Evaluation of New Antifoaming Agents on Egyptian Lubricating Oil

M. Abd-Elfattah , H. Salah and R. Farouq

***Abstract*— Antifoam agents is a common additive in many types of lubricating oils and hydraulic fluids. These additives can detect when the useful life of a lubricant is over, but fall short when trying to gain insight on how long a lubricant in current use could last. Foams pose serious problems which cause defect on surface coatings and prevent the efficient filling of containers, so the purpose of the defoamant is to retard the formation of stable foam on the surface of the oil in the sump, gearbox, or reservoir.In the present work Poly dimethyl siloxane(PDMS) and Poly methyl methacrylate (PMMA)were investigated as antifoam agents. The efficiency of the antifoaming was determined according to ASTM-D-892 by three sequences that differ only in measuring temperature. Also, some properties such as density, total acid number, and viscosity were measured according to standard methods .A percent ratio recommended is 25% PDMS and 75% PMMA which has been examined as deformer additives for lube oil.**

***Keywords*— Antifoaming agents, Efficiency of antifoaming, Lube Oil additives .**

I. Introduction

Oil additives and fluid additives are chemical substances added to oils and industrial fluids to impart or improve certain properties. Oil additives include viscosity modifiers, deposit control additives, anti-corrosion agents, and rust-inhibiting additives [1].Lubricating oils are not completely free of air. Whether during operation or storage in barrels, oils are constantly in an exchange process with their air-containing environment. Even if the oil is free of air bubbles, it will have a proportion of dissolved air. This depends primarily on the gas solubility, but pressure and temperature also have an effect. Some mineral oils can have air content approaching 9 to 11 percent volume at atmospheric pressure and room temperature. As long as the air remains dissolved in the oil, this generally is not a problem[2].In different industrial applications foam is both desirable and undesirable. Formation of foam is also one of the most interesting phenomena's. In all lubricant applications, foam is regarded as undesirable, because it interferes with the lubrication process and can cause serious problems due to false lubricant level and excessive wear due to the presence of compressible air bubbles. The new oil may be good with respect to antifoaming behavior, but as the oil undergoes thermo-oxidative degradation and simultaneously contamination from other oils or from other sources, oil foaming increases. Such conditions also degrade other properties of oil, like emulsion forming tendency and air Entrainment. The best method to control these properties is to eliminate contaminant as soon as these are generated or create conditions so that degradation does not take place. With a proper lubricant system design and appropriate additive selection, it is possible to avoid or control degradation to a large extent and prolong the life of the lubricant[3].The stability foam is governed by the interface rigidity, elasticity and viscosity and not by the oil surface tension. Viscous oils produce more stable foam. Higher temperatures produce more foam in oils, but the foam stability is less because of lower viscosity at higher temperatures [4].Several destabilizing effects can break foam down such as:

Gravitation causes drainage of liquid to the foam base, Osmotic pressure causes drainage from the lamellas to the Plateau borders due to internal concentration differences in the foam and Laplace pressure causes diffusion of gas from small to large bubbles due to pressure difference. Films can break under disjoining pressure, these effects can lead to rearrangement of the foam structure at scales larger than the bubbles[5].A defoamer or an anti-foaming agent is a chemical additive that reduces and hinders the formation of foam in industrial process liquids. The terms anti-foam agent and defoamer are often used interchangeably[1].The foaming of lubricants is a very undesirable effect that can cause enhanced oxidation by the intensive mixture with air, cavitation damage as well as insufficient oil transport in circulation systems that can even lead to lack of lubrication. Beside negative mechanical influences the foaming tendency depends very much on the lubricant itself and is influenced by the surface tension of the base oil and especially by the presence of surface-active substances such as detergents, corrosion inhibitors and other ionic compounds [6].Anti-foam agents prevent foaming by destroying bubbles when they reach a free surface almost as rapidly as they are formed. Many materials have some anti-foaming ability, the most effective product so far found are the silicon polymers (polymethyl siloxanes) and these have found extensive use in engine oils [7]. Polymethacrylate in different forms is the most famous type of deformer[8-10].Also,some researcher used poly(Methyl methacrylate) and give good results as deformer [11-12] and other tried silicon speciesfor treatment and show good results [13]. In the present work Poly dimethyl siloxane(PDMS) and Poly methyl methacrylate (PMMA)were investigated as new antifoam agents as a mixture with different ratio to compromise

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II. MATERIAL AND METHODS

The anti-foaming used is mixture of polymethylmethacrylate & siloxane in different ratios and tested with lube oil.

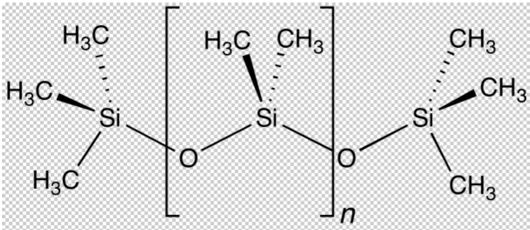

Fig. (1) structure of Siloxane

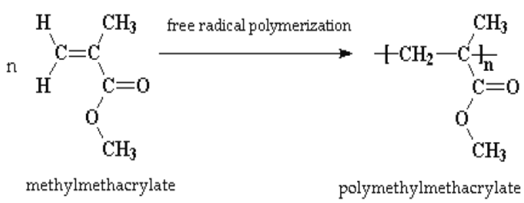

Fig.(2) structure of polymethylmethacrylate

- Samples of anti-foaming additives: different ratios of PMMA and Poly dimethyl Siloxane (PDMS) as wt% of lube oil beside pure addition of PMMA & pure addition of Poly dimethyl Siloxane, 5000 ppm as wt% of lube oil.

- The variables studied were density, viscosity, total acid number and Antifoam Test Method (Foam Efficiency) ASTM D-892

III. III.RESULTS AND DISCUSSIONS

Polymethylmethacrylate (PMMA) and poly-dimethyl Siloxane (PDMS) were used as anti-foaming additives which mixed in different ratio of 5000 ppm additives on oil as wt% besides using each additive individually (5000 ppm). The ratios used are related to PMMA: PDMS as follows:
PMMA: PDMS = (2:1 – 1:2 -1:1 -1:3 – 3:1)

A. Effect of Antifoaming Concentration on lube oil Density:

As shown in Figure (3) , as PDMS Concentration increases, the density of lube oil increases (up to 25 %) then decreases(from 25 % to 50 %) then increases and this can be attributed to the ratio 1: 1 (50%: 50%)is the best ratio of anti - foaming performance .While figure (4) shown the effect of each anti -foaming individually on the lube oil density using 5000 PPM.

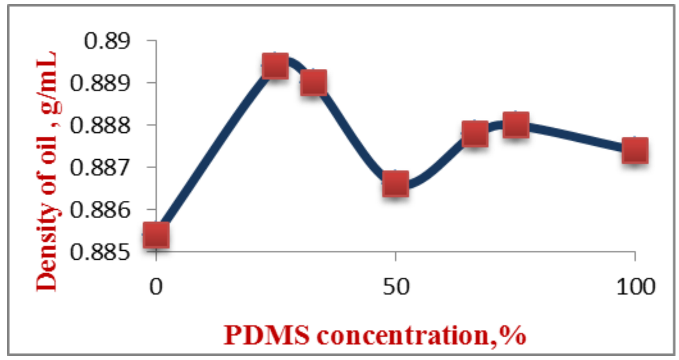

Fig.(3) Relation between Density of Oil With the corresponding PDMS Antifoaming Concentration

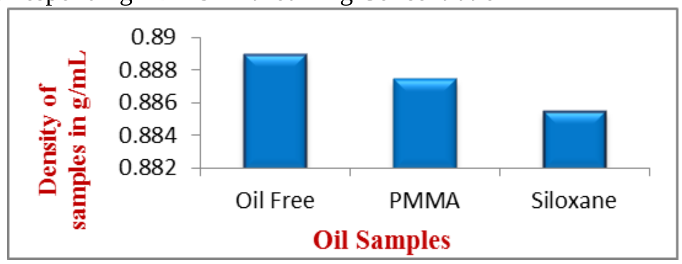

Fig.(4) Relation between Densities of lube Oil With each Antifoaming Concentration 5000 PPM

B. Effect of Antifoaming Concentration on lube oil Viscosity:

As shown in Figure (5) as PDMS concentration increases, the viscosity of the lube oil slightly changes up to 75 %PDMS then increases. While figure (6) shown the effect of each anti -foaming individually on lube oil viscosity using 5000 PPM.

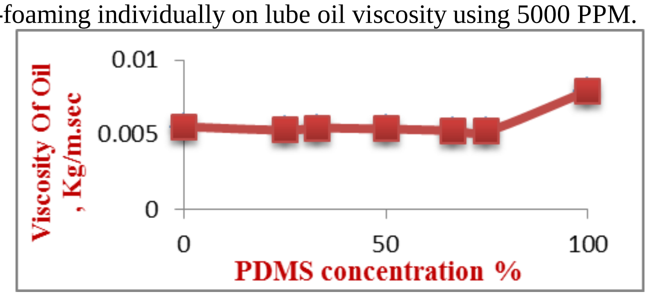

Fig. (5) Relation between Viscosity of Oil With the corresponding Antifoaming Conc.

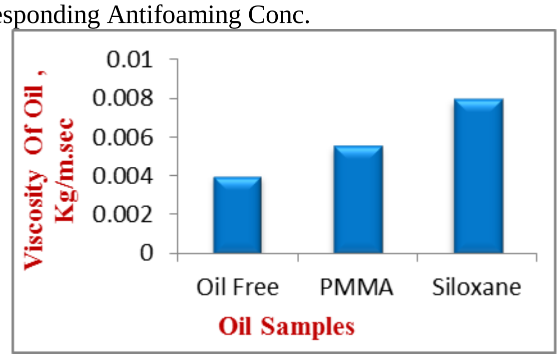

Fig. (6) Relation between viscosities of lube Oil With each Antifoaming Concentration 5000 PPM.

C. *Effect of Antifoaming Concentration on lube oil TAN*:

As shown in Figure (7), PDMS concentration increases, the TAN of lube oil slightly change increasing as overall.

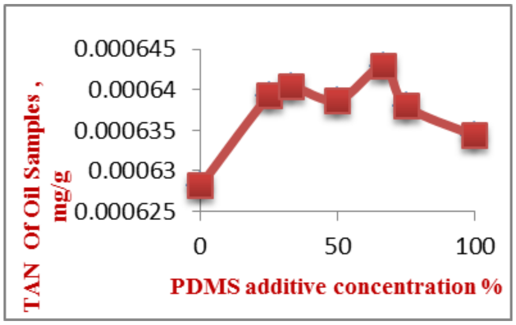

Fig. (7) Relation Between total acid number Of Oil With the corresponding Antifoaming Concentration.

D. Effect of Antifoaming Concentration on lube oil foam efficiency:

As discuss pervious, the foam efficiency has 3 sequences depends on temperature, as shown in figures (8-10), the effect of different ratio of PMMA & PDMS on foam efficiency during the 3 sequences. The results show that, the highest foam efficiency in sequence 1 is 66.5% and this is a bad performance and the best and the same performance in sequence 1 at 100% PDMS and the recipe of 75% PMMA & 25% PDMS as shown in figure (8).

While in sequence 2 which is the most important step, the worst foam efficiency is 120% at 66.5% PDMS, and the best performance in sequence 2 at and 100% PMMA and 25% PDMS as shown in figure (9).

While in sequence 3 the worst foam efficiency is 200% at 66.5% PDMS, and the best performance in sequence 3 at 25% PDMS and 100% PMMA as shown in figure (10).
From the previous results, the blending with PDMS decrease the cost and the anti-foaming additive PMMA is a new one in this field which has not yet established his performance as an anti-foaming additive for lube oil.

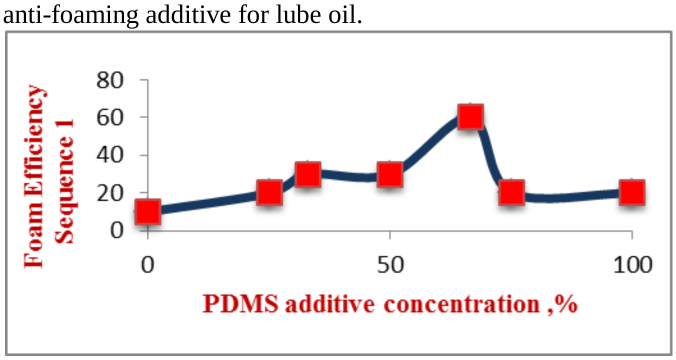

figure (8) Relation Between foam efficiency squence 1 Of Oil With the corresponding Antifoaming Concentration.

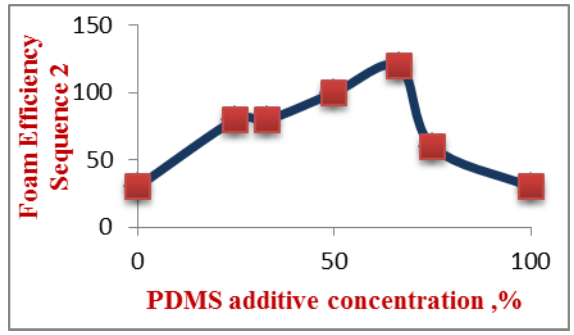

Figure (9) Relation Between foam efficiency squence 2 Of Oil With the corresponding Antifoaming Concentration.

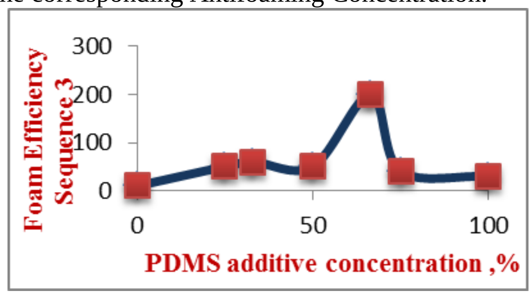

Figure (10) Relation Between foam efficiency squence 3 Of Oil With the corresponding Antifoaming Concentration.

IV. CONCLUSION

A new material had been considered as antifoam additive which is Polymethylmethacrylate (PMMA) but its characterization has not been fully examined as deformer additives in the lube oil.

Poly dimethyl siloxane (PDMS) which is recommended as antifoam additive as deformer has been used. A percent ratio recommended is 25% PDMS and 75% PMMA which has been examined as deformer additives for lube oil. Decreasing the price of the deformer by adding PMMA due the high price of PDMS.

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