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Characterization of the Foam Products Used for Extinguishing Fires

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Abstract

This paper presents the experimental researches to determine viscosity variation versus temperature of foam concentrate products used for extinguishing fires in the oil industry. In order to perform the experimental research the author used two distinct equipments - Tamson mark viscometer with capillary extrusion and Brookfield DV-III Ultra rotational viscometer – and got the results of dynamic viscosity for four foam concentrate products.

Key words: *viscosity, foam concentrate, temperature*

Introduction

The technological process and lifestyle are provided and supported by current energy use obtained from the use of different sources. Even if at international level is campaigning to reduce classics fuel consumption, so far were not found viable alternatives to replace them.

Oil was and is considered one of the fundamental elements of modern economic life, even being dubbed “black gold”. It is considered by some experts of the field “blood economy”, constitute the contemporary era “core menu” for industry, transport and the first condition for national defense of states, but oil and its derivatives are known as wood fuel, highly flammable which can lead to fires with disastrous consequences.

Oil and its derivatives are stored in tanks park, consisting of several tanks, usually large. Given the fire risk involved, they are equipped with systems, installations, devices, appliances and other means of preventing and extinguishing fires.

Used for firefighting foams are conglomerates of air bubbles, wrapped in a thin film of foam solution, whose density is lower than liquid fuel. They are used mainly to form a compact layer above the liquid fuel, to prevent and / or extinguish a fire by eliminating oxygen and cooling the combustion zone.

Insulating layer by extinguishing product formed on the surface of burning liquid fuel is also designed to stop heat transfer by radiation, with resulting cooling of the surface layer and stopping the emission of volatile, leading to interruption of the combustion process and prevents relighting of fire.

Foam also has the property to adhere to surfaces, this property ensuring a degree of protection from adjacent fire points.

Concentrated foaming agents, manufacturing various grades and classes are often incompatible and should not mix, unless agreed in advance that does not entail an unacceptable loss of effectiveness. Foaming agents may be used in combination with other substances for fire fighting, particularly carbon dioxide and dry powder.

Foam firefighting systems not used where water is banned, and when burning substances can react with foaming agents and can form toxic or explosive mixtures.

In foam firefighting systems are used only foam products that have been certified by the General Inspectorate for Emergency Situations.

Features of Concentrated Foaming Agents

Concentrated foaming agents used in foam extinguishing installations will be chosen so as to have the desired effect on various types of liquid fuel.

Some foam is recommended to be used both for oil but also for polar fluids and solvents.

Depending on their composition, concentrated foaming agents can be:
- protein foam (P) - they are liquid substances derived from protein hydrolysates;
- flouroprotein foam concentrates (FP) - they are concentrated protein by adding fluorine surface active agents;
- synthetic foam (S) - they are based on mixtures of hydrocarbon and surface active agents and may contain fluorinated surface active agents with additional stabilizers;
- alcohol resistant foam (AR) - they may be suitable for use on oil and additionally are resistant to decomposition when applied to surface water miscible liquid fuels Some alcohol-resistant foam concentrate may precipitate a polymer membrane on the surface of alcohol;
- aqueous film forming foam (AFFF) - they are generally based on mixtures of surface active agents and fluorinated hydrocarbon and the capacity to form an aqueous film on the surface of some hydrocarbons;
- film forming fluoroprotein foam (FFFP) - they are flouroprotein foam who have the ability to form an aqueous film on the surface of some hydrocarbons.

Fire fighting foams are classified according to the coefficient of expansion (ratio of foam volume and foam solution volume was generated), so:
- low expansion foam: $k = 1$ to 20;
- medium expansion foam: $k = 21$ to 200;
- high expansion foam: $k > 201$.

Requirements for concentrated foaming agents are specified in SR EN 1568 with the general title “Fire extinguishing media. Foam concentrates”.

For concentrated foaming agents determine the following properties:
- sediment;
- pH;
- surface tension;
- coefficient array;
- airy and drainage for;
- viscosity;
- fire test performance.

In order to conduct certain laboratory tests, foaming agents may be subjected to conditioning at low or high temperature.

To increase efficiency in fire extinguishing were created products in the composition of certain components which are major risk to the environment.

Among the firefighting products with negative environmental effects include some concentrated foaming agents.

Thus, according to the Directive 2006/122/CE of the European Parliament end of the Council, some of firefighting foams was included in category PFOS, perfluorooctane sulfonates, being persistent, bioaccumulative and toxic to mammalian species and, therefore, indicate cause for concern.

PFOS fulfill the criteria for classification as very persistent, very bioaccumulative and toxic. PFOS also have a potential for long range environmental transport and have the potential to produce adverse effects and therefore fulfill the criteria for being considered as persistent organic pollutants (POPs).

However, existing stocks of fire-fighting foams containing PFOS should be identified and their use should be allowed to continue only for a limited time to prevent possible further emissions from the use of such products.

Firefighting foams that have been placed on the market before 27 December 2006 can be used until 27 June 2011. Until 27 December 2008, Member States have been establishing and communication within the Commission an inventory of existing stocks of fire-fighting foams containing PFOS. The uses of PFOS will be phased out as soon as the use of safer alternatives is technically and economically feasible.

Determination of Viscosity Variation versus Temperature

Currently there are a number of 15 fire-fighting foams used lawfully placed on the market in Romania.

Viscosity determination is made according to existing norms, depending on fire-fighting foam type:

- Newtonian firefighting foams;
- pseudo-plastic firefighting foams.

In case of Newtonian firefighting foams fluid flow occurs in layers moving at different speeds. If a force is applied tangential to the surface of contact between the liquid layers, the fluid immediately begins to run. If the force increases, the flow velocity will increase proportionally.

The viscosity of Newtonian firefighting foams is determined according to ISO 3104, and use the following terminology:

- density, ρ: mass per unit volume of a substance at a given temperature;
- kinematic viscosity, v: resistance to flow of a liquid under the force of gravity;
- dynamic viscosity, η: ratio of shear stress and velocity gradient of a liquid. Sometimes called dynamic viscosity coefficient, or simply, viscosity. Also, dynamic viscosity is a measure of resistance of a liquid to flow or deformation.

In case of pseudo-plastic firefighting foams, their viscosity decreases with increasing shear rate at constant temperature.

Thus, for determining viscosity, including for firefighting foams can be used different types of viscometer, such as for example: Höppler viscometer; Ubbelhöde and Ostwald viscometer with

capillary extrusion; Engler viscometer; Rheotest rotational viscometer; Brookfield viscometer; and others.

Determination of viscosity for some firefighting foams properly placed on the market in Romania was made at the National Center for Fire Safety and Civil Protection, specialized unit within the General Inspectorate for Emergency Situations, for the following four products: one pseudo-plastic Filfoam A 836 and three Newtonian Filfoam 916 Kerr, Profoam 806 G, Fluorofoam 806.

To make determinations were used:
- Tamson mark viscometer with capillary extrusion;
- Brookfield DV-III Ultra rotational viscometer.

The Brookfield DV-III Ultra rotational viscometer has built-in rheological algorithms to allow rapid and repeatable material characterization, including flow curves, yield points, time dependencies and temperature profiles. Overall viscosity range capability is 0.1 to 800 million cP (mPa•s). The Brookfield DV-III Ultra rotational viscometer works with Cone/ Plate and coaxial cylinder geometries as well as standard Brookfield LV/ RV/ HA/ HB spindle sets.

Fig. 1. Photo of the Brookfield DV-III Ultra rotational viscometer

The experimental tests for four firefighting foams to temperatures of 15, 20 and 25^{o}C, were obtained the following values of dynamic viscosity:

Table 1. Viscosity values versus temperature

Firefighting foam	**Temperature** ^{0}C	**Viscosity** cP
Filfoam A 836	15	1800
	20	1660
	25	1000
Filfoam 916 Kerr	15	4.9
	20	4.6
	25	4.1
Profoam 806 G	15	12
	20	11
	25	10
Fluorofoam 806	15	6.8
	20	6.3
	25	6

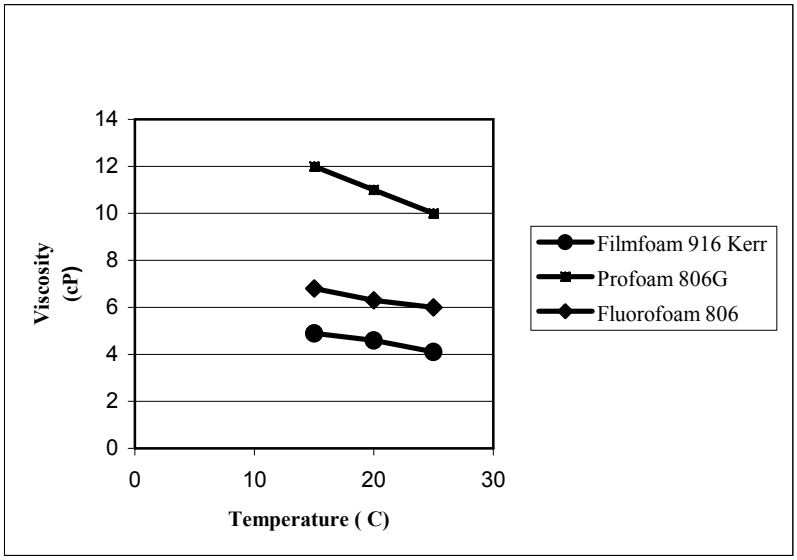

Fig. 2. Viscosity variation versus temperature for Newtonian firefighting foams

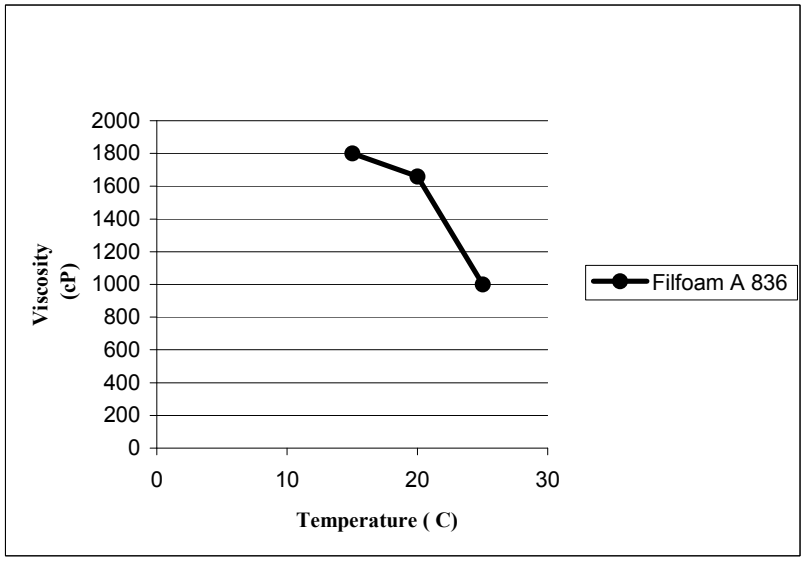

Fig. 3. Viscosity variation versus temperature for pseudo-plastic firefighting foam

Conclusions

1. For extinguishing fires in the oil industry there are a variety of firefighting foams which were tested on specific standards to meet marketing requirements. The specific properties of each foam concentrate results from its chemical composition have a decisive influence on their effectiveness in extinguishing fires.

2. According to the European Directives firefighting foams that have been placed on the market before 27 December 2006 can be used until 27 June 2011, because they was included in category PFOS, perfluorooctane sulfonates, being persistent, bioaccumulative and toxic to mammalian species.

3. In order to characterize the firefighting foams should research their rheological. Of firefighting foams that focus on viscosity variation with temperature was determined, the best behaved and foaming agents Filfoam 916 Kerr and Fluorofoam 806.

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Caracterizarea produselor spumante folosite la limitarea şi stingerea incendiilor

Abstract

Articolul de faţă prezintă cercetările experimentale în vederea determinării variaţiei vâscozităţii în funcţie de temperatură pentru produsele spumante concentrate folosite la stingerea incendiilor în industria de petrol. Pentru realizarea cercetărilor experimentale, autorul a folosit două echipamente distincte - vâscozimetrul cu extrudere capilară marca Tamson şi vâscozimetrul rotaţional Brookfield DV-III Ultra - şi a obţinut rezultate ale vâscozităţii dinamice pentru patru produse spumante concentrate.