федерация  
e-mail: ilnur049@mail.ru

**Abstract.** Variety of modern foam extinguishment equipment with coefficient of air filled foam, methods of its obtaining and applying technologies, make foam almost universal method in the sphere of firefighting, including the sphere of Fuel and Energy Complex. However, air filled foam being one of the method of firefighting has a range of unsolved problems.

The authors analyze the basic historical facts, scientific researchers and prospects of further development of today’s method of fire extinguishment.

Foam extinguishing in oil and gas industry is one of the most widespread, effective and even the possible one. In fact, all kinds of air filled foam are applied to protect the objects: low, medium, high expansion foam. By the way, foam generators are applied in accordance with their function, chemical composition and method of foam application.

The important thing is that in 60s researchers of fire extinguishment of flammable liquids did not have much success. It became clear that low

expansion foam from existing foam generators and chemical foam were ineffective during extinguishment of large fires. At the same time higher expansion foam was applied, obtained from inflatable foam generators. But experiments did not have good results. Today with the help of modern generators it became possible to obtain foam with the expansion, nearly 1000 without boost air charging. Nowadays the most important problem is further development of scientific school, which is now unfortunately lost. Variety of modern foam extinguishment equipment with coefficient of air filled foam, methods of its obtaining and applying technologies, make foam almost universal method. However, air filled foam being one of the method of firefighting has a range of unsolved problems.

The authors forecast some trends related to the developing of foam firefighting.

**Аннотация.** Разнообразие современного оборудования пенного пожаротушения по диапазону кратности воздушно-механической пены, способам ее получения и технологии применения делает сегодня пену почти универсальным средством борьбы с огнем, в том числе и в сфере ТЭК. Однако, воздушно-механическая пена, как средство пожаротушения, имеет ряд не полностью разрешенных проблем.

Авторами анализируются основные исторические факты, научные исследования и перспективы развития данного метода пожаротушения.

Пенное пожаротушение в нефтегазовой отрасли является наиболее популярным, эффективным, а порой и единственно возможным. Для защиты объектов фактически применяют все виды воздушно-механических пен: пена низкой, средней и высокой кратности. При этом используются пенообразователи в соответствии с их назначением, химическим составом, способом подачи.

Важным аспектом является то, что в 60-е годы работы по изучению возможности тушения крупных пожаров горючих жидкостей (ГЖ) не имели особого успеха. Стало окончательно ясно, что пена низкой

кратности из существовавших пенообразователей и химическая пена неэффективны при тушении крупных пожаров. Одновременно пробовали применять пену более высокой кратности, получаемую надувными пеногенераторами на сетках. Но эксперименты не приносили соответствующих результатов. На современном этапе в генераторах новой конструкции стало возможным получение пены кратностью около 1000 без наддува воздуха.

Сегодня одной из важных задач в этой области является дальнейшее развитие научной школы, которая, к сожалению, в настоящее время частично потеряна. Разнообразие современного оборудования пенного пожаротушения по диапазону кратности воздушно-механической пены, способам ее получения и технологии применения делает пену почти универсальным средством.

Авторами прогнозируются некоторые тенденции по совершенствованию пенного тушения.

**Key words:** fire extinguishment, air filled foam, fire outbreak, foam generator, subsurface suppression, tank, foam expansion.

**Ключевые слова:** пожаротушение, воздушно-механическая пена, возгорание, пеногенератор, подслоное тушение, резервуар, кратность пены.

Variety of modern foam extinguishment equipment with coefficient of air filled foam, methods of its obtaining and applying technologies, make foam almost universal method. In this article we discuss the basic historical moments of origin of today's method of fire fighting and show the prospects of foam extinguishment developing.

L.M. Rozenfeld's researchers are considered to be a beginning of foam extinguishment, who introduced into production the structure of foam generators

based on animal blood protein and synthetic PAV (surfactants) of some kerosene suites, which were intended for obtaining air filled foam.

At the end of 1930 the problem of applying foam to extinguish fires had not been studied systematically. After the developing of PO-1 and PO-2 the researchers offered to study the properties of firefighting foams to improve their strength.

At the end of 1940 and the beginning of 1950 several large fires of oil store took place. In 1949 Central Research and Planning Institute of Residential Public Buildings was ordered to develop recommendations of extinguishment such fires. At the same time the Ministry of Oil Industry of USSR built special fire landfill in Baku for these purposes, the main showplace of which became tank with the volume 5000 cu m. Under the leadership of I.I. Petrov territory for testing in model tanks was equipped, which served further in the sphere of foam extinguishment developing.

Researchers of fire extinguishment of flammable liquids continued without much success. It became finally clear that low expansion foam from existing foam generators and chemical foam were ineffective during extinguishment of large fires. At the same time higher expansion foam was applied, obtained from inflatable foam generators. But experiments did not have good results. The peak of oil production in 1960 required solving this problem strongly.

In January, in 1962 the fire department was established, which soon got the legendary for nowadays All-Russian Research Institute for Fire Protection of Ministry of Russian Federation for Civil Defense, Emergencies and Elimination of Consequences of Natural Disasters № 5. The work plan of the department had the theme of developing fire extinguishment of oil in rock solid sunken oil storage. At the end of the same year on the landfill in Almet'yevsk, large scale experiments with firefighters of Tatarstan and Moscow were held. However new projects didn't solve the problem.

In 1963 in the newly formed fire department under the direction of I.I. Petrov I.I., complex exploration works of foam extinguishment were began. The

laboratory of foam generating agents headed by Kazakov M.V. analyzed the structure of existing in the world foam generators and searching regularities of behavior of foam depending on components. The laboratory, headed by V. Ch. Reutt, with the participation of I.I. Petrov researched the influence of methods of producing foam on its extinguishing qualities. Key element to solve the problem was finally found, foam generator.

A new milestone in the modernization of fire extinguishment method began in the 70 s of 20 s century. At that time still some fire testing stations studied the problems of foam fire extinguishment. During the experiments with the usage of grid foam generator with boost air charging, from which usually got foam with the expansion rate 300 and more, charge air device was broken. However foam didn't stop to form. It differed little bit from usual high expansion foam. Later initiative developers began to offer their own constructions of foam generators to the main management, which sent these offers to the Central Research Institute for review and conclusion regarding practical worthiness.

First large fire was extinguished during large scale experiments, giving less 0,1 l/s for one square meter of burning surface even for a short time. As a result the efficiency of fire extinguishment methods increased by times.

So, the essential solution of problem took place. The development of practical norms and recommendations of fire extinguishment in tanks with the usage of foam with medium expansion rate began. Work in this new direction, concluded with the experiments in autumn, 1965, at a port of Baku and in 1996, at a port of Leningrad, showed high efficiency of low expansion rate foam even during extinguishment large capacities on Boards. As a result amendments were made in the USSR shipping register, in accordance with which medium foam expansion rate, getting with the help of generators PGV600 became the main method of fire extinguishment on ships. This research became one more step in developing partnership of Ministry of maritime fleet with the Institute. In 1967 special research laboratory was founded, it was a part of Central scientific research institute, located in Leningrad (Nowadays it is a branch of ST

Petersburg All-Russian Research Institute for Fire Protection of Ministry of Russian Federation for Civil Defense, Emergencies and Elimination of Consequences of Natural Disasters).

The head of SNIL in 1968 became V. I. Somov. To participate the research work of foam fire extinguishment the member of fire testing station of Sverdlovsk A.A. Kotov was invited, who developed foam generators with expansion rate 1000. With his participation, fire foam extinguishment began in bulges. Unfortunately, a lot of problems appeared and such works were stopped.

At the same year under the leadership of Kazakov the structure of foam generator PO-1S was developed, the foam of which could more successfully extinguish fire of water soluble flammable liquids, such as lower alcohol and organic acids, acetone and etc., aggressive to usual foam, and with the research laboratory of fire department Ministry of Interior of Azerbaijan USSR the method of extinguishment of such flammable liquids in tanks was developed. This work was ended in 1971 with accepting «Recommendations about how to extinguish flammable liquids in tanks».

On the sixteenth of April in 1973 «The directions how to extinguish oil fires and oil products in tanks» were confirmed, developed on the basis of results of researches of All-Russian Research Institute for Fire Protection of Ministry of Russian Federation for Civil Defense, Emergencies and Elimination of Consequences of Natural Disasters, which replaced all the previous norms in this area.

After accepting this document the research intensity of applying foam increased. The focus was made on studying automatic fire extinguishment systems.

In 1984 successful acceptance tests were held, issued by expert plant GIPH alcohol foam generator, called FORETOL. Interdepartmental commission confirmed its high efficiency and awarded to the technical conditions the status of serial production. Lagging from West is decreased.

Studying chances of reducing the number of fluorSAS (superficially active substance) and cheapen the structure became the next task in the sphere of foam generators. By the time new big problem appeared in the field of fire safety. At the beginning of 1980 the production of methanol was increased for the needs of production of fertilizers purposely for its export. Extinguishing tactics legalized in 1971 with its recommendations based on preliminary dilution of flammable liquids after evacuation of product, was inapplicable on this scale. FORETOL the foam generator also could not radically solve the problem because of raw materials lack and its cost.

In 1986 acceptance testing of new foam generator was held. Designed on the basis of preceding to it FORETOL, the compound contained half as much fluorSAS (фторПАВ), the part of which was cheaper than previous SAS (ПАВ).

Later half of 1980 N. V. Sotnikov under the leadership of A. F. Sharovarnikov created the foam generator with the medium expansion rate of ejection type with the record low flow g/s. Thereby quick audit of foaming capacity was possible in the laboratory without usage of landfill equipment. N. V. Sotnikov also offered an interesting method of foam application ( which analogs did not exist in the world), which allowed to reduce the necessary rate of foam application in 1.5 times. For realization of subsurface suppression in 1987 the group under the leadership of A.F. Sharovarnikov was given, it was called sector of new types of extinguishment. Its main focus became the development of self-contained types of extinguishment, investigation of extinguishing foam application regularities under the bed of fuel and studying the possibility of extinguishing foam in the body of fire when jet fire stream falls in it. All these researchers, including the recommendations of subsurface suppression did not get the continuation.

The most important research of the institute in 1988 in the sphere of foam generators was the end of developing the standards with the foam generators regularities, began in the mid of 1980, it stopped with putting in force GOST P 50588 in 1993.

With the beginning of the economy of country the developing foam generators compound due to All-Russian Research Institute for Fire Protection of Ministry of Russian Federation for Civil Defense, Emergencies and Elimination of Consequences of Natural Disasters step by step lost its actuality. The deficiency of raw materials even for the most effective foam generators stopped. Accordingly, organizations wishing to start production of foam generators needed to find only a suitable formulation among the already developed foam generators. Since the mid of 1990 in Russia any kind of foam generators were available, even the best ones in the world. Market competition led to the liquidation of inefficient production, production of “Film-forming”, FORETOL and “Universal” was stopped.

By the mid of 1990 many new compounds appeared on the market, their assortment changed constantly. Due to acute shortage of normative indicator values, helped to check the quality of different foam generators, which were made on the basis of European requirements and ISO (International Standards Organization), necessity of revision of standards appeared in 1993. Fire worthiness requirements were developed NPB (Fire worthiness requirements) 304-2001, contained the requirements to foam generators and their test methods.

In 2007 the recommendations « Usage procedure of foam generators for fire extinguishment» were issued [2]. In 2009 GOST P 53280. 1 was brought into action, with the requirements to foam generators to fire extinguishing of water soluble polar liquids and with test methods, developed on the basis of suitable section, annulled by that time NPB 304-2001[3].

Due to certain circumstances an amount of experimental work significantly decreased, however, normative documents continued to be revised. By 1999 fire extinguishing in tanks recommendations of 1991 were actualized [4].

Scientific work in this sphere gradually faded. However, it would be wrong to consider that the prospects of such work were absent. As far as the region of interest covers the most substantial and current fire safety directions, it unchangingly attracts the attention among the specialist of other directions,

including All-Russian Research Institute for Fire Protection of Ministry of Russian Federation for Civil Defense, Emergencies and Elimination of Consequences of Natural Disasters. For example, new application of previous developing of All-Russian Research Institute for Fire Protection of Ministry of Russian Federation for Civil Defense, Emergencies and Elimination of Consequences of Natural Disasters received the development. With the help of that ancient setting and modern foam generator in full level testing, petrol flame in tank, with capacity of 5000 m<sup>3</sup>. (burning surface area 344 m<sup>2</sup>) was extinguished within 30 s. On the basis of this developing the prospect of increasing power weight ratio during fire extinguishing in tanks opened [5].

Since the mid of 1990 in Russia any kind of foam generators were available, even the best ones in the world. Market competition let to the liquidation of inefficient production.

The first national setting for receiving foam with the help of compression method was also created. Replacement of grids to perforated with round holes sheets, allowed not only ease the production conditions of medium expansion foam, but also dramatically changed the design of foam generators with high expansion.

## **Conclusions**

Foam extinguishing in oil and gas industry is one of the popular, effective and also only possible method. All kinds of air filled foams are actually used to protect the objects: low, medium, high expansion foam. Foam generators are used accordingly to their function, chemical compound and supply method. Thus, we can identify the trends for improving foam extinguishment.

- creation of new modern foam generators;
- creation of separate components-supplements to existing foam generators, which increase their quality (additive polymers to improve foam stability);
- improving the design of foam generators (high expansion foam, obtained without forced air supply or filled with inert gas);

- improving tactical options of fire extinguishing with foam application.

However, the most important and difficult task in this way is renewal of scientific school in the sphere of foam extinguishment, which is today unfortunately lost.

## References

1 Korolchenko A. Ya., Korolchenko D.A. Fire and explosion hazard of substances and materials and methods of their extinguishment. Reference book: a book in two separate volumes. M.: «FIRESCIENCE», 2004. Part 1. p. 110. [in Russian].

2 Federal State Institution Fire Safety Research Institute EMERCOM of Russia and State Institution of EMERCOM of Russia. Recommendations «Usage procedure of foam generators for fire extinguishment», 2007.45p. [in Russian].

3 All union state standards P 53280.1-2010. Automatic extinguishing settings. Fire fighting agents. Foam generators for fire extinguishing of water soluble flammable liquids. General technical requirements and testing methods. M., 2010. I. «STANDARDINFORM» p.12. [in Russian].

4 Fire Code 83-99 Automatic settings of water and foam extinguishment. Operating controls. General technical requirements. Testing methods, M., 1999. p. 183. [in Russian].

5 Usage procedure of foam generators for fire extinguishment: Instructions.- M.; Fire Safety Research Institute, 1996. p. 27. [in Russian].

## Список используемых источников

1 Корольченко А. Я., Корольченко Д. А. Пожаровзрывоопасность веществ и материалов и средства их тушения. Справочник: в 2-х ч. М.: «Пожнаука», 2004. Ч. I. С. 110.

2 Порядок применения пенообразователей для тушения пожаров  
Рекомендации ФГУ ВНИИПО МЧС России и ГУ УОП МЧС России. М.,  
2007. 45 с.

3 ГОСТ Р 53280.1-2010. Установки пожаротушения автоматические.  
Огнетушащие вещества. Пенообразователи для тушения пожаров  
водорастворимых горючих жидкостей подачей сверху. Общие технические  
требования и методы испытаний. М., 2010. Ч. I. 12 с.

4 НПБ 83-99 Установки водяного и пенного пожаротушения  
автоматические. Узлы управления. Общие технические требования.  
Методы испытаний. М., 1999. 183 с.

5 Порядок применения пенообразователей для тушения пожаров:  
Инструкция. М.: ВНИИПО, 1996. 27 с.

### **About the authors**

#### **Сведения об авторах**

I.F. Hafizov, Candidate of Engineering Sciences, Associate  
Professor of the Chair “Fire and Industrial Safety” FSBEI NPE “Ufa State  
Petroleum Technological University”, Ufa, the Russian Federation

Хафизов И.Ф., канд. техн. наук, доцент кафедры «Пожарная и  
промышленная безопасность» ФГБОУ ВПО УГНТУ, г. Уфа, Российская  
Федерация

I.A. Khairetdinov, Master of Group MFS-12 of the Chair “Fire and Industrial  
Safety” FSBEI NPE “Ufa State Petroleum Technological University”, Ufa,  
the Russian Federation

Хайретдинов И.А., магистр гр. МПБ-12 кафедры «Пожарная и  
промышленная безопасность» ФГБОУ ВПО УГНТУ, г. Уфа, Российская  
Федерация

e-mail: ilnur049@mail.ru