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Influence Of Some Emulsifiers on the Characteristics of the Emulsified Fuels

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Abstract

The aims of this paper were to prepare some new emulsifiers by recovering of PET waste and to study the influence of emulsifier agent over physical properties of emulsified fuels. The emulsifying agents used were monoglycerides and nonionic polymeric compounds. The emulsified fuels were characterized by viscosity, freezing point and flash point. It was established the optimal compositions for emulsified fuels.

Keywords: *Emulsified fuels, surfactants, emulsifier agent*

Introduction

Emulsified fuels properties are given, between others, by surface – active character of molecules contained in fuels, such as low molecular weight fatty acids, naphtenic acids and asphaltenes. These molecules can interact and reorganize at oil/water interfaces. These effects are very important in the case of heavy oils because this type of oils contains a large amount of asphaltene and surface-active compounds [1, 2]. On the other hand, the properties of emulsified fuels are dictated by emulsifier nature and its properties. Emulsification of heavy fuels with monoglycerides and cosurfactants has an important contribution on clean combustion of fuels and can be realized with small cost prices [3]. Another emulsifier used for preparation of emulsified fuels was a nonionic polymer obtained by conversion of solid wastes of PET (polyethylene terephtalate) [4]. The advantages of this raw material are low cost price and large PET availability [5]. Because of high oxygen content of PET, the combustion of fuels emulsified with this type of surfactant leads on lower pollution emission [6].

The aims of this paper was to prepare an nonionic polymeric emulsifier agent by using as raw material PET wastes and to study the emulsifiers nature influence over properties of fuels emulsified with monoclycerides and nonionic polymers.

Preparation of nonionic polymer

The raw materials used for nonionic polymer preparation were PET wastes and glycol. The process takes place in discontinuous conditions, in two stages. First stage was transesterification of PET with glycol, at 200 – 210°C, with ethylene glycol elimination. The obtained product was submitted to another transesterification with methyl ester of fatty acids, at 150°C, with methanol elimination – stage two. The final product was separated and conditioned with aromatics solvents, to obtain finally the polymeric emulsifier.

Emulsified fuels preparation

There were prepared 7 samples of emulsified fuels (E1 – E7) using as emulsifying agent monoglycerides (M), ethoxylated fatty acid (FAE), nonionic polymer (P) and binary mixtures of those, 66%M + 33%FAE, 50%M + 50%FAE, 66%M + 33%P and 50%M + 50%P. With the nonionic polymer were prepared samples of emulsified fuels having emulsifier concentration between 1% and 15% wt. It was study the influence of emulsifier type on emulsified fuels viscosity, the influence of water and ethylic alcohol on emulsified fuels properties. It was made some tests regarding the influence of ethylic alcohol on emulsified fuel flash point.

Results and discussions

The viscosity of emulsified fuels with nonionic polymeric emulsifier is lower in comparison with those on monoglycerides basis, making first easier to handle (figure 1).

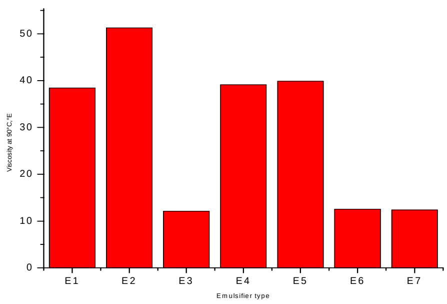

Fig. 1. The influence of emulsifier on the emulsified fuel viscosity

For the sample of emulsified fuels on monoglycerides basis, the viscosity increase exponential with water content between 3 – 30%wt. (figure 2).

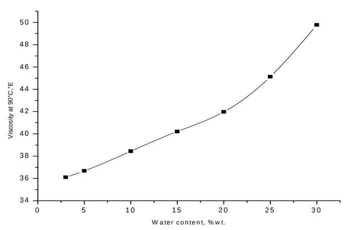

Fig. 2. The influence of water on the viscosity of fuel emulsified with 1,5% wt. monoglycerides (M)

For the emulsified fuels with binary mixture 66%M + 33% FAE the viscosity is getting higher when water content increase, more pronounced between 1% and 20% wt., and with a gentle slope for water concentration in range 20 – 30% wt. (figure 3).

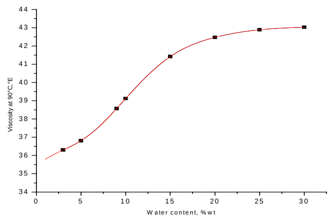

Fig. 3. The influence of water on the viscosity of fuel emulsified with
1,5% wt. bynary mixture 66% M+ 33% FAE

If the concentration of FAE cosurfactant increase in binary mixture used as emulsifier agent, the viscosity of emulsified fuels increase almost linear with emulsion water content (figure 4).

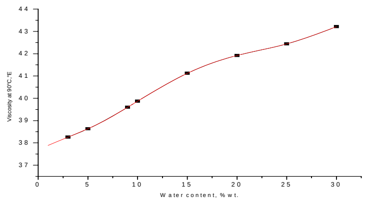

Fig. 4. The influence of water on the viscosity of fuel emulsified with
1,5% wt. binary mixture 50% M + 50% FAE

The viscosity of fuels emulsified with binary mixture 66%M + 33% P increase slowly at low water content (1% – 9%wt.) and with a pronounced slope at water concentrations between 15 – 30% wt. (figure 5).

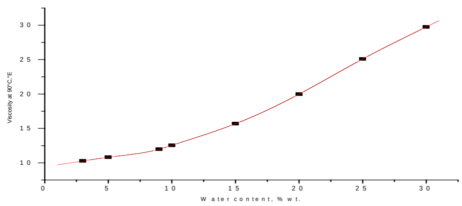

Fig. 5. The influence of water on the viscosity of fuel emulsified with
1,5% wt. binary mixture 66% M + 33% P

If the polymeric cosurfactant content increase in binary mixture used as emulsifier agent, it was observed a linearization of emulsified fuel viscosity variation with water content (figure 6).

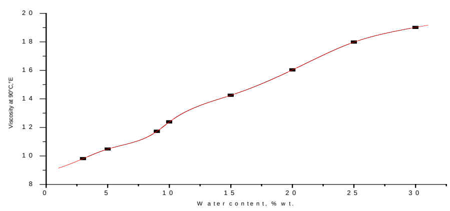

Fig. 6. The influence of water on the viscosity of fuel emulsified with
1,5% wt. binary mixture 50% M + 50 % P

There were determinate some physical properties for nonemulsified heavy fuel and for fuel emulsified with monoglycerides, ethoxylated fatty acid, nonionic polymer and binary mixture of monoglicerides and FEA, respectively nonionic polymer, in different proportions (table 1).

Table 1. Properties of emulsified fuels with 1,5% wt. emulsifier and 5% wt. water

Nr.	Emulsifer agent	Density at 20°C, g/cm^3	Viscosity at 90°C, °E	Flash point, °C	Freezing point, °C
1	Nonemulsified fuel	1,0253	41.55	55	8,3
2	M	1,0296	38.70	62	-9,8
3	FAE	1.0274	51.60	61	2,1
4	P	1,0290	12.55	59	-12
5	66% M + 33% FAE	1,0330	36,81	62	-5
6	50% M + 50% FAE	1,0282	36,63	62	-4
7	66% M + 33% P	0,9582	12,38	62	-6,2
8	50% M + 50% P	0,9587	9,81	82,2	-7

Freezing point of emulsified fuels on binary mixture monoglycerides – nonionic polymer basis is lower in comparison with other systems with binary emulsifier. That means these emulsified fuels can be used at low temperatures, without any problems on feeding system of burners [4].

The variation of water content in fuel emulsified with different amount of nonionic polymer can leads at emulsified fuel viscosity growth (figure 7). It was observed a pronounced increase in range 6 – 15 %wt. water. Emulsified fuels with 2 %wt. water content have the lowest viscosity values, an advantage when these emulsified fuels are used in burning plants.

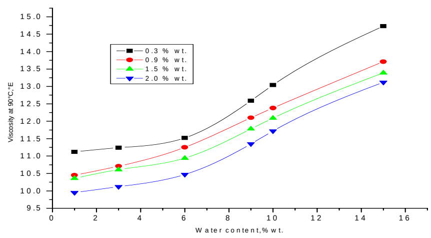

Fig. 7. The influence of water on viscosity of emulsified fuels with different emulsifier proportions

When the emulsifier proportion increase in emulsified fuel, the flash point increase too (figure 8). It is preferred a higher water content in emulsion, for having low flash point, that means a higher efficiency of burner.

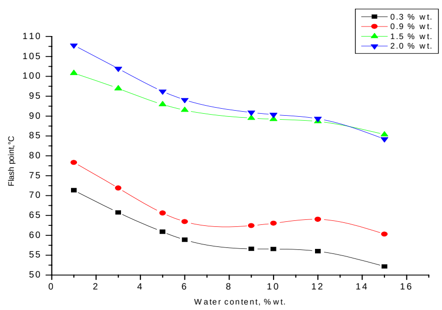

Fig. 8. The influence of water on flash point of emulsified fuels with different emulsifier proportions

When the water amounts increase in emulsified fuels, its flash point increase too, unfavorable for emulsified fuels using conditions [4]. Regarding emulsifier concentration necessary to formulation of emulsified fuel, when this one growth, the freezing point decrease (figure 9), and the emulsified fuels could be used at low temperatures without any problems.

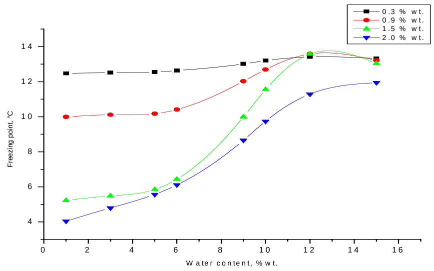

Fig. 9. The influence of water on freezing point of emulsified fuels with different emulsifier proportions

By adding ethylic alcohol in emulsified fuel, emulsion stability is not affected but the flash point decrease with ethanol percent increasing. The viscosity of emulsified fuels is getting higher when ethanol – water mixture content increase (figure 10). For the same water and ethanol content, the viscosity of emulsified fuel decrease when ethanol concentration in binary mixture is getting higher.

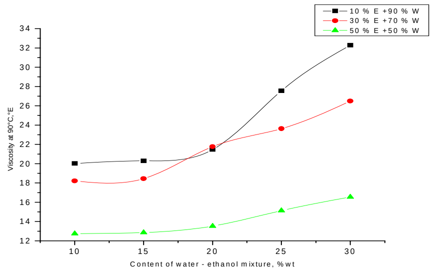

Fig. 10. The influence of ethylic alcohol on emulsified fuels viscosity

Conclusions

By using nonionic polymer cosurfactant rheological and combustion properties of emulsified fuels on monoglycerides basis are improved. The emulsified fuels formulated by this method are stable and can be utilized in combustion plants at relatively low temperatures without any problems on feeding systems of burners. By adding ethylic alcohol, the flash point of emulsified fuel decrease, which improve burner efficiency.

Recovery of PET wastes to obtain polymeric emulsifier is an efficient alternative for emulsified fuels preparation. According to the stability, structure, viscosity, flammability and water content, the optimum emulsion is found as the emulsion with 92% wt. of fuels, 2% wt. polymeric emulsifier and 6% wt. of water. Ethanol addition in concentration under 5% wt. improves combustion properties of emulsified fuels.

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Influența unor emulgatori asupra proprietăților combustibililor emulsionați

Rezumat

În această lucrare s-a urmărit prepararea unor noi emulgatori prin recuperarea deşeurilor de PET şi studiul influenței acestor agenți de emulsionare asupra proprietăților fizice ale combustibilului emulsionat. Emulgatorii folosiți sunt compuşi pe bază de monogliceridă şi polimer neionic. Combustibilii emulsionați au fost caracterizați prin viscozitate, punct de congelare şi temperatură de inflamabilitate. A fost stabilită compoziția optimă a combustibililor emulsionați.