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EVALUATION OF OIL / TRIBOLOGY AS A MEASURE OF ENERGY AND COST SAVING AT SSGC, PAKISTAN

Huzaifa Nadeem[1], Rizwan Ahmed Memon[2], Abdul Ghafoor Memon[3], Bilal Shams[4]
[1] Student of Mechanical Engineering Department
Mehran University of Engineering & Technology, Jamshoro, Pakistan
[2]Professor of Mechanical Engineering Department,
Mehran University of Engineering & Technology, Jamshoro, Pakistan
[3]Associate Professor of Mechanical Engineering Department
Mehran University of Engineering & Technology, Jamshoro, Pakistan
[4]Assistant Professor, Petroleum and Natural Gas Engineering Department
Mehran University of Engineering & Technology, Khairpur Mirs, Pakistan
Corresponding author-mail: (engg.huzaifa@yahoo.com)
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***Abstract*— Lubrication is the essence of maintenance for Equipment and Machineries. Proper maintenance can enhance the life span of equipment; decrease the cost of failure, energy consumption, and breakdown time resulting in increase of production. Lubricants being used currently at Sui Southern Gas Company Ltd (SSGCL) were adopted several years ago and require replacing at intervals of 250 Hrs / 3000 KMs. Lubricants offered in today's market offer much greater maintenance intervals which will result in reduced maintenance associated costs and better equipment life. This research is aimed at deriving a tribology of different lubricants offered in today's market and find the optimum lubricant and estimate cost benefits for Machines, Equipment and Vehicles (MEVs) at SSGCL. The research was performed at Base Camp, Khadeji, SSGCL. Obtained results show that the newly selected Lubricant increases the maintenance intervals up-to 750 Hrs / 9000 KMs. The costs associated to maintenance were decreased 3 folds and the energy consumption was significantly reduced.**

***Index Terms*— Cost Saving, Equipment, Lubricants, Machineries, Maintenance, Oil Tribology, Vehicles**

I. INTRODUCTION

SET of activities required to restore the item in good working condition is known as Maintenance. In the field of maintenance engineering, vital role has been played by the lubrication results in the reduction of cost, saving energy and increasing the overall productivity of the system and also make the system environmental friendly by controlling the CO_2emissions. Maintenance can be of two types i.e. corrective & Preventive Strategies. In Interval based maintenance, the most important part is to check the proper lubrication of the system to overcome the friction, increase the life of equipment, and to reduce the cost associated with the labor & the lubricants.

Friction is the force resisting the relative motion of solid surfaces, fluid layers, and material elements sliding against each other. Lubrication is used to overcome unnecessary friction, to remove the excess heat from the system and to run the system smoothly without wearing and tearing of moving parts. Therefore, it is mandatory to choose the suitable lubricant to reduce the break downs and wears of machine.

The primary function of engine lubrication is to control engine abnormalities, wear of liners and piston rings and crankshaft bearings [1]. The bases used (TBN) are one of the major requirement for the control of wear between moving parts caused by the acids produced after the combustion of fuel [2]. The level of alkalinity falls after the usage of engine oil and to keep the equipment in the well balanced condition it is necessary to alkalinity level above a minimum value. The best way to use oil consists of sufficient TBN (Total Base Number) so that it never falls below from its minimum value [3].

Demand of economical fuel vehicles are increasing day by day and increasing the pressure on engine manufacturers world-wide [4]. Hence, fuel efficient lubricants are highly demanded to provide addition economic features. In today's uprising market, the design of low weight vehicles is of prime importance. Synthetic oil with low viscosity is used, which helps in the economical fuel of the system [5].

Engine Friction is mainly caused by the piston and piston rings in an IC engine [6]. During the combustion of diesel engine, production of soot particles takes place and those particles

either escaped into the environment or mixed with the lubricant. Wear of engine can be developed by the soot particles. Abrasive found in the soot will cause the parts to wear. If the level of suit increased significantly the process of starvation can also be started which can also increase the wear of engine. If the lubricant with higher level of suit will be used, the level of acids around the piston will be increased where all the volatile gases and high temperature exits results in corrosion [7].

Lubrication oil is called as engine's blood. Proper lubrication is necessary for all moving parts of an internal combustion engine to increase the power output and engine service life, and avoids failure of the components. In a same way, Engine lubricants are used to reduce the friction between the moving parts [8]. The main formation of engine oil consists of base oil and additive packages particularly with alkalinity and anti-wear capabilities [9].

The best way to keep the MEVs (Machineries, Equipment and Vehicles) in good working condition is to provide a proper lubrication system, which can increase the total life span of the equipment, works against the non-useful friction, increase the productivity of work and reducing the costs associated with its maintenance [10].

Existing maintenance and lubrications methods at Sui Southern Gas Company are based on traditional methods which were developed some 40 years ago, perishing the labor costs, maintenance costs, and also reducing the productivity of the system. Existing maintenance schedules at Sui Southern Gas Company contains the change interval of oil i.e. 3000 KMs for the vehicles and 250 Hours for the Machineries and equipment. Hundreds of MEVs operating around the two major provinces i.e. Sindh and Baluchistan need to be maintained via proper scheduled maintenance. Oil Filters of Machines and Equipment which cost around 50,000 Rs need to be changed after the short interval of 3000 KMs / 250 Hrs (Based on a records available at the Maintenance Log Book of Equipment, Machineries and Vehicles at SSGC) [11].

The oil that is being used at Sui Southern Gas Company can be replaced by suitable oil for MEVs which can be useful for the company and can save huge amount of money and energy associated with it. The oil change interval of the MEVs can be increased up to 9000-12000 KMs for Vehicles and 500-750 Hours for machineries. Hence, it will also reduce the costs associated with filters that need to be changed at each short interval, the breakdown time of MEVs will be reduced and the productivity of the MEVs will increase [12],[13].

Main objectives of this study are to analyze the procedure and process used in the selection of oil, to determine suitable oil for the MEVs at SSGC and to provide associated energy cost benefits. Comparative analysis has been done to compare the engine oil of 15W40 Grade from four different oil marketing companies to achieve the results.

This study has been carried out at base camp Khadeji of SSGC and the result may be applicable at all the maintenance departments of SSGC. Moreover, the industries that are using engine oil in massive quantities can also get advantage through this research work.

II. METHODLOGY

This Research work is exclusively designed by considering scheduled maintenance which mainly requires the change of lubricants and filters after defined intervals. Increasing the life cycle of the MEVs, reducing the financial losses associated with them and increasing the productivity of the machineries by the selection of proper engine lubricants at SSGC are the core values of this article/ research. However, this whole process can be helped by proper records of lubricants used at SSGC, the defined interval of changing lubricants, cost associated with each maintenance of MEVs and the consumption of engine oil/ lubricants on daily/ monthly basis.

The above offered approach of selecting suitable oil has brought in use alongside the existing mineral oil/ lubricants using in MEVs at pipeline construction jobs of SSGC. The results from both the systems have beenanalyzed and compared in terms of quality, time consumption and cost in order to find the feasibility of selecting the suitable engine oil for the MEVs working at SSGC.

After collecting all the information, Oil of same grade i.e. 15W40 from four reputed oil Companies have been poured in Volvo Trailers of same man ufacturing year.

BRAND AND PRODUCT NAME OF OILS:

Company	Grade	Product
M/SPSO	15W40	DEO 9000
M/S SHELL	15W40	RIMULA R4X
M/S TOTAL PARCO	15W40	RUBIA WORKS 1000
M/S ORIENT OILS	15W40	VALVOLINE 15W40

Samples have been obtained at running intervals of 3000KMs, 6000 KMs and 9000 KMs of each oil from all the Volvo Trailers. 3 Samples drawn from each oil have been sent to the Oil Analysis Lab to know the characteristics/ parameters of oil. Parameters that have taken into account are **TBN (TOTAL BASE NUMBER), KINEMATIC VISCOSITY at 100°C and VISOCITY INDEX.** These three parameters are enough to define the current condition/ quality of oil. Hence these three parameters have been compared of all the oil samples at different intervals.

A) TOTAL BASE NUMBER: TBN is a measurement of basicity that is expressed in terms of number of milligrams of potassium hydroxide per gram of oil sample (mg KOH/g). TBN is an important measurement in petroleum products. As the engine runs, hydrocarbons burns inside the engine produce acids which need to be neutralized to keep the smooth running

of machine. For this sake, the lubricant with good TBN is generally considered as good and it also helps in increasing the drain interval of lubricants.

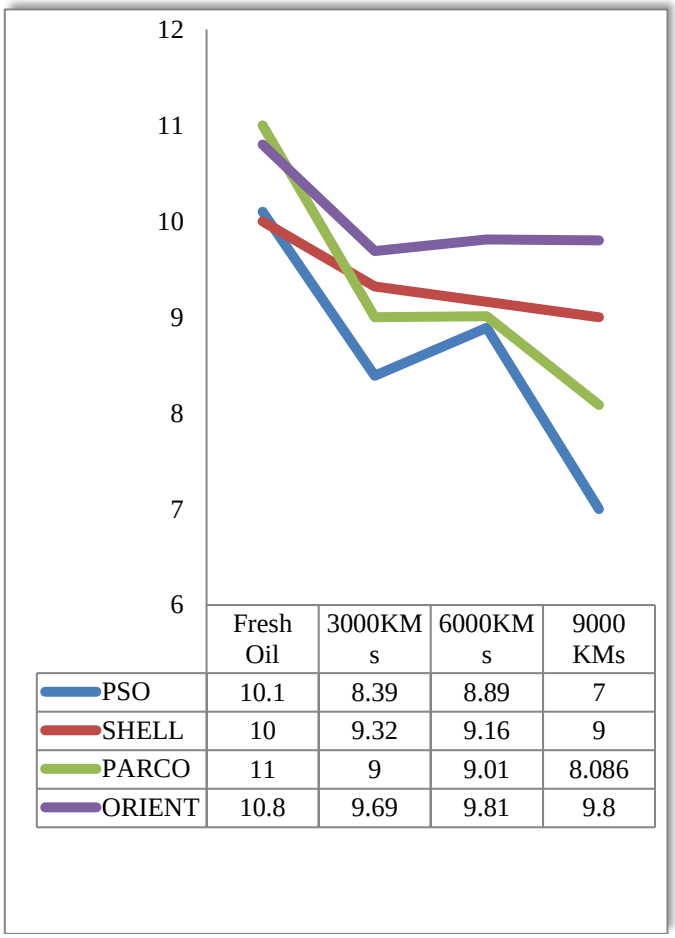
B) KINEMATIC VISOCITY**:** It is a measure of a fluid's internal resistance to flow under gravitational forces. It is determined by measuring the time in seconds, required for a fixed volume of fluid to flow a known distance by gravity through a capillary within a calibrated viscometer at a closely controlled temperature.

C) VISCOSITY INDEX: The viscosity index (VI) is an arbitrary, unit less measure of the change of viscosity with temperature, mostly used to characterize the viscosity-temperature behavior of lubricating oils. The lower the VI, the more the viscosity is affected by changes in temperature.

III. RESULTS

After conducting the samples from each vehicle at different interval, oil analysis reports have been achieved to compare the different parameters mainly TBN, KV and VI.

A) General Comparison of Total Base Number

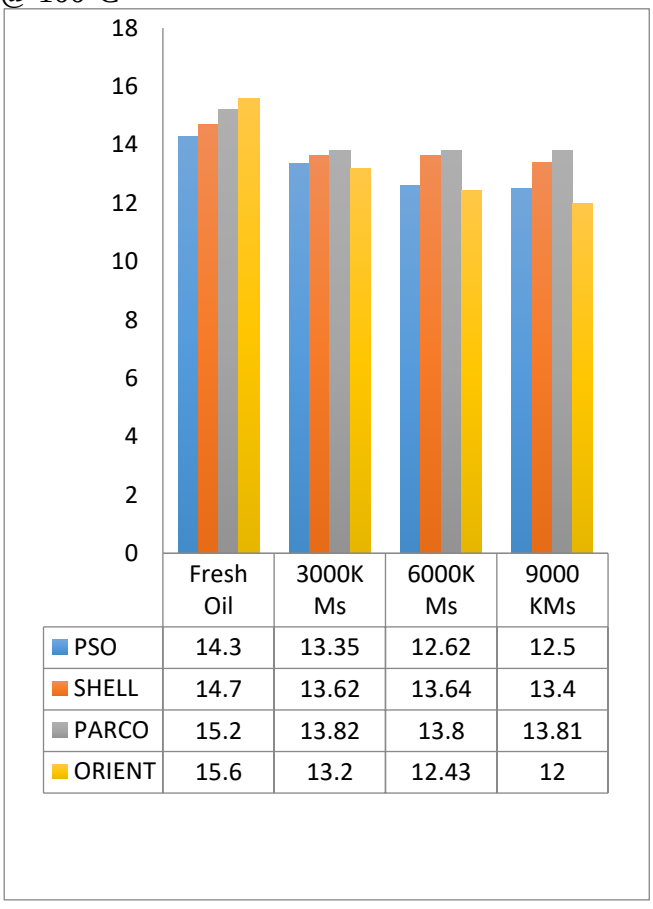


	Fresh Oil	3000KMs	6000KMs	9000 KMs
PSO	10.1	8.39	8.89	7
SHELL	10	9.32	9.16	9
PARCO	11	9	9.01	8.086
ORIENT	10.8	9.69	9.81	9.8

Figure 1: Comparison of Total Base Number (mg KOH/gm) of Oils at Different Running KMs

While comparing the TBN (Total Base Number) of oils, it is observed that the TBN of PSO Product reduced dramatically after 9000 Kms and goes out of acceptable limits while Shell, Parco and Orients' products stays in the acceptable limits. Total Base Number of PSO oil i.e. DEO 9000 decreasing with the running KMs. The results has been obtained by the report given by oil analysis. This variation shows that the TBN of subject oil decreases with the running KMs but remains in the acceptable limit even after the running KMs of 9000. This graph shows that the TBN of Parco Oil i.e. Rubia Works 1000 decreases with the running KMs but remains in the permissible limit even after the running KMs of 9000. This can be seen from the above results that the TBN of Orient Oil also decreases with the Running KMs of Trailer but remains in the permissible limit even after the running KMs of 9000.

B) General Comparison of Kinematic Viscosity (cSt) @ 100°C

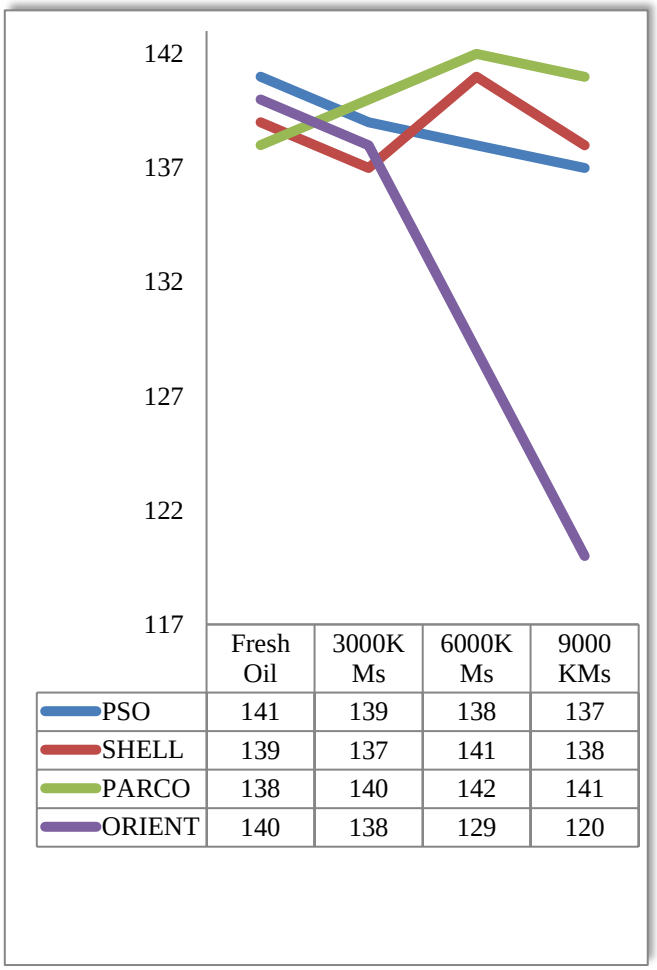


	Fresh Oil	3000KMs	6000KMs	9000 KMs
PSO	14.3	13.35	12.62	12.5
SHELL	14.7	13.62	13.64	13.4
PARCO	15.2	13.82	13.8	13.81
ORIENT	15.6	13.2	12.43	12

Figure 2: Comparison of Kinematic Viscosity @100°C (cSt) of Oils at Different Running KMs

In Figure 2, the Kinematic viscosity of oils has been compared and it is observed that the kinematic viscosity of Orient's oil has been dropped significantly at 6000KMs and 9000 KMs while Kinematic viscosity of remaining oils stays in the acceptable limits.

C) General Comparison of Viscosity Index:



	Fresh Oil	3000K Ms	6000K Ms	9000 KMs
PSO	141	139	138	137
SHELL	139	137	141	138
PARCO	138	140	142	141
ORIENT	140	138	129	120

Figure 3: Comparison of Viscosity Index of Oils at Different Running KMs

The Viscosity Index of all the oil at different running KMs has been compared. All the data has been extruded from the lab results. It can be easily understood by the graph that the Viscosity index (Temperature dependent Viscosity) of the Orient's Oil is dramatically reduced and goes out of the acceptable limits while Oils Supplied by PSO, Shell and Parco stays in the acceptable limits.

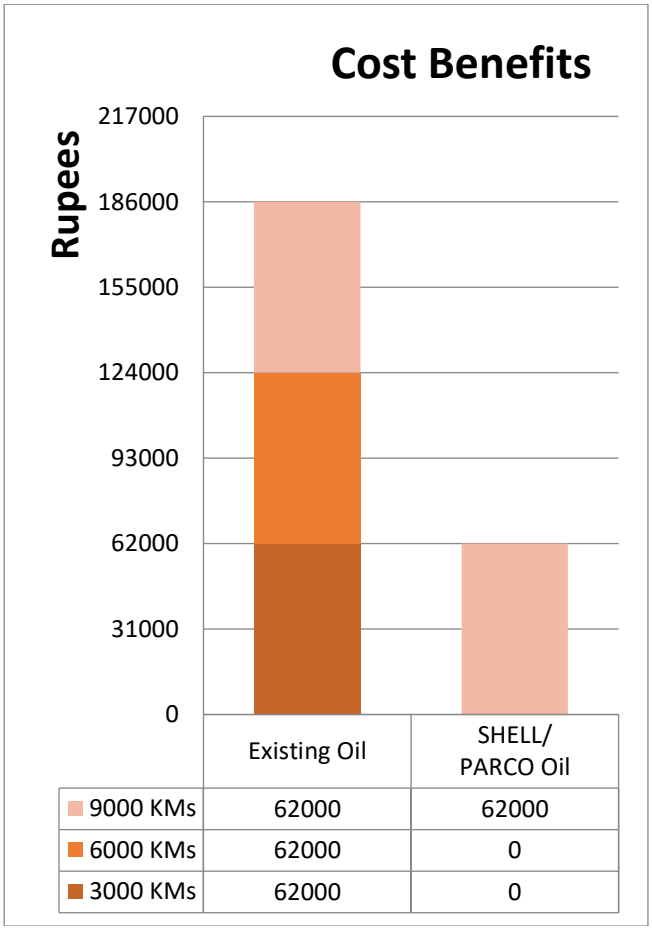
D) GENERAL OBSERVATION/ COMPARATIVE ANALYSIS:

By concluding above results, it is learnt that the Total Base Number of PSO's Oil i.e. DEO 9000 has reduced significantly in Fig 1. Hence, this oil cannot be used for longer drain intervals.

In the same way, the Viscosity Index and Kinematic Viscosity of Orient Engine's Oil i.e. VALVOLINE 15W40 have reduced dramatically. Therefore, this oil also cannot be used for larger drain intervals.

While parameters of Shell and Parco Engine Oils i.e. **Rimula R4X and Rubia Works 1000** respectively, remain in the acceptable limits of all three characteristics i.e. TBN, KINEMATIC VISCOSITY AND VISOCITY INDEX. Therefore, both these oils can be used for larger drain intervals of up to 9000KMs and have already replaced the existing engine oil.

E) COST BENEFITS: After conducting the comparative analysis of all the oil, Engine Oil from Shell and Parco retain its characteristics in acceptable limits even after running 9000 KMs (3 times of the normal drain interval i.e. 3000 KMs).
Hence, if the filter cost is around 50000Rupees/ Maintenance and Oil Cost is around 12000 Rupees/ Maintenance, then 62000 Rupees/ Maintenance will be charged. If we enhance the drain interval up to 9000 KMs, the maintenance can be significantly reduced to 3 folds and Cost benefit will be shown in Figure 4:



	Existing Oil	SHELL/ PARCO Oil
9000 KMs	62000	62000
6000 KMs	62000	0
3000 KMs	62000	0

Figure 4: Cost of Maintenance (Rs) Before & After Selection of Lubricant.

It can be seen from the above that the cost benefits in running 9000 KMs will be around 120,000 Rs, excluding the time and labor cost associated with it.

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IV. CONCLUSION

From the experimental work, it is evident that the new selected oils have many advantages over the existing one as it has clearly reduced the cost of maintenance up to 3 times. The productivity of the MEVs have increased, the cost associated with the labor has been reduced and the breakdown time of MEVs because of short drain interval has been lessen. Filters that were replacing after 3000 KMs now needs to be change at 9000 KMs. Currently, there is a fleet of more 1000 MEVs at SSGC Pakistan which consumes an average engine oil of 500 liters/day. In this manner, millions of rupees can be saved. Furthermore, this research can also be applied to any automotive/ construction industry who consumes oil at larger extend.

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