

Study on Effects of Additives on Viscosity Index of Lubricating Oil

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Abstract— In this paper the effect of additives on kinematic viscosity of lubricating oils (base oils) at two different temperatures 40° C and 100° C were investigated. Triphenylphosphate (TPP) and 5 Benzyl 1H tetrazole (BTZ) were used as additives. Different lube oils were prepared by adding additives in required concentrations to base oil. These oils were tested for viscosity at both the temperatures and viscosity index was calculated for all the oils. It was observed that viscosity decreased with the increase in additive concentrations and viscosity index increased with increase in additive concentrations.

Key words: Kinematic Viscosity, Viscosity Index, Triphenyl phosphate, 5 Benzyl 1 H tetrazole

I. INTRODUCTION

Lubricant is a substance introduced between two surfaces in motion to reduce the friction between them. A lubricant forms a layer which allows for two touching surfaces to be separated and “smoothed” thus lessening the friction between them. Modern lubricants are prepared from base oils and additives. The base oils have certain properties like separating the moving surfaces, removing heat and reducing the friction between the surfaces [1]. Many of these properties can be enhanced by adding additives to the base oils. The additives like viscosity improvers, pour point depressants, extreme pressure agents, rust and corrosion inhibitors etc are used [1]. Viscosity Index [VI] is one of the major properties of a lube oil. This VI can be defined as a property of lube oil which indicates the changes in viscosity with respect to temperature. This also indicates how stable oil can be at varying temperatures and under normal working conditions. The viscosities of the finest oils do not vary with the varying temperatures during normal working conditions. There are number of viscosity improvers available which try to enhance the viscosity index of the base oils. Co polymers of sunflower oil with methyl methacrylate and decylacrylate can be used as viscosity improvers for lube oils [2].

An additive package contains special types of polymers, which in small proportions remarkably improve rheological properties of oils such as viscosity and viscosity index. However when oil is in use due to break down of molecules there is decrease in friction and wear. The addition of additives improves the flow properties by reducing the viscosity [3]. The contribution of additives for longer sustainability of commercial lube oils would be better compared to base oils without additives [4]. Turbine fuel when blended with spindle oil shows better results for parameters like viscosity density and aniline point [4]. So the VI improvers act by bulging of the polymer chain at higher temperature and thereby avoiding the decrease in base oil viscosity [5-7]. So there are numerous viscosity improvers available. In this work the effect of Tri phenyl phosphate and 5 Benzyl tetrazole on kinematic viscosity and viscosity index of a lubricant was studied.

II. EXPERIMENTAL

A. Test Method:

This method is carried out according to ASTM 2270. The pictorial representation of the Ostwald U tube viscometer and photograph of the test apparatus used are shown in the Figures 1 and 2 respectively.

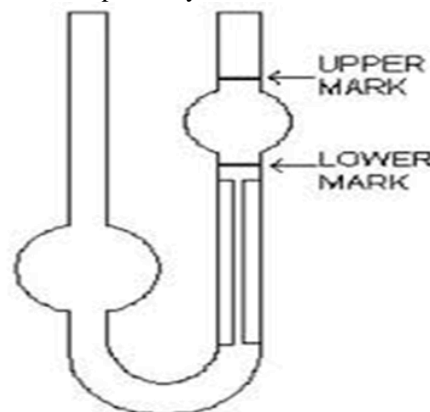


Fig. 1: Pictorial representation of Ostwald U tube Viscometer



Fig. 2: Photograph of Viscosity Test Apparatus

The water bath was maintained at a temperature of 40°C using a controller. A clean dry Ostwald's U-tube viscometer (D-Type) was charged with the oil sample up to the mark. The viscometer was kept in the bath allowed to reach the test temperature. The head level of the test tube was adjusted using a vacuum pump.

Once the test sample reached the upper mark the sample was allowed to flow down to the lower mark under gravity. The time required to pass from the upper mark to the lower mark was noted down. Kinematic viscosity is calculated using the formula:

$$\text{Kinematic viscosity} = t \times k$$

t = time taken by the sample to flow from first mark to the second mark

k = constant of the viscometer used

The above procedure was repeated for the next trial. The average of these readings was taken and reported

the kinematic viscosity of the oil at 40⁰ C. The same procedure was followed to obtain the kinematic viscosity of the oil for 100⁰ C by maintaining the oil bath at required temperature. The viscosity index was calculated using the formula.

$$V = 100 \frac{(L - U)}{(L - H)}$$

Where V indicates the viscosity index, U the kinematic viscosity at 40 °C (104 °F), and L and H are various values based on the kinematic viscosity at 100 °C (212 °F) available in ASTM D 2270.

B. Results And Discussions:

In the present work the lube oils were prepared by mixing two additives namely Triphenyl phosphate and

Benzotetrazole with two types of base oils (Base oil 1 and Base oil 2). The additives were first dissolved in toluene and isopropanol alcohol solvents respectively and these additive solutions were blended with base oils to set the lube oils with known concentrations of additives. These oils were tested for kinematic viscosity as explained above and viscosity index of these oils were calculated by using the above formula.

Table 1 gives the details of kinematic viscosity and viscosity index of lube oils prepared with different concentrations of triphenyl phosphate (TPP1– 5) using base oil 1 (BO1). Viscosity tests were carried out for commercial oils also and results obtained are also given in Table 1. These results are also shown in Figure 3.

Oil sample No	Oil sample composition	Base oil ml	Volume of solvent with the additive ml	TPP added g	Kinematic viscosity at 40°C Cst	Kinematic viscosity at 100°C Cst	Viscosity Index
1	BO1	100	--	0	9.60	2.58	90.101
2	BO1+TPP1	100	2	0.09	8.93	2.45	92.800
3	BO1+TPP2	100	4	0.19	7.85	2.29	93.465
4	BO1+TPP3	100	6	0.28	7.93	2.23	96.310
5	BO1+TPP4	100	8	0.37	7.20	2.15	97.360
6	BO1+TPP5	100	10	0.45	6.65	1.99	99.460
7	Commercial oil	100	-	-	6.04	2.00	102.600

Table 1: Kinematic viscosity and viscosity index for various oil samples prepared from BO 1 and TPP

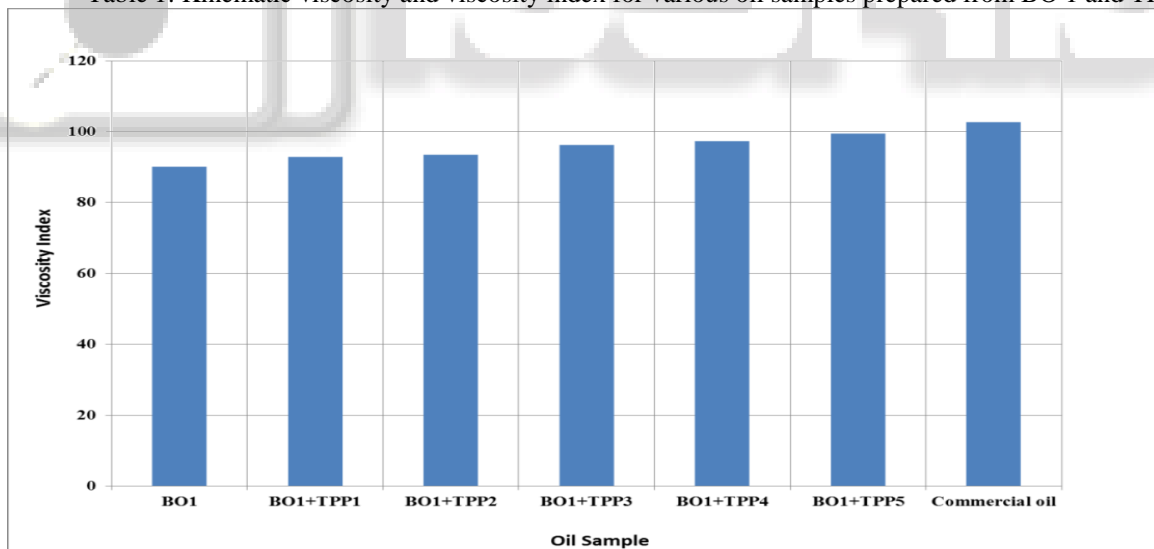


Fig. 3: Viscosity Index of oil samples prepared from BO 1 with TPP additive

Similarly lubricating oils were prepared with Base oil 2 (BO2) with TPP, Base oil 1 (BO1) with BT and Base oil 2 (BO2) with BTZ and tested. Results of these tests are given in Tables 2, 3, 4 and shown in Figures 4,5,6

respectively. Viscosity tests were carried out for commercial oils also and results obtained are also given in these tables and figures.

Oil sample No.	Oil sample composition	Base oil ml	Volume of solvent with the additive ml	TPP added g	Kinematic viscosity at 40°C Cst	Kinematic viscosity at 100°C Cst	Viscosity Index
1	BO2	100	-	0	12.25	3.06	87

2	BO2+TPP1	100	2	0.09	11.46	2.85	90.79
3	BO2+TPP2	100	4	0.19	10.135	2.69	93.02
4	BO2+TPP3	100	6	0.28	9.19	2.5	94.67
5	BO2+TPP4	100	8	0.37	8.005	2.35	110.7
6	BO2+TPP5	100	10	0.45	7.0649	2.2	118.43
7	Commercial oil	-	-	-	8.91	2.5	106

Table 2: Kinematic viscosity and viscosity index for various oil samples prepared from BO2 and TPP

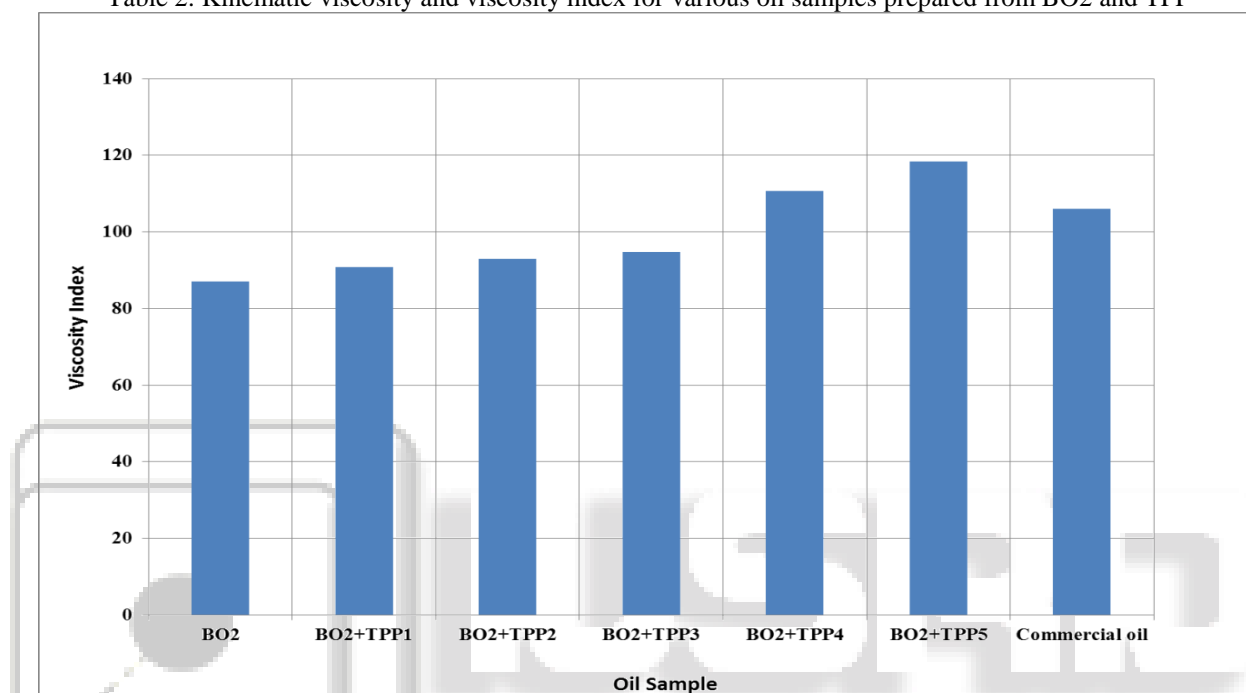


Fig. 4: Viscosity Index of oil samples prepared from BO 2 and TPP

Oil sample No.	Oil sample composition	Base oil ml	Volume of solvent with additive ml	BTZ added g	Kinematic viscosity at 40 °C cst	Kinematic viscosity at 100 °C cst	Viscosity Index
1	BO1	100	-	-	9.6	2.58	90.101
2	BO1+BTZ1	100	2	0.08	9.25	2.387	92
3	BO1+BTZ2	100	4	0.17	8.93	2.45	93.5
4	BO1+BTZ3	100	6	0.23	8.56	2.38	97
5	BO1+BTZ4	100	8	0.33	7.841	2.3	105
6	BO1+BTZ5	100	10	0.41	6.92	2.15	112.5
7	Commercial oil	-	-	-	6.04	2.00	102.6

Table 3: Kinematic viscosity and viscosity index for various oil samples prepared from BO 1 with BTZ additive

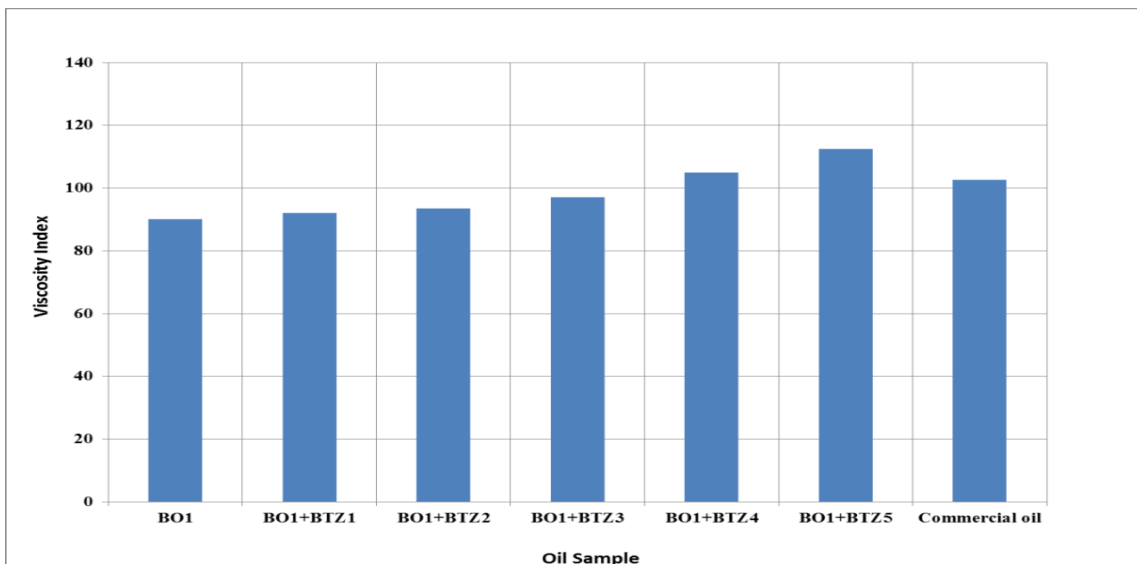


Fig. 5: Viscosity Index of oil samples prepared from BO 1 with BTZ additive

Oil sample No.	Oil sample composition	Base oil ml	Volume of solvent with additive ml	BTZ Added g	Kinematic viscosity at 40 °C cst	Kinematic viscosity at 100 °C cst	Viscosity Index
1	BO2	100	–	–	12.25	3.06	87
2	BO2+BTZ1	100	2	0.08	12.724	3.048	93.05
3	BO2+BTZ2	100	4	0.17	11.65	2.89	95.2
4	BO2+BTZ3	100	6	0.23	10.89	2.799	99.146
5	BO2+BTZ4	100	8	0.33	8.22	2.35	108.36
6	BO2+BTZ5	100	10	0.41	7.994	2.00	117.962
7	Commercial oil	–	–	–	8.91	2.5	106

Table 4: Kinematic viscosity and viscosity index for various oil samples prepared from BO 2 with BTZ additive

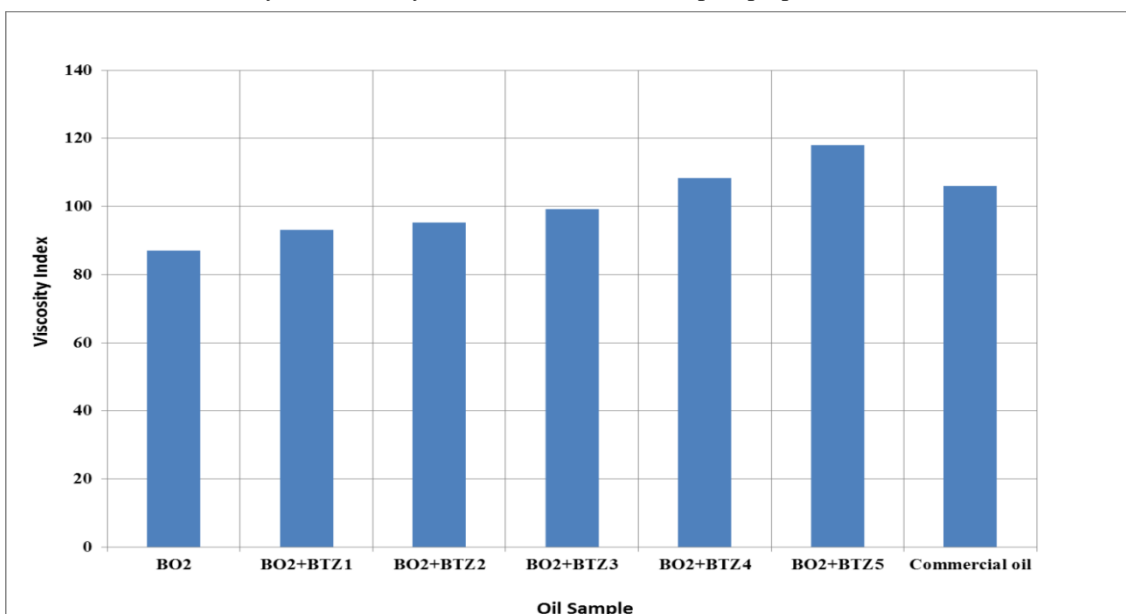


Fig. 6: Viscosity Index of oil samples prepared from BO 2 with BTZ additive

III. CONCLUSION

It is seen from the tables as well as from the figures that kinematic viscosity of oil samples prepared decreases and viscosity index increases with increase in additive concentrations. Also the viscosity index of the lubricant tested is sensitive to the percentage additive. Small amount of the additive was adequate to give the desired result. Base oil 2 gave better results with both additives tried.

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