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Estimation of Corrosion Action of Emulsified Fuels upon some Metals and Alloys

Octav Pantea*, Dorin Bombos*, Mihaela Bombos**, Sonia Mihai*, Ion Bolocan*

* Petroleum-Gas University of Ploiesti, Bucharest Bd., No. 39, 100520, Ploiesti, Romania
e-mail: ibolocan@upg-ploiesti.ro

** National Institute of Research- Development for Chemistry and Petrochemistry ICECHIM-Bucharest, Splaiul Independenţei, No. 202, 060021, Bucharest, Romania

Abstract

The aim of this paper is to establish a relation between corrosion rate variation for different metals and alloys and the composition of emulsified fuels – the corrosive environment. Emulsified fuels with polymeric nonionic emulsifier agent and different water content were tested.

Keywords: *Emulsified fuels, surfactants, emulsifier agent*

Introduction

Steels corrosion represents the most usual type of corrosion, especially in acid solutions [1]. For example, it presents a practical importance the acids attack upon iron and steels in petroleum and petrochemistry industry and in other electrochemical systems, too. Hydrochloric acid is a mineral acid with many uses, testing of the corrosion inhibition effect for some products being achieved in its presence [2-6].

Generally, the action of organic products as corrosion inhibitors is due to the presence of functional groups which are adsorbed on the metal surface. For example, polymers or macromolecules, which present functional groups (-OH, -COOH, $-NH_2$, etc.), are mentioned to posses inhibition character in different corrosive media [7-8].

The behavior of metals and alloys in non aqueous and partially aqueous media has a practical importance both in chemical industry and in petroleum domain. The behavior of metals in contact with petroleum emulsions is different compared to aqueous solutions.

The influence of the petroleum product can be in connection with the metal acidity regarding its oxidation and reduction. Petroleum products influence the exchange current and the transfer coefficient and the corrosion reaction rate, too. The properties of organic liquids and their influence upon metals corrosion are studied a little. The aggressiveness of organic liquid and petroleum emulsions increases in presence of impurities, the corrosion rate of metals having considerable higher values than in their absence. The stainless steels and those which are alloyed are resistant in petroleum products and their suspensions.

The selection of raw materials and of the emulsion characteristics used for the study achievement took into account the choice of the most favorable conditions from the corrosive action point of view. Thus, the selected emulsion is a cationic one (stable at a low pH), water content had relatively high values (20%), such that to favor the formation of a direct emulsion (the continuous phase is water).

Experimental Data

There is presented the characterization of the corrosive medium which there were made the corrosion tests.

The raw materials used for the experimental program were the following:

Heavy petroleum fuel, with the following characteristics:

Table 1. The characteristics of the heavy petroleum fuel

No.	Characteristic	Fuel
1.	Density at 20^{o}C, kg/m^3	1,0413
2.	Mineral acidity	none
3.	Water, %gr.	0.4
4.	Freezing point, ^{o}C	-5,7
5.	Inflamability point, ^{o}C	66
6.	Viscosity, cSt , at 50^{o}C	4,86
7.	Water and sediment, % gr.	1.2
8.	Caloric power, kcal/kg	9670
9.	Distillation PRF, °C	
	0 % vol. distillate	327
	10 % vol. distillate	380
	20 % vol. distillate	412
	30 % vol. distillate	447
	40 % vol. distillate	475
	50 % vol. distillate	502
	60 % vol. distillate	528
	70 % vol. distillate	540
	80 % vol. distillate	551
	90 % vol. distillate	557
	100 % vol. distillate	560

Polymeric non ionic emulsifier based on fatty acids, polyethyleneterephtalate and glycerol, with the following characteristics:

- aspect: viscous liquid, dark color;

- density at 25°C: 0,9178 g/cm^3;

- saponification index: 336,4 mg KOH/g sample.

The determination of the corrosion rate was made by the technique of the resistance at polarization for 5 steels (monel OLC45,OL37, drilling rod steel, drilling hoe steel) and brass in corrosive media consisting in the fuel emulsion brought to an acid pH by hydrochloric acid dosing, having the characteristics presented in the following table:

Table 2. The characteristics of the fuel emulsion

pH	Density at 20°C	Viscosity at 50°C, mm^2/s	$T_{inflamability}$, °C	$T_{freezing}$, °C	Eletrical conductivity , µS
3	1,0180	4,4	50	-4	0,7

The corrosion tests were made on a potentiostat Princeton Applied Research.-Biologic VPS.

By the linearity zone extrapolation of the polarization curves for the 5 steels and brass used at the corrosion test, it is determined the value of the corrosion potential which is correlated with the gravimetric index K_g, respective with I_{cor}, by the relation:

$$K_g = \frac{I_{cor} \cdot A \cdot 10^4}{Z \cdot F}$$

Where: z – valence of the metal in solution
K_g – gravimetric index
P – penetration index
F – 26.8A·h
A – metal atomic mass

Results and Discussions

In table 3 there are presented the determined experimental values: I_{cor}, E_{cor}, R_p, and K_g, P calculated from the values of the corrosion current for each alloy.

The low value for I_{cor} <1μA/cm^2 demonstrated that the 6 tested alloys are stable and OLC 45 is perfect stable.

The brass having a penetration index P = 0,002 mm/year is situated in the group of resistance to corrosion- category very stable, with a stability coefficient equal to 2.

Monel belongs to the group of resistance to corrosion- category perfect stable and it has a stability coefficient equal to 1.

Table 3. Values of the corrosion parameters

Material	*E_{cor}(mV)*	*I_{cor}(μA/cm^2)*	*β_c(mV)*	*β_a(mV)*	*R_P(Ω)*	*P(mm/year)*	*Kg (g/m^2·h)*
Brass	-289.184	0.168	51.1	33.4	155271	0,0022	0,002
Monel	-208.821	0.070	46.9	38.3	372006	0,00081	0,00073
OLC45	-574.093	0.017	110.7	169.8	1499756	$1,97 \cdot 10^{-4}$	$1,78 \cdot 10^{-4}$
OL37	-681.715	0.113	45.5	43.0	230902	$1,31 \cdot 10^{-3}$	$1,18 \cdot 10^{-3}$
Drilling rod steel	-884.711	0.328	58.6	68.6	38 018	$3,8 \cdot 10^{-3}$	$3,42 \cdot 10^{-3}$
Drilling hoe steel	-531.345	0.735	43.6	42.8	35472	$8,51 \cdot 10^{-3}$	$7,66 \cdot 10^{-3}$

The determination of the corrosion rate was made by two techniques: the method of linear polarization and the method of resistance at polarization. Polarization curves for the five steels and brass are presented in figures 1-6.

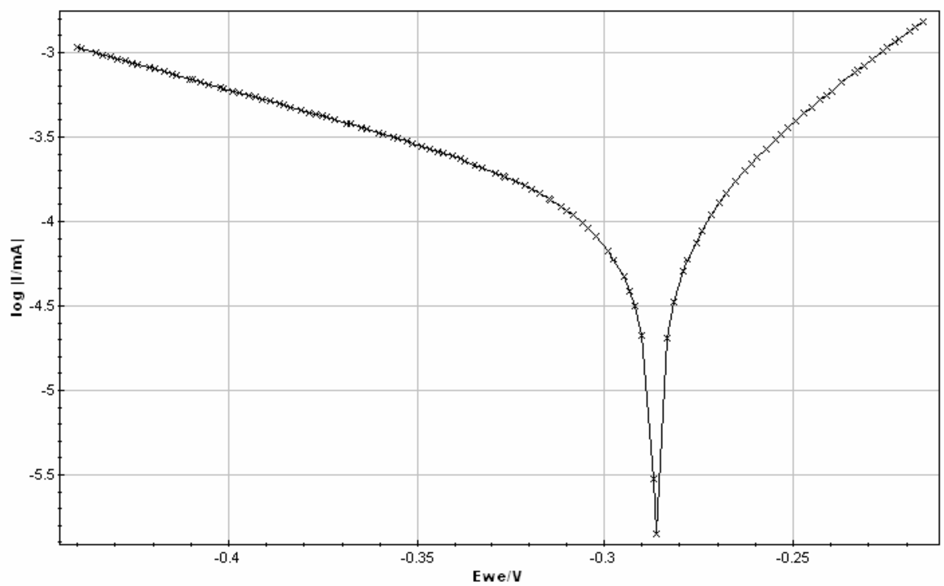

Fig. 1. Polarization curves for brass at $t=20^0C$

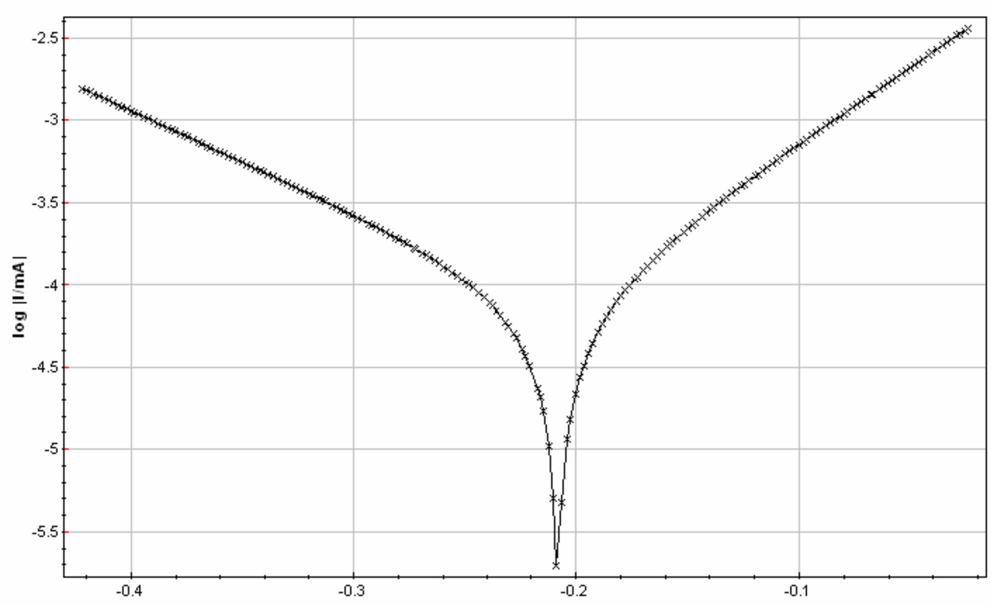

Fig.2. Polarization curves for monel at $t=20^0C$.

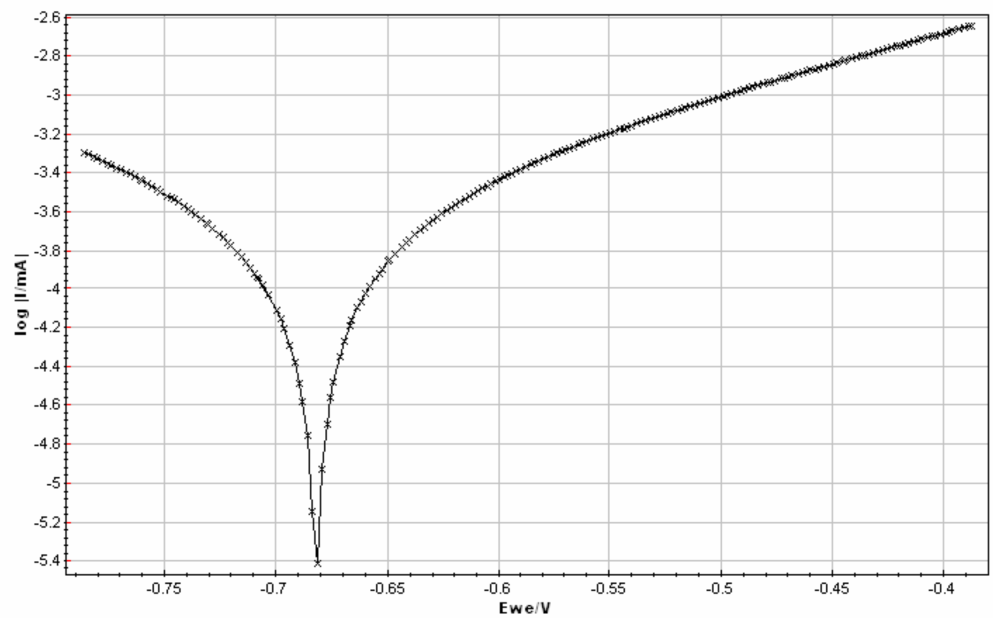

Fig. 3. Polarization curves for OLC37 at t=20^{0}C

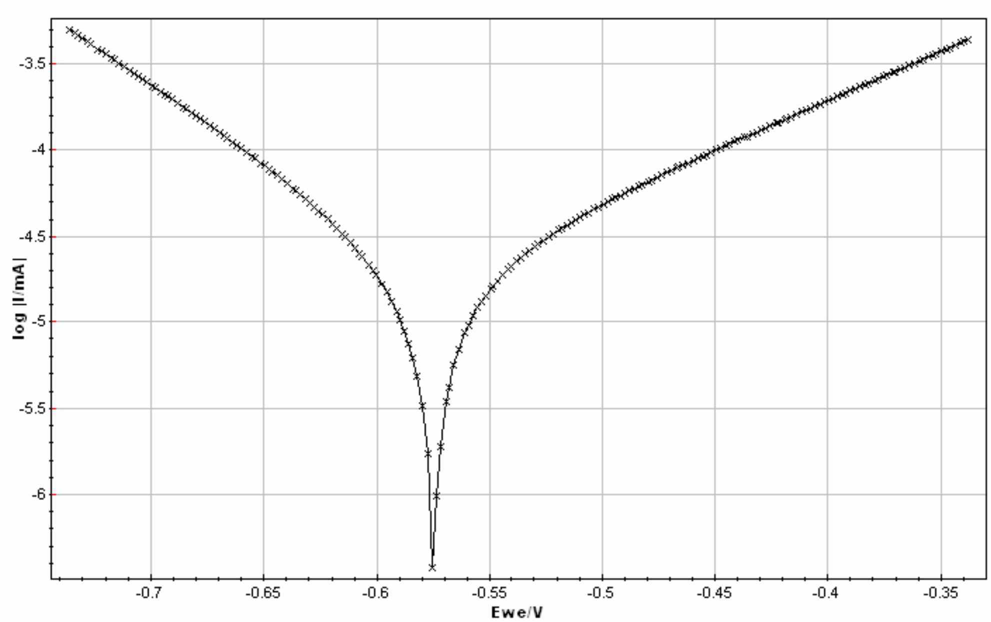

Fig. 4. Polarization curves for OLC 45 at t = 20^{0}C

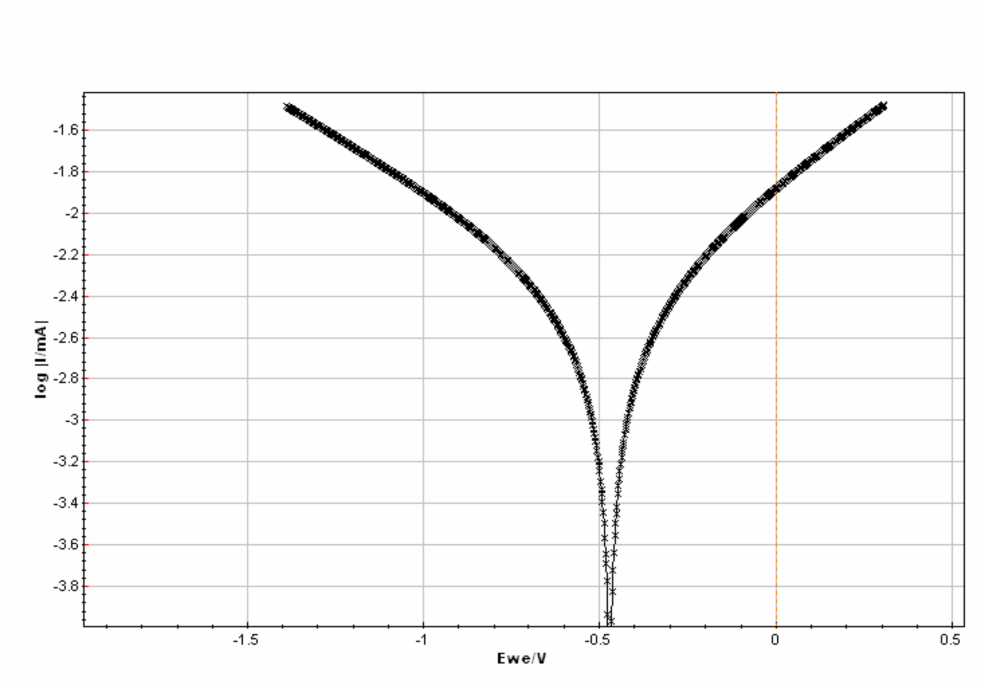

Fig.5. Polarization curves for the drilling rod at t= 20^0C

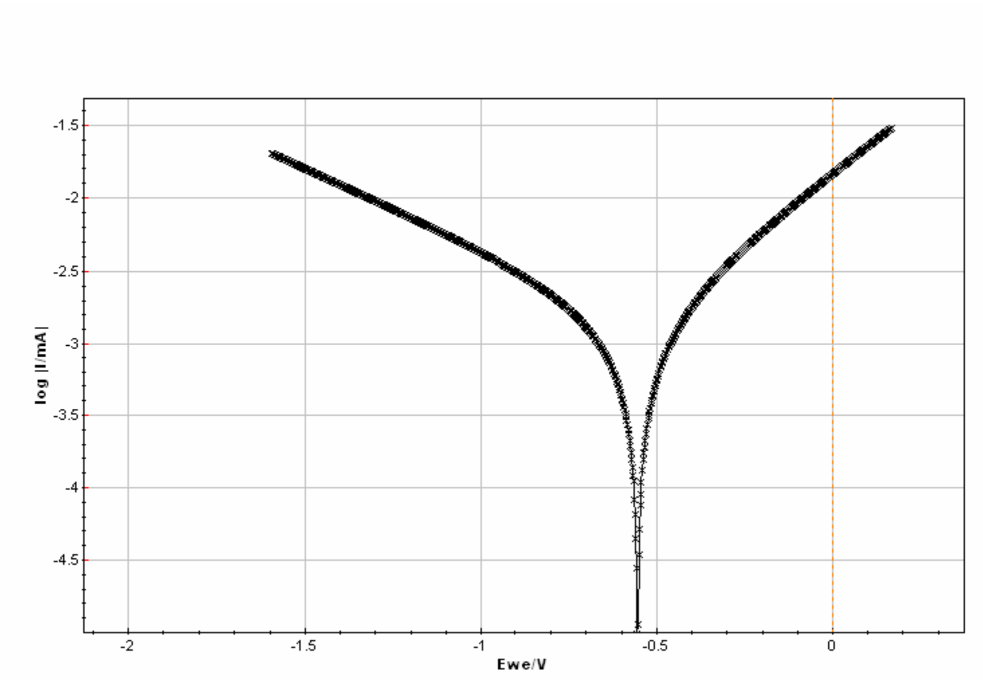

Fig. 6. Polarization curves for the drilling hoe at t=20^0C

Conclusions

The corrosion tests were made on emulsified fuels formulated by means of a non ionic emulsifier of polymeric type based on fatty acids, polyethyleneterephtalate and glycerol. Based on the obtained experimental data, there result the following conclusions:

The use of a non ionic emulsifier for preparation of fuel emulsions permitted the prepared emulsions testing at pH values which favourize metals corrosion.

OLC 45 steel is the most stable alloy tested for the used corrosive medium, having a corrosion rate of approximately 4 times lower than monel steel and it is perfect stable. The corrosion rate being very low, it is recommended for this steel to be used for manufacture of pipes which transport petroleum emulsions.

OLC 37 steel has the corrosion rate of $1.31 \cdot 10^{-3}$mm/year and it takes part in the group of resistance at corrosion „very stable" and it has the stability coefficient 2. This steel is corrodated approximately 6 times more than OLC 45.

The steels used for the drilling rods and hoes have approximately equal corrosion rates, taking part in the group of resistance at corrosion „very stable", the drilling rod steel has the stability coefficient 2 and the drilling hoe steel has the stability coefficient 3.

The corrosion tests indicated a low value of $I_{cor} < 1 \mu A/cm^2$, which shows that the 6 tested alloys are stable and OLC 45 is perfect stable compared to the fuel emulsion.

The short corrosion rate is due to the corrosion inhibition action of the functional groups of hydroxyl and carboxyl type present in the polymeric emulsifier macromolecule, which is adsorbed on the metal surface and protects it.

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Evaluarea acțiunii corosive a combustibililor emulsionați asupra unor metale şi aliaje

Rezumat

Lucrarea studiază variația vitezei de coroziune pentru diferite metale şi aliaje în funcție de compoziția combustibililor emulsionați – mediul corosiv. Au fost testați combustibili emulsionați cu emulgator neionic de tip polimeric, cu diferite proporții de apă.