ISSN 2321-807X

Conservation liquids on the bases of turbine oil of grade T-30 and corrosion inhibitor

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Conservation liquids have been prepared by adding to T-30 turbine oil different amounts of amidoamine compounds synthesized in 2:1 molar ratio of technical petroleum acids (TPA) to polyethylenepolyamine (PEPA), nitro-compound and phenol-p-alkyl(C_8-C_{12})phenolformaldehyde olygomers on the basis of $C_{14}H_{28}$ containing α-olefin, as well as composition on the bases of them. Defined that the use of these compounds as compositions records high result as corrosion inhibitor in protection of metal constructions.

Keywords: Corrosion; inhibitor; conservation liquids; turbine oil; technical naphthenic acid; polyethylenepolyamine; amidoamine; α-olefin; nitro-compound.

Council for Innovative Research

Peer Review Research Publishing System

Journal: Journal of Advances in Chemistry

Vol 11, No. 7

editorjaconline@gmail.com, www.cirjac.com

ISSN 2321-807X

At present in the global and local sphere of highly developed technologies the protection of metal equipments from corrosion is one of the urgent problems.

It should be mentioned that the atmospheric corrosion is spontaneous process and the metal destruction mostly depends on the climate conditions, the degree of air pollution with the different chemical compounds and additives in this process [1].

Metal corrosion in atmosphere occurs in the result of the physical – chemical processes developed in the solid phase and gas medium limit and it leads to the deterioration of their quality [2, 3].

The one of the efficient protection methods from corrosion in modern science is the application of universal inhibitors [4].

Some chemical substances having inhibitor properties are known from the period of acquaintance of mankind with the chemical compounds. The researches conducted on the study of this process have been started after the second half of the XX century. Before this period minerals oils was mainly used for protection of the devices, mechanisms and equipments prepared from metal. However,the protection ability of oils used without inhibitors were low as it was not possible to prevent the penetration of water on the metal surface that may intensify rusting by this way [5].

It is more valuable and cheap from the technical poin of view to use conservation liquids (water repellent fluids) and greases for preventing atmospheric corrosion [6]. At present the demand on conservation liquids and greases is increasing year by year due to the intensive technological development, simultaneously demand for them gets higher [7].

As the region that Azerbaijan Republic situated is under the constant influence of the Caspian basin therefore the corrosion problems are always actual for our country [8].

Therefore the researches in the trend of the generating new variations of compounds used as corrosion inhibitors arouse interest. The compounds with the corrosion inhibitor function are also different from the point of view of classification. For example, amides of petroleum acids [5], nitrating products of ethylene olygomers [5], heteroatom (O-, N-maintaining) derivatives of linear (structure) olefins, high molecular amines and amine complexes [10] are available as a polifunctional corrosion inhibitor. For obtaining nitrocompounds process of nitrolysis of olefins are also used.

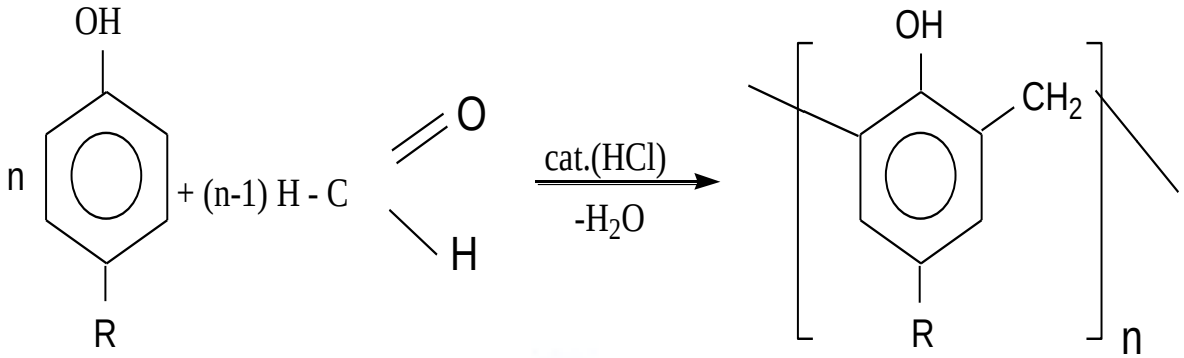
Russian scientists have used phenolformaldehyde olygomers maintaining ethoxy-groups in content (composition) as a decelerating (moderating) inhibitor of oil equipment corrosion. These olygomers also have additional properties as a reagent providing asphalt-, resin-, parafin separating and a deemulsifier influenced in low and high temperature with the purpose of destruction of resistant emulsions in oils of various composition[11]. P-alkyl(C_8-C_{12}) phenolformaldehyde olygomers solved unlimited in petroleum oils have also shown satisfactory results in the studies on this purpose. However nitrogen maintaining (modificated with benzylamine, benzamide, benzodiamine) p-alkyl(C_8-C_{12}) phenolformaldehyde olygomers have been recommended as an additive vs. corrosion in motor oil (base oil) of grade M-8, as well as increasing thermal oxidation stability of oil [12]. It should be mentioned that having a high thermal oxidation stability is important as the acids generated in the end result during the oxidation of hydrocarbons in oils caused the corrosion of metal constructions in contact with them.

By taking into consideration all of these have been carried out amidoamine combining of polyetylenepolyamine with technical oil acids, nitrating product of $C_{14}H_{28}$ containing α-olefin, as well as phenol-, p-alkyl(C_8-C_{12}) phenolformaldehyde olygomers and study of compositions on the bases of them in turbine oil of grade T-30 as a corrosion inhibitor.

The synthesis of components used with the purpose of obtaining of conservation liquids have been described in the following schemes (figures).

ISSN 2321-807X

1. The synthesis of phenol- and p-alkyl(C_8-C_{12})phenolformaldehyde olygomers.



n=6-8

here is obtained phenolformaldehyde olygomers if R=H,

but p-alkyl(C_8-C_{12})phenolformaldehyde olygomers if R=C_8-C_{12}.

2. The synthesis of amidoamine on the bases of polyethylenepolyamine with technical oil acids:

3. Nitrating reaction of α-olefins is the exothermal reaction running by the free radical mechanism.

As seen in the nitrating reaction scheme in the process nitrocompounds of various composition (mono- and di- nitroderivatives) is generated.

The corrosion protection effects have been determined by adding to the turbine oil of grade T-30 each of these components separately, as well as in different weight ratios in the state of composition. To this end experiments have been conducted proper to the ГОСТ-90-54-75 by using the metal plates of grade «polad-3» («steel-3») in agressive (hostile) mediums- in thermal-moisture chamber «Г-4», in sea water, in H_2SO_4 acid solution of 0,001% and the results have been described in Table 1.

ISSN 2321-807X

Table 1:- The data of protection from corrosion of conservation liquids on the basis of turbine oil of grade T-30

№	Composition of samples, %	Amount of inhibitor in sample, %	Period of protection from corrosion, day		
			In thermal-moisture chamber «Г-4»	In sea water	In solution of 0,001% of H_2SO_4 in water
	T-30 turbine oil 100	-	34	15	9
K 1.	T-30 oil 90 Ж$_{14}$ Н$_{28}$ α-olefin nitrocompound 10	10	108	75	45
K 2.	T-30 oil + amidoamine 97 (in weight ratio of 1:1 TPA:PEPA) 3	3%	8	4	5
K 3.	T-30 oil + amidoamine 95 (in weight ratio of 1:1 TPA:PEPA) 5	5%	10	5	6
K 4.	T-30 oil + amidoamine 93 (in weight ratio of 1:1 TPA:PEPA) 7	7%	12	7	8
K 5.	T-30 oil + amidoamine 90 (in weight ratio of 1:1 TPA:PEPA) 10	10%	13	9	10
K 6.	T-30 oil + amidoamine 97 (in weight ratio of 2:1 TPA:PEPA) 3	3%	10	5	7
K 7.	T-30 oil + amidoamine 95 (in weight ratio of 2:1 TPA:PEPA) 5	5%	12	7	8
K 8.	T-30 oil + amidoamine 93 (in weight ratio of 2:1 TPA:PEPA) 7	7%	14	8	10
K 9.	T-30 oil + amidoamine 90 (in weight ratio of 2:1 TPA:PEPA)10	10%	15	11	12
K 10.	T-30 oil 97 phenolformaldehyde olygomer 3	3	173	22	28
K 11.	T-30 oil 95 phenolformaldehyde olygomer 5	5	180	35	37
K 12.	T-30 oil 93 phenolformaldehyde olygomer 7	7	187	42	43
K 13.	T-30 oil 90 phenolformaldehyde olygomer 10	10	192	48	49
K 14.	T-30 oil 97 alkylphenolformaldehyde olygomer 3	3	52	8	9
K 15.	T-30 oil 95 alkylphenolformaldehyde olygomer 5	5	105	12	14

K 16.	T-30 oil 93 alkylphenolformaldehyde olygomer 7	7	137	16	19
K 17.	T-30 oil 90 alkylphenolformaldehyde olygomer 10	10	160	21	29
K 18.	T-30 oil 97 phenolformaldehyde olygomer 1,5 $C_{14}H_{28}$ α-olefin nitro-compound 1,5	3	185	33	34
K 19.	T-30 oil 95 phenolformaldehyde olygomer 2,5 $C_{14}H_{28}$ α-olefin nitro-compound, 2,5	5	190	47	47
K 20.	T-30 oil 93 phenolformaldehyde olygomer 3,5 $C_{14}H_{28}$ α-olefin nitro-compound, 3,5	7	197	85	90
K 21.	T-30 oil 90 phenolformaldehyde olygomer 5 $C_{14}H_{28}$ α-olefin nitro-compound 5	**10**	**210**	**103**	**115**
K 22.	T-30 oil 90 alkylphenolformaldehyde olygomer 5 $C_{14}H_{28}$ α-olefin nitro-compound 5	10	126	57	62
K 23.	T-30 oil 90 alkylphenolformaldehyde amidoamine 1,5	3	40	30	33
K 24.	T-30 oil 90 alkylphenolformaldehyde olygomer 2,5 amidoamine 2,5	5	70	32	38
K 25.	T-30 oil 90 alkylphenolformaldehyde olygomer 3,5 amidoamine 3,5	7	95	43	47
K 26.	T-30 oil 90 alkylphenolformaldehyde olygomer 5 amidoamine 5	10	175	50	52
K 27.	T-30 oil 97 phenolformaldehyde olygomer + $C_{14}H_{28}$ α-olefin nitro-compound +	3	187	48	48

	amidoamine (in weight ratio of 1:1:1) 3				
K 28.	T-30 oil 95 phenolformaldehyde olygomer + $C_{14}H_2$ α-olefin nitro-compound + amidoamine (in weight ratio of 1:1:1) 5	5	198	69	72
K 29.	T-30 oil 93 phenolformaldehyde olygomer + $C_{14}H_{28}$ α-olefin nitro-compound + amidoamine (in weight ratio of 1:1:1) 7	**7**	**205**	**98**	**108**
K 30.	T-30 oil 90 phenolformaldehyde oliqomeri + $C_{14}H_{28}$ α-olefin nitro-compound + amidoamine (in weight ratio of 1:1:1) 10	**10**	**220**	**113**	**125**
K 31.	T-30 oil 90 alkylphenolformaldehyde olygomer + $C_{14}H_{28}$ α-olefin nitro-compound + amidoamine (in weight ratio of 1:1:1) 10	10	137	95	95

Note: **K 1-K 31** are the coded numbers of conservation liquids.

As seen in Table 1, conservation liquids of nitro-compounds content have the higher protection ability rather than conservation liquids of amidoamines content. In general, availability (presense) of polar, nitrogen-maintaining functional groups and hydroxyl (OH) group in nitro-compounds and amidoamines cause dehydration by their easy adsorption to the metal surface and thereby nitrogenous compounds have dual effect – on the one hand they act as a dehydrator and on the other hand as an inhibitor by generating a cover on surface.

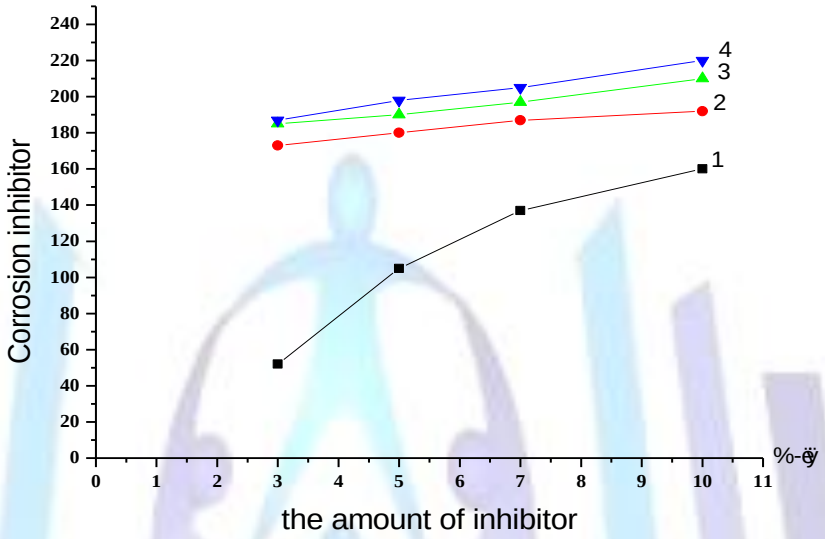
Therefore used nitro-compound which is more polar rather than amidoamine connects more strongly with metal surface and releases better water molecules.

Furthermore, the protection effect of conservation liquids prepared by using phenolformaldehyde olygomer is higher than the protection effect of conservation liquids prepared with alkylphenolformaldehyde olygomer. However as if the consentration of alkylphenolformaldehyde olygomer in T-30 turbine oil is 10 %, its protection effect in thermal-moisture chamber «Г-4» is 160 days (Table 1, k-17), but that amount of phenolformaldehyde olygomer is 192 days (Table 1, k-13). It can be explained by the fact that phenolformaldehyde olygomer being of polar character is more easily adsorbed by the surface rather than its analogue of non-polar nature having long chained alkyl groups (alkyl groups with long chain). Due to the causes that mentioned above its inhibitor effect is high. It should be mentioned that also being branched of alkyl groups it prevents dense settling of molecule adsorbed in metal surface.

Although inhibitors separately show weaker result, it has high performance as a composition has been determined in the researches.

The protection effect from corrosion of metal plates was very slow in the various concentrations of the appendix of T-30 turbine oil of amidoamine combination seems in the Table-1. However, the protective effect displays higher result in

the consumption of these compounds as a composition. For example: when the protection effect from corrosion of amidoamine combination (TNT:PEPA 2:1 weight ratio) to the 10% concentration of appendix of turbine oil in the thermo-humidity chamber is 15 days, then the using of these compounds as a composition is 220 days, which is explaining by observation of synergism event in their action mechanism. Therefore, the continuation of researches on the bases of the composition contained corrosion inhibitors prepared from synthesized compounds was carried out with the conservation liquids.



Picture:-1. «Г-4» phenol- in the thermo-humidity chamber, p-alkyl(C_8-C_{12}) phenolformaldehyd oligomers, the indicators of testing of corrosion inhibitors on the basis of amidoamin and nitro compounds.

1. T-30 turbine oil + alkylphenolformaldehid oligomer
2. T-30 turbine oil + phenolformaldehid oligomer
3. T-30 turbine oil + phenolformaldehid oligomer + $C_{14}H_{28}$ α-olefin nitro compounds
4. T-30 turbine oil + phenolformaldehid oligomer + $C_{14}H_{28}$ α-olefin nitro compounds + amidoamin

As shown in chart 1, the addition to T-30 turbine oil the phenol-, p-alkyl(C_8-C_{12}) phenolformaldehyde oligomers, nitro compounds and amidoamine not separately but as composition inhibitor is more advisable (example 4).

Thus, the preparation of liquid conservation on the base of proposed phenol-, p-alkyl(C_8-C_{12}) phenolformaldehyde oligomers, nitrocompounds and amidoamines compositions is considered more appropriate.

RESULTS

For corrosion protection of metallic constructions of the novolac-type phenol-, p-alkyl (C_8-C_{12}) phenolformaldehyde oligomer, the C_{14}-C_{28} containing of nitration product of α-olefin separated from amidoamine on the base of technical acids with polyethylenpolyamine and by using as a composition form, the protection effect of conservation liquids with base oil on the base of brand turbine oil have been studied comparatively.

The protection ability of the conservation liquid (water repellant fluid) made from the fenolformaldehyd oligomer in the same concentration of p-alkyl (C_8-C_{12}) fenolformaldehyd oligomer is higher than has been observed.

According to the appropriate containing composition of p-alkyl (C_8-C_{12}) fenolformaldehyd oligomer to the nitro-combination of the C_{14}-H_{28} containing α-olefin of formaldehyde with the composition in the same concentration has show much better result.

The corrosion protection effect of the liquid conservation (water repellant fluids) obtained from different concentration of T-30 turbine oil of the three component mixture weight ratio 1:1:1 is high and getting higher as the turbidity increase.

The proposed conservation liquid by having high conservation values from corrosion do not only prove to show the same result with the known brand conservation liquids, moreover it is superior to them, can be recommended for metal

ISSN 2321-807X

structures as corrosion protection.

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