BULETINUL Universităţii Petrol – Gaze din Ploieşti	Vol. LXI No. 2/2012	57-62	Seria Tehnică

Experimental Research Referring to Obtaining Mixture Water-Foam Concentrate Used for Extinguishing Fires of Petroleum Products

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Abstract

The paper presents experimental research regarding the optimization of achieving a mixture of water and foam concentrate, which form foaming agents used to extinguish fires in the oil industry. In the framework of research account was taken of the phenomena and processes encountered in fires from petroleum industry, so that, during tests have been used equipment and accessories used in actual practice interventions of fire-fighting.

Key words: *flow rate, water, foam concentrate, fire* .

Introduction

The main method of fire-fighting in case of petroleum products fires consists of freely flowing of a stable layer on the burning liquid's surface, this method being so effective due to the fact that the foam film cools the upper layer of the burning liquid, but also for isolating it from oxygen.

Also, foaming agents used in fire-fighting have a reduced thermoconductive coefficient, thus making difficult transmission of heat from the flame's nucleus to liquid and preventing vapors from coming out of fluid in the area of combustion, and also applying a mechanical influence on flame [4].

In this context, it's trying to find the most effective ways to achieve foams for extinguishing fires, which, depending on the type of burning liquids, to respond the best to requirements for fire-fighting tactics.

The main aim for optimizing fire-fighting foams is to improve their main characteristics, which directly influence the efficiency of extinguishing and these are the following: chemical composition, fluidity, expansion rate, drain's time, thermal stability, density and tolerance to the fuel [2].

Experimental Tests to Determine the Flow Rate of Foam Concentrates for Obtaining Fire-Fighting Foams Used for Extinguishing Fires of Petroleum Products

The flow rate of foam concentrate must be harmonized to the flow of water, as the concentration in the water for extinguishing should be 1 %, 3 % or 6 %, depending on the type of foaming fluid or the product to be put out.

At the same time, water flow rate entering into Venturi pipe is dependent on the required jet's length or the hydraulic resistance of the entire route through which the liquid is directed inside the oil tank.

Thus, in order to obtain a good effectiveness to fire-fighting, it is necessary to obtain qualitative foam, which is directly related to the flow of foam concentrate which is introduced in the water relieved on the burning surface. This flow rate can be adjusted from the vacuum created in the area of cylindrical Venturi, where the vacuum is maximum and dependent on the flow of water.

To achieve foaming fluid's introduction into the water passing through the Venturi the vacuum must be less than atmospheric pressure. Such a condition is difficult to be done in this case because, by working at the inlet pressures up to 10 bar, it is hard to get an important vacuum's level.

As performing elements to create vacuum can be used drosels with cylindrical drawer or with conic, flat or cylindrical shutter etc.

For the development of this mixture – water-foam concentrate - is suggested to use the drosel with conical drawer controlled by the vacuum carried out in the Venturi pipe. Schematic design of this drosel is shown in Figure 1.

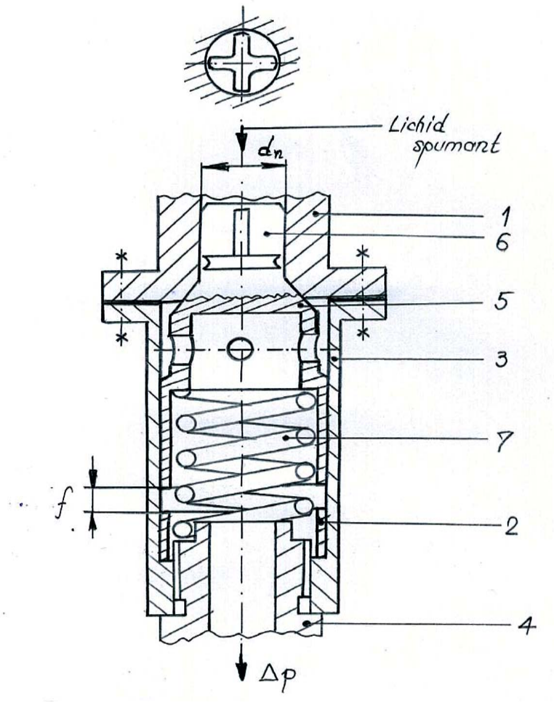

Fig. 1. Drosel with conical drawer:
1-fitting to foam concentrate container; 2 - spacer ring; 3 - frame; 4 - fitting to Venturi pipe; 5 - drawer cone; 6 - drawer guide; 7 - spring

Among the drosel's component a spacer ring is observed as it limits the opening. Under the terms of a constant flow rate, when the vacuum created by the Venturi pipe remains constant, this spacer ring is designed to provide the concentration of foaming liquid into water of 1 %, 3 % and 6 %.

In extinguishing fire's practice have been also carried out, different tests to determine optimum thickness of the foam layer to be applied on the burning liquid's surface, depending on ignition temperature, their respective values being written in the Table 1 [1, 3].

Table 1. Thickness of the foam layer, depending on burning materials [1]

Nr. crt.	Fire type	Thickness of the foam layer (cm)
1.	Combustible liquid with ignition temperature > 120 ^{0}C	10
2.	Combustible liquid with ignition temperature between 28…120 ^{0}C	15
3.	Combustible liquid with ignition temperature < 28 ^{0}C	20

To determine the flow rate of foaming liquid used to obtain an optimum foam layer thickness which should be used to extinguish fires in the petroleum industry, has been designed a device, whose sketch and quotas are shown in Figure 2.

The device on the whole is shown in Figure 3 and has been tested in conditions close to situations determined by real fires.

It was connected to a fire truck type APCA 12.215 equipped with a diesel engine type D 2156 HMN8 and with a centrifugal pump type PSI 50/8, by means of a fire hose type "C" (fig. 3).

Using the device shown above have been made a few measurements for determining the quantity of foam concentrate that is absorbed from the graduated container (14).

Thus, through the fire hose type "C" (5), which has been connected to centrifugal pump type PSI 50/8, the water from the fire truck's tank was driven through the device. Depending on the input pressure measured with the pressure gauge (3) have been determined quantities of liquid absorbed from graduated container (14) through the hose (1).

Also, at different values of the input pressure, have been determined levels of vacuum carried out in the nozzle's areas (6), (7), (8), values displayed on the dial gauge (13). The amount of liquid relieved through the fire hose (12) at different values of input pressure, for a certain period of time can be determined by measurement of the level gradually accumulated in the container (15).

Results Processing, Analysis and Interpretation

Have been carried out a few measurements for different values of inlet pressure of the water from the fire truck tank, starting with the value of 4 bar. Gradually the engine speed was increased, so the pressure values measured on the gauge dial (3) to vary up to 10 bar.

In the first stage of the tests have been measured the values of the vacuum recorded on the dial gauge (13), which are written in Table 2.

In the second stage of experimental tests for variations of the water inlet pressure between 5 to 12 bar have been measured quantities of liquid drawn from the graduated container (fig. 4).

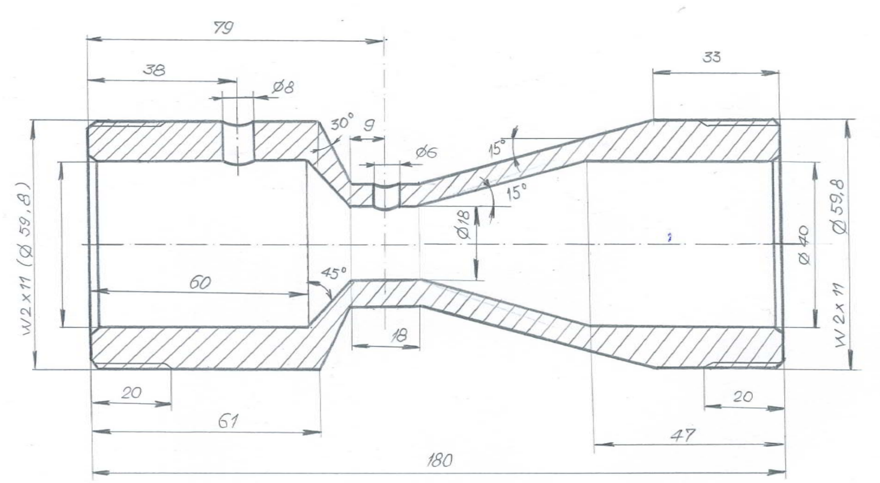

Fig. 2. Device's sketch used to determine the flow rate of foam concentrate

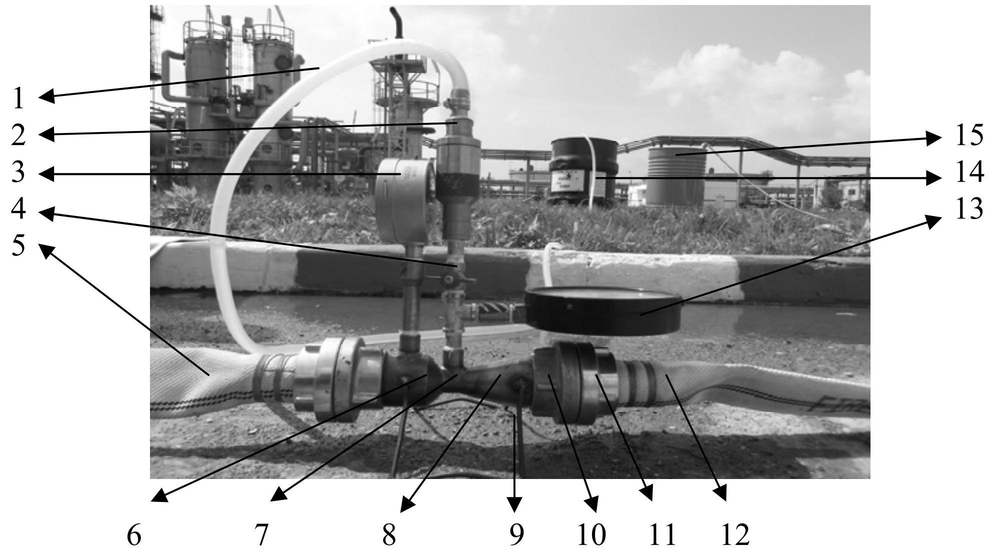

Fig. 3. The device's assembly used to determine the flow rate of foam concentrate
1- foam concentrate suction hose; 2 – drosel; 3 - inlet pressure gauge; 4 - tap; 5 -fire hose type "C" from fire truck; 6 - convergent nozzle, 7 - cylinder nozzle, 8 - divergent nozzle; 9 - support stand; 10 - fixed connection type "C"; 11 - mobile connection type "C"; 12 - hose type "C" for relief product; 13 - vacuum Gauge; 14,15 - graduated containers.

Conclusions

For obtaining foams used in extinguishing fires of oil products it is necessary the introduction of the foam concentrates into the water relieved from the fire truck tank, water passing through the Venturi pipe and creating a vacuum that must be less than atmospheric pressure.

The vacuum is not easy to be carried out in cases of regular fires, since working at the inlet pressures up to 10 bar, it is hard to get a very important vacuum.

The vacuum created varies directly proportionally with the values recorded for the inlet pressure of the water into the Venturi pipe, and the noticeable vacuum values are to be found above the inlet pressure of 4 bar, where the vacuum is approximately -0.8 (table 2, fig. 5).

In close connection with the vacuum created is also the amount of liquid absorbed, which varies directly proportionally with the inlet water pressure at the entrance into the device and with the vacuum created inside it (table 3, fig. 6).

Fig. 4. Inlet pressure and vacuum gauges.

Table 2. Vacuum depending on water inlet pressure

Nr. Crt.	p_i, bar	Δp, bar
1.	4	0.80
2.	5	0.81
3.	6	0.82
4.	7	0.84
5.	8	0.88
6.	9	0.90
7.	10	0.92

Table 3. Amount of absorbed liquid depending on inlet pressure

Nr. Crt.	p_i, bar	Q, l
1.	5	0.450
2.	6	0.600
3.	8	0.800
4.	10	0.900
5.	11	1.100
6.	12	1.200

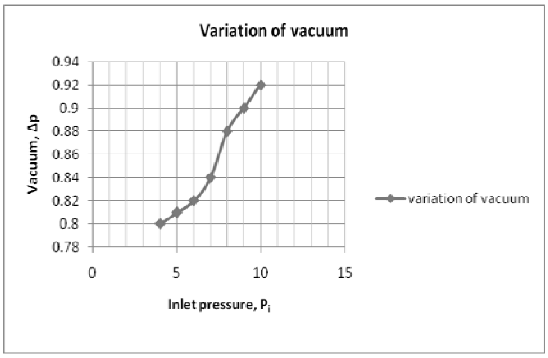

Fig. 5. Variation of vacuum depending on inlet pressure, p_i

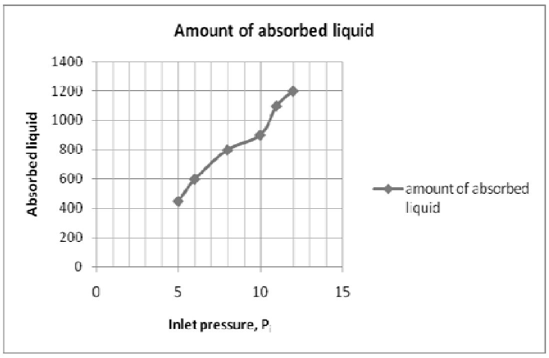

Fig. 6. Variation of the amount of absorbed liquid depending on inlet pressure, p_i

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4. * * * – http:/www.instalatia_de_stins_incendiul_cu_spuma/

Cercetări experimentale privind obţinerea amestecului apă-lichid spumant destinat stingerii incendiilor de produse petroliere

Rezumat

Articolul de faţă prezintă cercetările experimentale privind optimizarea obţinerii unui amestec de apă şi lichid spumant, care formează spumele utilizate la stingerea incendiilor din industria petrolieră. În cadrul cercetărilor s-a ţinut cont de fenomenele şi procesele întâlnite la incendiile din industria de petrol, astfel că pe timpul testelor au fost utilizate echipamente şi accesorii folosite în practica intervenţiilor reale de stingere a incendiilor.