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Study on different types of car coolant used in Libyan market: additives dropout

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Abstract: In this research, the effect of four types of coolants used in the local market, (namely Abrad, Freezetone, Algabl Green, and Algabl Red), on the rate of additive dropout quantity was studied, and the cylinder block alloy of the Chevrolet Optra engine car was used as the study material, The results of the chemical analysis technique show that the investigated material is Al-Si alloy. The cylinders have a rectangular cross-section. The samples were placed inside a glass container for each type of coolant, three samples were used. A sensitive balance was used with an accuracy of 1/10000 to measure the weight of the samples before testing and their weight after the immersion process for different periods of time to calculate the rate of additive dropout in g/h/cm2. Preliminary results showed that the additives were deposited on the samples surfaces in different quantities. In addition, after cleaning the samples with distilled water and drying them, these deposits remained stuck to the samples. Through the results obtained after weighing, it was found that the Algabl green coolant has the lowest rate of sedimentation. The additive dropout quantity was about 0.00000478 g/hr/cm^2, followed by Freezetone with 0.00000713 g/hr/cm^2, while the amount of additive dropout with the Abrad type was 0.00002543 g/hr/cm^2. The additives dropout causing deteriorating cooling system performance, where deposit the additive on cylinder block wall will reduce the transferred heat generated inside composition chambers, cylinder heads and blocks are highly and dynamically loaded structures that transfer a lot of heat, so the choice of coolant type for engine is very important to ensure that engine is operating properly.

Keywords: (additives dropout, engine car coolant)

Introduction

Liquid coolants like water and ethylene glycol are used into cooling system of internal combustion engines, and to improve their thermo physical properties metal oxides is added. Generally, a coolant is diluted by city water and well water. Since the quality of the waters is largely differ from place to place, a special care must be exercised when a corrosive water, which includes a lot of sulfate ion and chlorine ion, or a hard water, which includes a large of calcium and magnesium, is used [1, 2]. The quality of water in Japan is regarded as generally good, while water in Europe and Asia is hard and that in America the chance is high that water containing a high degree of sulfuric acid ion and chlorine ion is used for dilution, which can reflect on additives of coolant, and should be considered [3]. Additives for coolant are classified into the following four types. The first is called an anode type that becomes immobilized after forming an oxidation film or adsorption film on a metal surface. The second

is called a cathode type that covers the metal surface with hydroxide deposited due to a chemical reaction or electrochemical reaction and thereby inhibits rust. The third is called an adsorption type that forms an anticorrosive film of a single molecule through combining with metal. The last is a film-forming type that forms insoluble polymer after reacting to copper [2, 4]. Engine was made of cast iron because of ease casting and nonappearance of appreciable shrinkage of volume, vibration damping wear resistance and machinability. Recently, aluminum used in automobiles to produce many engine parts such as piston and cylinder block to save weight [5, 6]. Engine coolant used in vehicle to minimize the degradation of nonmetals and prevent the corrosion of the metals in the cooling system. Various forms of corrosion could occurred in cooling systems of engine, including uniform corrosion, galvanic corrosion, crevice corrosion, pitting corrosion, intergranular corrosion, erosion corrosion, and cavitations corrosion [7]. An applicable treatment is used to give the cooling water the correct properties that prevents service problems. cooling water that has not had treatment can soon cause problems in the cooling system such as corrosion, sediment or hard particles. Corrosion protection oils (emulsion oils) are not recommended for the treatment of the cooling water. If instructions about the use of corrosion protection oils are not obeyed and coolant checks are not sufficient, then water / oil emulsion can occur. This can cause the cooling system to become clogged. Recently, there are a lot of coolant liquids in the Libyan market, some of which are manufactured locally and others are imported. Some of these liquids caused problems in car engines, such as corrosion and blockage of the engine or radiator caused by additives dropout. In this study, the percentage of additives dropout for four different coolants will be determined and the corrosion at core plug measured.

Experimental procedure

A consumed car engine cylinder block used in the present study. The chemical composition of the alloy was determined using FOUNDARY-MASTER Pro emission spark spectrometer. Table 1 shows the chemical composition of cylinder block alloy.

Table1: the chemical composition of cylinder block alloy

Element	Cr	Zn	Mg	Mn	Cu	Fe	Si	AL
Wt.%	`0.0260	0.714	0.257	0.151	2.59	0.762	11.5	Bal.

Twelve specimens are taken from cylinder block, three for each coolant type, which are cut into plates (35 mm×35 mm×12 mm) and then grounded and polished. Subsequently, they are immersed into engine coolants, which are Abrad, Freeztone, Algabl green, and Algabl Red for 72, 120, 216, , and 360 hr at room temperature as shown in Figure 1. The weight of additives dropout, and that precipitated on specimens is measured using a 1/10000 electronic balance.

Fig. 1 : Experimental setup

Results and discussion

Figure 2 shows the surface morphologies of samples after 360 hr of immersion in coolants.

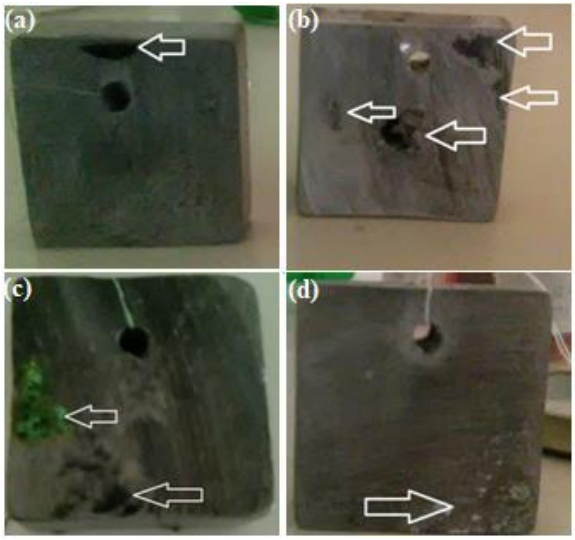

Fig. 2 : Effect of coolant type on surface of cylinder block alloy (a) Algabl green, (b) Algabl red, (c) Abrad, and (d) Freeztone

As can be seen, the surfaces of the alloys extremely affected by the extension of immersion time, and the surface revealed significant additives dropout. It has been reported that many coolant additives like silicate and phosphate, which used as corrosion inhibitors in engine coolant, have limited solubility [8]. That meant that if the antifreeze or additives got too concentrated in the coolant, then the excess phosphate and/or silicate would “dropout” of the coolant. These dropout problems caused premature water pump failures, radiator blockages, and heater core problems. Table 2 shows weight of samples before and after immersion on coolant liquids during 72, 120, 216 and 360 hrs.

Table 2 : Weight of samples before and after immersion in coolants

		ABRAD			Algabl Red			Algabl Green			FREEZETONE	
sample No.	1	2	3	1	2	3	1	2	3	1	2	3
original Wt. g	38.2874	35.7261	35.7255	35.4405	32.3886	36.2103	34.8777	30.7508	37.0199	38.9742	31.85	34.2368
Area, cm^2	43.30458	42.6451	42.3577	40.4787	40.3726	42.74574	42.934642	41.7195	45.4320	42.9275	43.8436	42.8007
time, hr												
72	38.2918	35.7933	36.0393	35.4587	32.507	36.4925	34.8968	30.7724	37.0483	38.998	31.8863	34.2843
120	38.2961	35.7975	36.046	35.4626	32.3112	36.4646	34.898	30.7685	37.0471	39.0057	31.8881	34.2833
216	38.3217	35.8651	36.1334	35.5072	32.5955	36.4817	34.9232	30.7845	37.0845	39.1735	31.9316	34.3781
360	38.319	35.8621	36.123	35.5094	32.5926	36.4885	34.9144	30.7884	37.0652	39.1755	31.9322	34.3783

Fig. 3 shows three samples average of additives dropout quantity for four types of coolant. Indeed, considerable differences are noticed in the case of Algabl Green and Freeztone compared with Abrad and Algable Red, which were 0.00000478, 0.00000713033 g/hr/cm^2 for Algabl Green and Freeztone, respectively, while 0.00002.54304 and 0.0000263792 g/hr/cm^2 for Abrad and Algable Red, respectively.

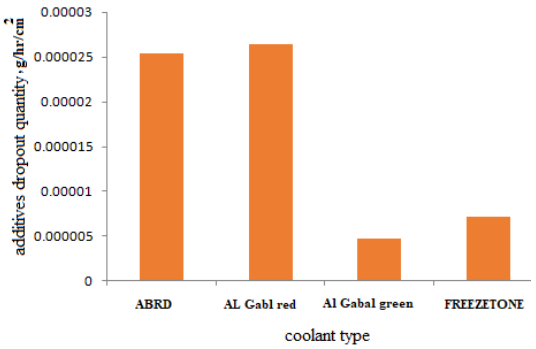

Fig. 3 : Effect of coolant type on additive dropout quantity

The additives can drop out of solution, causing deteriorating cooling system performance and wear in the coolant pump. This situation is greatly aggravated by poor coolant maintenance. In fact, more than 40% of diesel engine downtime is caused by cooling system failure. Even with good maintenance, conventional automotive or heavy duty coolant should be replaced every 2 or 3 years [9]. Most cooling system water contains calcium and/or magnesium from drinking water supplies. Water that contains over 100 ppm of these minerals is considered “hard water”. It is wonderful to drink, but these minerals can form scale in engine cooling systems. As the concentration of these minerals increases, so does the probability that you will have cooling system scale problems. The level of dissolved solids in coolant water is generally referred to as the “total hardness” reported in parts per million (ppm). Cooling system additives that contain anti-scale chemicals can allow the use of moderately hard water. It is

best to use water that is at least as good as the recommended water quality listed in the ASTM standards [10].

Conclusion

In this study, the effects of engine coolant car on quantity of additive dropout were investigated. A significant notes observed using visual inspection, as the additives precipitate on the samples with different colors, However, these deposits were in different quantities with the different type of coolant used. Weight measurements showed that Al Gabal green was the lowest in dropout rate, which produced locally, compared with Abroad coolant type that import from overseas. In addition, the high dropout rate of Al Gable red compared with Al Gable green could be related to the dye type, as both coolants are produced by the same local company.

References

1. Alves, L.O.F.T., et al., Comparative performance analysis of internal combustion engine water jacket coolant using a mix of Al2O3 and CuO-based nanofluid and ethylene glycol. Energy, 2022. 250: p. 123832.
2. Iijima, K. and S.O.K. Iwakata, Development of Non-Amine Type Engine Coolant. Komat's Technical Report, 2002. 48(149).
3. Cape, J.N., D. Fowler, and A. Davison, Ecological effects of sulfur dioxide, fluorides, and minor air pollutants: recent trends and research needs. Environment International, 2003. 29(2-3): p. 201-211.
4. Kokilaramani, S., et al., Microbial influenced corrosion of processing industry by re-circulating waste water and its control measures-A review. Chemosphere, 2021. 265: p. 129075.
5. Eyre, T., Wear resistance of metals. Treatise on Materials Science and Technology, 2013. 13: p. 363-442.
6. Alakoul, K.A., A.R.H. Wetaify, and A.N. Huseein, Protection of engine cylinder against thermal and mechanical failure by nano-oxide coating.
7. Rowe, L., Automotive Engine Coolants: A Review of Their Requirements. Engine Coolant Testing: State of the Art, 1980. 705: p. 3.
8. Рузимов, С. and Д. Муйдинов, STUDY ON CAR ANTIFREEZE AND COOLANT: MAIN PROBLEMS, MAINTAINING, REPAIRING AND DIAGNOSING SERVICES. Журнал Технических исследований, 2020. 3(5).
9. Hudgens, R. and R. Hercamp. Test Methods for the Development of Supplemental Additives for Heavy-Duty Diesel Engine Coolants. in Engine Cooling Testing: Second Symposium. ASTM STP. 1986.
10. Ruzimov, S. and D. Muydinov, STUDY ON CAR ANTIFREEZE AND COOLANT: MAIN PROBLEMS, MAINTAINING, REPAIRING AND DIAGNOSING SERVICES. ТЕХНИКА ФАНЛАРИ. 5(3): p. 46.