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Effect of Zinc-Dialkyl-Dithiophosphate Additive on Viscosity and Density of Pongamia Oil Bio-Lubricant.

Gurudatt.H.M[1], Dr.T.Nagaraju[2]
[1] *Department of Mechanical Engineering, P.E.S College of Engineering Mandya, India-571401*
[2] *Professor and Head of the department, Department of Mechanical Engineering, P.E.S College of Engineering Mandya, India-571401*

Abstract: *New bio lubricant was produced by introducing Zinc-Dialkyl-Dithiophosphate (ZDDP) into commercialized Pongamia oil. ZDDP is added which lowers the kinematic viscosity and reduces the density. The newly developed bio lubricant oil was tested with a Cannon fenske viscometer for viscosity test and with hydrometer for density test while Pongamia oil with 2 wt% ZDDP showed least kinematic viscosity and decreasing trend of both kinematic viscosity and density up-to 2wt% of ZDDP and both density and viscosity increases with increase in ZDDP above 2wt% of ZDDP. Pongamia oil with 2 wt% ZDDP showed a desirable kinematic viscosity value of 36.9 Cst. Hence addition of 2wt% ZDDP to pongamia oil is desirable.*
Keywords: *Pongamia, ZDDP, Bio-lubricant,*

I. Introduction

Demand for environmentally friendly lubricants are increasing because of the high concern for environmental protection. Vegetable oils are being explored as a source of environmentally acceptable lubricant as they have exposed their anti-wear and fatigue resistance properties rather than mineral oils, as well as improved deterioration load carrying capacity [1]. Plant oil lubricants also obtain most of the properties required for lubricants such as high viscosity indices because of their high molecular weights, low volatility and good lubricity because their ester bonds enable the oil molecules to stick to metal surfaces through physical bonding and offer better boundary lubricity compared to non polar petroleum-based mineral oil [2]. However, oxidation stability of vegetable oil is one of the problems in formulating bio-lubricants using vegetable oils [3]. The high content of unsaturated fatty acids in vegetable oils produces the oil less cooperative in stabilizing the oxidation. The modification of the vegetable oil or addition of antioxidant additives could help in stabilizing the oxidation process [4]. The degradation of lubricant oil can be decreased by the addition of ZDDP into the base parent oil as the effective anti wear and antioxidant additive [5]. Their long and polar fatty acid chains can provide high strength lubricant films that interact strongly with metallic surfaces [8].

II. Methodology

In this study, 0wt%, 1wt%, 1.5wt%, 2wt%, 2.5wt% and 3wt% of ZDDP was added into commercialized pongamia oil to study the lubricity effect of the oil. The blending process is done using Magnetic Stirrers machine. The prepared samples were then heated to 70ºC for 20 minutes to ensure that ZDDP is properly dissolved into the parent base oil. After sample preparation, the samples were then tested for kinematic viscosity at 40ºC using a Canon fenske viscometer and density test is carried out using hydrometer.

III. Results And Discussion

3.1 Effect on Kinematic Viscosity: The prepared samples were tested using Canon fenske viscometer at 40ºC. Table 1 shows the kinematic viscosity of six different concentrations of oil tested using Canon fenske viscometer. From Figure 1, it is evident that the value of kinematic viscosity at 40ºC reduces to 36.3cSt when the oil was added with 2 wt% ZDDP while increases with increase in wt% ZDDP. With the addition of 2wt% ZDDP the newly developed oil has been found to create a boundary film which forms on the metal surfaces contacting. The film formed by ZDDP acts as a friction reducer showing that ZDDP additive in the right amount is beneficial [6]. At higher concentration the excess ZDDP adversely effect on the boundary film formation. Zinc forms a film on the metal surface. With the increase of weight percentage of the oil, more film is formed on metal. This condition may be contributed to the increase of the viscosity due to the excess of the metal present in the oil[7]. This resulted in significant increment of kinematic viscosity of oil with addition of 2.5wt% and 3wt% ZDDP.

Table 1:- Kinematic Viscosity Results.

Sl No.	Weight Percentage of ZDDP	Time taken in Min			Kinematic Viscosity in (Cst)
		Trial		Average	
		1	2		
1	0	44.26	44.42	44.34	39.906
2	1	42.44	42.58	42.51	38.259
3	1.5	41.54	41.58	41.56	37.404
4	2	41.01	41.09	41.05	36.945
5	2.5	41.44	41.59	42.04	37.836
6	3	42.55	42.58	42.52	38.268

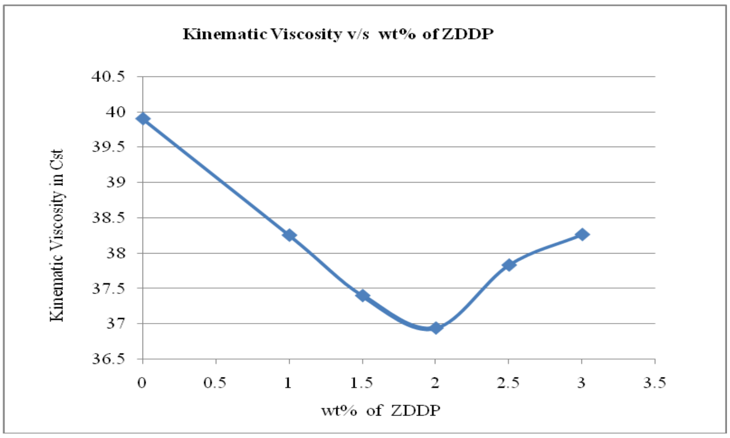

Fig 1:- Variation of Kinematic viscosity v/s wt% of ZDDP

3.2 Effect on density: The density test for pongamia base oil added with different percentage of ZDDP additive is carried out using hydrometer. Table 2 Shows the density test results of pongamia oil blended with different percentage of ZDDP additive carried out at 40ºC temperature. From fig 2 It is clear that the density of pongamia oil decreases with addition of ZDDP additive up to 2%, Further increase on ZDDP additive results in increase in density of pongamia oil this is because at higher concentration the excess ZDDP adversely affect the boundary film formation [7].

Table 2:- Density Test Results

Sl No.	wt% of ZDDP	Density (g/cm^3)
1	0	0.924
2	1	0.917
3	1.5	0.913
4	2	0.91
5	2.5	0.915
6	3	0.92

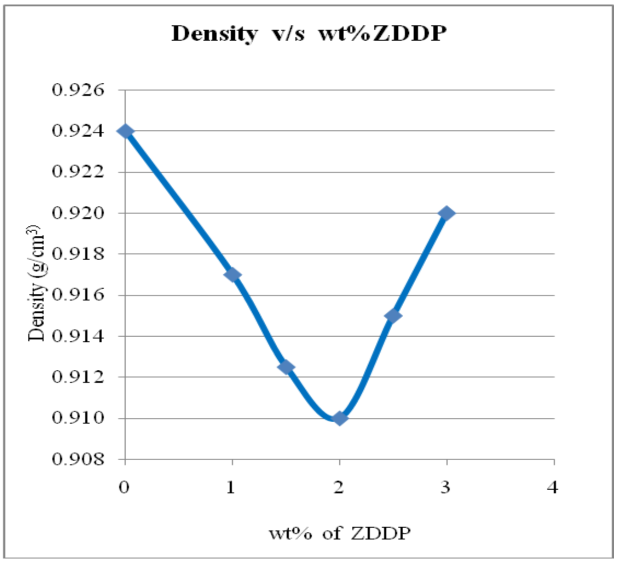

Fig 2:- Variation of Density V/S Wt% Of Zddp

IV. Conclusion

From the results pongamia oil with 2 wt% ZDDP showed least kinematic viscosity and decreasing trend of both kinematic viscosity and density up-to 2wt% of ZDDP and both density and viscosity increases with increase in ZDDP above 2wt% of ZDDP. Pongamia oil with 2 wt% ZDDP showed a desirable kinematic viscosity value of 36.9 Cst. Hence addition of 2wt% ZDDP to pongamia oil is desirable.

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