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COMPARISON OF SOME PHYSICAL PROPERTIES OF FOAM CONCENTRATES – PYRONIL AND ALFA A

The choice of a suitable foam concentrate is the first precondition of achieving a foam (as an extinguishing agent) with optimal properties to extinguish A and B class fires. On the basis of the given facts, this article compares some physical properties of foam concentrates and their effect on the environment (environmental friendliness).

Keywords: foam concentrate, physical characteristics, Alfa A, Pyronil, effect on grass stands

INTRODUCTION

The existence of mankind has been accompanied with fire accidents since its birth. In the ancient times the natural fire accidents were the only fire source necessary for our ancestors to survive in unpleasant natural conditions. Fire was not always just a servant but caused damages and for many cultures and civilisations it was the reason of their fall.

We are trying to find an effective extinguishing agent for rapid extinguishing with the least harmful effect on the environment.

Extinguishing agents are inorganic and organic substances or their mixtures in solid, liquid or gas state. This is a summary of basic properties required for every extinguishing agent:

- high extinguishing effect (fast interruption of combustion on a large area with little consumption of an extinguishing agent)
- no harmful effects on objects and materials being extinguished (environmental friendly)
- no harmful effects on human and live organisms while using and storing
- availability, low prices, storing stability

There are many extinguishing agents. Their properties are determined by physical and chemical reactions occurring while interrupting combustion [1].

The objective of this article is to characterise and compare physical and chemical properties of Alfa A and Pyronil foam concentrates (tensides) used for foam production and their consequent effect on grass stands.

Foam concentrates characterisation

Concerning the chemical structure, a foam concentrate is a surface-active substance (tenside) which has to perform following functions:

- very good water solubility
- adhesive to wetted substance

A molecule of tenside consists of two parts:

- hydrophilic, water-soluble part which guarantees good water-solubility and creating of true and colloid solutions
- hydrophobic part which is absorbed on the surface of wetted substance and guarantees tenside adhesiveness to wet surface [3].

According to the character of hydrophilic molecule part, tensides are divided into:

- anionic, the hydrophilic molecule part is anion,
- cationic, the hydrophilic molecule part is cation,
- nonionic, the molecule of surface-active substance does not create ions.

Classification of foam-making additives according to STN EN 1568

According to the composition the foam making additives they are divided into the following groups:

- *protein foam concentrates* (P): liquids created from hydrolysed proteins,
- *fluoroproteine foam concentrates* (FP): protein concentrates with fluorinated surface active additives,
- *synthetic foam concentrates* (S): concentrates consisting of mixtures of surface active hydrocarbons can have fluorinated surface active agents with added stabilisers,
- *alcohol resistant foam concentrates* (AR): are suitable for extinguishing hydrocarbon fuel beside they are resistant to disintegration if used on the surface of burning, water soluble fuel, some of them can form polymeric layers on alcohol surface,
- *aqueous film-forming foam concentrates* (AFFF): generally consist of mixture of hydrocarbon and fluoroproteine surface-active agents and can form water film on the surface of some hydrocarbon fuel,

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- *film-forming fluoroproteine foam concentrates* (FFFP): fluoroproteine concentrates which can form water film on the surface of some hydrocarbon fuel [5].

EXPERIMENTAL PART

The objective of the experimental part was the comparison and characterisation of measurements and experiments. These experimental methods were carried out to verify some foam concentrates properties.

Testing the foam concentrates

The main reason of testing the foam is to identify the foam efficiency. Concerning the given fact that the foam is not a clearly chemically defined agent, as its basis can be of various foam concentrates and can be made by different methods of foam expansion. So it is possible to achieve a different quality of foam for the use of the same concentrate. [3].

The aim of the experiments is to verify the basic technical properties of foam concentrates:

- density determination
- water-solubility determination
- determination of pH-metry
- viscosity determination
- electric conductivity determination
- dry matter determination
- effect on grass stands

The density determination of chosen foam concentrates was realised by a densimeter. The ambition was to work with liquids whose density is close to water density.

The water solubility determination is based on the preparation of various concentrations of foam solutions. We worked with 0.4 % and 4 % foam solution concentrations and 100 % concentrates.

The pH number determination of foam solutions was determined by a pH-meter.

The viscosity determination was carried out by an Engler viscosimeter. The viscosity of chosen foam concentrates was measured at 20 °C temperature.

The electric conductivity determination was determined by a conductometer with glass electrode.

The dry matter determination was measured for 100 % concentrate only.

The effect on the grass stands was determined by application of 0.4 % and 4 % foam solution concentrations and 100 % concentrate and the following visual judgement [4].

RESULTS AND DISCUSSION

Description of the foam concentrates agents and their application.

Table: 1.

Foam concentrat	Characterisation	Application
Alfa A	<i>Foam concentrate (tenside)</i> yellow to brownish colour liquid, good water solubility, distinctive smell	forms water film, very good at wetting the surface in 0.4 to 6 % foam solution concentration
Pyronil	<i>Synthetic foam concentrate</i> dark brown colour liquid, good water solubility, distinctive smell	production of medium and light foam from 6 % foam solution concentration

Density of foam concentrate is the fraction of weight and volume. The results of the arithmetic mean achieved from the density values at 20°C are mentioned in table 2.

The water solubility is very important because of its influence on the density values of foam concentrates, the results are mentioned in table 2.

Based on the pH determination it is possible to state the conclusions about corrosive behaviour and bacterial disintegration of water foam concentrate, the values mentioned in table 2.

The viscosity determination provides us with results of behaviour during blending and suction process. The more viscous the solution is the worse the suction ability and hosepipe flow is. The viscosity depends on temperature (increases with lowering temperature)[2].

The determination of electric conductivity obviously shows dependence of conductivity values on concentration of foam solution.

The determination of percentile share of dry matter in foam concentrate shows amount of substance after water evaporation and a possibility of its deposition in the soil [4].

By preparing various concentrations of foam solutions it was found out that all tested substances were soluble into whole water volume.

The density of solutions is relatively the same, comparable to water density which is around 1000 kg.m⁻³. Foam concentrates had slightly higher density up to 1010 kg.m⁻³ for Alfa A and Pyronil as well, the manufacturer declares density ranging from

The determination of chosen physical properties of foam concentrates Alfa A and Pyronil

Table 2.

Name of the sample	Solution concentration [%]	Solution density [g.cm ⁻³]	Solution pH	Solution conductivity [mS]	Foam concentrate viscosity at 20 °C [mPa.s]	Foam concentrate dry matter [%]
Distilled water	100	1000	7	10		
Alfa A	0.4	1003	7.13	124		
	4	1003	5.9	140		
	100	1010	4.44	580	1 780	3
Pyronil	0.4	1004	6.37	132		
	4	1005	6.37	192		
	100	1010	5.68	7 300	1 785	15

990 to 1010 kg.m⁻³ for Alfa A, density values of Pyronil are not provided.

Concerning the pH number of foam solutions it was established that the values vary from 7.13 to 4.44 (Fig. 1). 100 % foam concentrates of Alfa A and Pyronil are significantly acid. Distilled water has the most suitable pH number 7, it's neutral. Foam solution of Alfa A with 0.4 % concentration is very close to this value. Water solutions of Pyronil have lower pH values, they are acid, which is in this case a disadvantage.

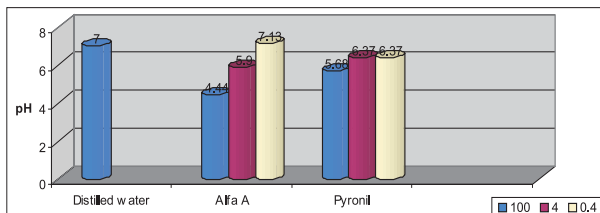


Fig. 1: pH dependence on concentration of foam solutions

The viscosity determination helps us to get results of reactions occurring during blending and suction process. The more viscous the solution is, the worse sucking ability and hose pipe flow rate is. Viscosity depends on temperature (increases with lowering temperature). It was possible to measure only the viscosity of 100 % foam concentrates in our laboratory conditions. The viscosity of Alfa A foam concentrate is 1780 [mPa.s] and 1785 [mPa.s] for Pyronil, which are almost the same.

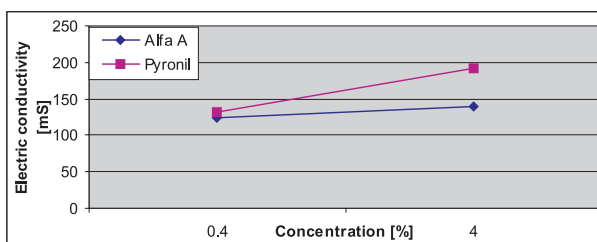


Fig. 2: Dependence of electric conductivity on foam solution concentration

Electric conductivity is an undesirable property of extinguishing foam solutions. The measurement results of both foam concentrates (Fig. 2) show that the conductivity increases with increasing concentration. The electric conductivity of 100 % concentrate is very high.

Determination of dry matter percentile share shows that dry matter percentile share of Alfa A is 5 times lower than Pyronil.

The effect on the grass stands is very important because of using foam concentrates in the exterior and their consequent effect on the environment.

We sprinkled 0.18 l of foam solution on the area of one box (0.09 m²), this volume was calculated on the area. We followed The Collection of Directives of the Presidium of Fire and Rescue Corps [6], which suggests the usage of 2 l volume per 1m². We noticed changes on the grass stands 10 days after the application of foam solutions.

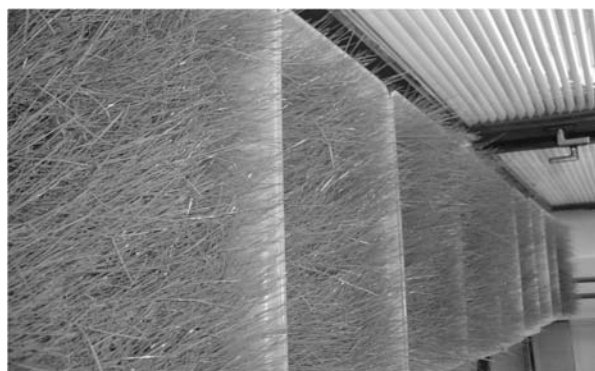


Fig. 3: The grass stands before foam concentrate applications

CONCLUSION

According to the carried-out experiments it was found out:

- Density of foam concentrates are relatively similar and comparable to water density,

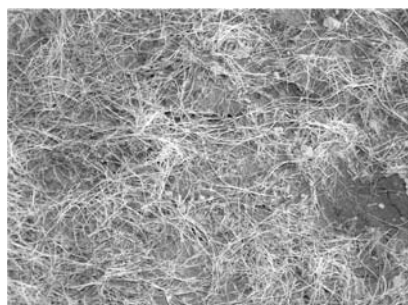


Fig. 4 : Samples after application of 100 % Alfa A concentrate. There were large visible changes, the grass was destroyed and died out in short time.

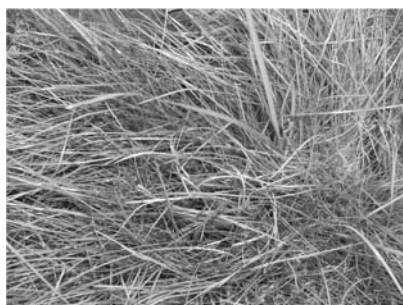


Fig. 5 : Samples after application of 4 % Alfa A concentrate. There were slight visible changes, the ends of grass stalks changed in shape and colour, became yellow and dried up.

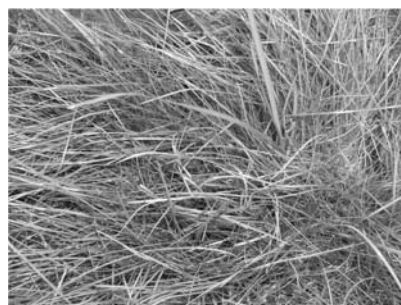


Fig. 6 : Samples after application of 0.4 % Alfa A concentrate. There were no changes visible.

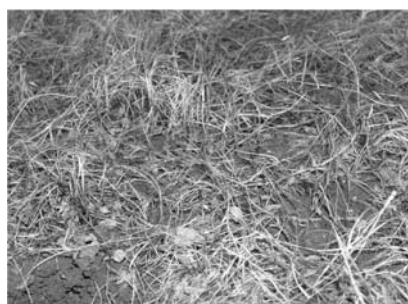


Fig. 7 : Samples after application of 100 % Pyronil concentrate. There were large visible changes, the grass was destroyed and died out in short time.

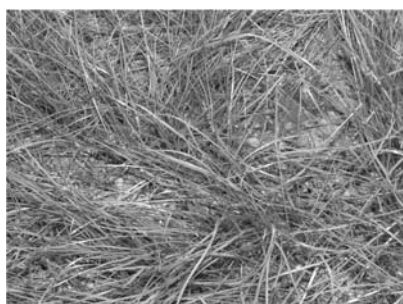


Fig. 8 : Samples after application of 4 % Pyronil concentrate. There were slight visible changes, the ends of grass stalks changed in shape and colour.



Fig. 9 : Samples after application of 0.4 % Pyronil concentrate. There were no changes visible.

- Water solubility is the same, foam concentrates were well soluble into whole water volume,
- pH number values decrease with increasing concentration, 100 % concentrates are very acid,
- Viscosity values are the same and comparable,
- Electric conductivity increases with increasing concentration and values are extremely high for 100 % Pyronil concentrate,
- Dry matter percentile share values are different and Pyronil values are 5 times higher than Alfa A values,
- There are negative effects on the environment of 100 % concentrates of both agents.

Summary

Fire accidents cause enormous damages even losses of human lives every year. It is necessary to develop and test new technologies, technical equipment and extinguishing agents for fire fighting.

The aim of this article was to test and compare the selected physical properties of foam solutions regarding to their effects on grass stands.

We assumed that the foam concentrates Alfa A and Pyronil would have similar parameters, suitable properties to produce foam and they would have a negative effect on the environment at higher foam concentrations.

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