EXPERIMENTAL INESTIGATION OF TEMPERATURE AND SHEAR DEPENDENT VISCOSITY OF A BIOLUBRICANT-RICE BRAN OIL

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Abstract— **Rice bran oil for food use has been commercially produced in many parts of the world for the past 2 decades. Despite its similarities to other common vegetable oils, rice bran oil offers numerous distinctive properties that make it very interesting as specialty oil in niche bazaars. It has a very appealing nut-like flavor and once extracted is very stable with good life. It is not only preferred for food also for a variety of engineering application especially as bio lubrication.**

Many syntactic oils are in the market and in usage for more than three decades; they are all mostly extracted from cured oils and or syntactically formed from chemical solvents. Since their afterlife effect is a worry for global climate and environmental condition, the Tribology sector of research is in the utmost necessity of making bio lubricants, which will be the next generation eco-friendly lubricants.

Literature reviews showed lots of syntactic oil application into lubrication having a wide range of application, the need for eco-friendly bio lubricant and their properties over temperature and operating nature is potentially a research gap.

Majority of lubrication oil is used in automotive and rotating components are synthetic and are not eco-friendly, in this present research work a experimental investigation of temperature and shear dependent viscosity of a bio lubricant-rice bran oil is proposed.

Index Terms—**rice bran oil, viscosity, bio lubricant, si engine.**

1. INTRODUCTION

Tribology is the science and engineering of interacting surfaces in relative wave. It includes the study and application of the principles of roughness, lubrication and uniform. Tribology is a branch of mechanical engineering and materials science. Tribology, although one of the oldest engineering disciplines, it is one of the least developed classical sciences to date. The reason is that Tribology like nano science is neither truly a single discipline nor well represented by steady state processes. It involves all the complexities of nano-constrained materials that are experienced over a wide range of scales during a shear occurrence. Lubrication can be considered as vital part of a machine as any of the working parts of development the various behaviours, gears and cams which make up any mechanism today must be carefully designed and precision made of the best materials to meet the demands of modern high speed construction. But without correct lubrication, these same working parts would soon develop rapid wear and eventual disappointment. Then the machine would be unusable as a production tool. All of us in the plant have an important role to play in an effective lubrication programme.

The foreman and machine operator can be sure of 'getting out the goods' only if the lubrication service man has properly lubricated the machine. In turn, the lubrication service man can loosen his machines properly only if the engineer has properly designed the machine and specified the right lubricant for it. And in opportunity, the conservation mechanic depends upon proper lubrication to keep the machines consecutively. It is a programme in which all of us have an important role to play. Lubrication is done to minimise friction between two interacting surfaces in relative motion. Friction occurs because a solid surface never microscopically smooth. Even the best machined surface has peaks and valleys called 'roughness'. When two such surfaces come into contact, it is only the peaks on the surfaces that make actual contact. These contacts support the normal load and deform plastically and get cold welded. Conditional upon the greatness of the normal load more and more high spots or peaks come into contact and the 'real area' of contact increases in contrast to the 'apparent area', which is the geometrical area of the exteriors in contact. Abrasion is believed to be caused by this adhesion. When two such surfaces have to be moved in relation to each other, some force will be required to sheer these interactions. This force is called frictional force. We study this in the subject called tribological, which helps in better visualizing conceptualize the problems of friction, wear and lubrication involved in relative motion between exteriors. Friction is directed by following two laws propounded by Amounting:

1. The frictional force is proportional to normal loads.
2. Friction is independent of the size of bodies.

Where can be defined as the undesired removal of material due to mechanical action. It is poorly understood in the scientific sense. By a conventional method wear is divided into following main types:

1. Adhesive
2. Abrasive
3. Corrosive
4. Fatigue

Adhesive wear means damage resulting when two metallic bodies rub together without the deliberate presence of an abrasive agent. Rough wear is categorized by damage to a surface by harder material introduced between two rubbing surfaces from outside. The ruthlessness of abrasive wear depends on the size and angularity of abrasive particles and also the ratio between hardness of metal and the rough particles, more the tendency to uniform. Fatigue wear occurs due to cyclic stresses in rolling and sliding contacts as in gear and rolling bearings. Corrosive wear occurs due to corrosion. Rusting is a familiar example. The presence of moisture, oxygen availability and dusty conditions accelerate corrosive wear.

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3. LITERATURE REVIEW

A Review", Advanced Engineering and Applied Sciences: An International Journal -23-32-(2012). Increasing environmental pollution concerns and diminishing petroleum reserves has brought in attention towards the use of non-edible vegetable oils as an alternative to petroleum oil based lubricants. Non edible vegetable oil plant contains high amount of oil in its seeds which can be converted into Bio lubricant. Bio lubricant is a renewable lubricant that is biodegradable, non-toxic and has a net zero greenhouse gases. **Boris Zhmud, et.al. (2013).** "Nano materials in Lubricants: An Industrial Perspective on Current Research", Lubricants 2013, 1, 95-101; doi: 10.3390/lubricants1040095. This paper presents an overview on the use of various classes of nanomaterials in lubricant preparations. The following modules of nanomaterials are considered: fullerenes, Nano diamonds, ultra dispersed boric acid and polytetrafluoroethylene (PTFE). Current advances in using nanometers in engine oils, industrial greases and greases are discussed. Results of several studies combined with formulation experience of the authors strongly suggest that nanomaterial's do indeed have potential for enhancing certain lubricant assets, yet there is a long way to go before stable formulations are developed. **Chauhan Prerna Singh, et.al.(2013),** " Chemical Modification In Karanja Oil For Bio lubricant Industrial Applications", Journal of Drug Delivery & Therapeutics; 2013, 3(3), 117-122. Vegetable oils are perceived to be alternatives to mineral oils for lubricant base oils because of certain inherent technical properties and their biodegradability. It considered to be the best alternative to substitute conventional mineral oil-based lubricating oils and artificial esters. This mainly reveals about mining of oil from dry Karajan seeds and study of its composition and physic-chemical properties and further its modification into trimesters to improve the oxidation and cold flow behavior. Here, we report the oxidant ring opening of peroxidised Karajan oil using behenic acid and *p*-toluene sulfonic acid (PTSA) as catalyst followed by esterification reaction with octanol and 2-ethylhexanol to form diesters. **S.G.E.Giap, Et.Al.(2009**),"The Assessment Of Rheological Model Reliability In Lubricating Behaviour Of Vegetable Oils", Engineering E-Transaction (Issn 1823-6379) ,Vol. 4, No. 2, December 2009, Pp 81-89. Viscosity as a function of shear rate and temperature can be modelled with a number of equations. Carreau, Cross, Arrhenius, etc. Each model has its own control, for which, under certain conditions the models failed to deliver an adequate observation of the fluid performances. The aims of the current study are to evaluate the viscosity changes of vegetable oils, model viscosity with well-known rheological balances, and to identify model limitation concluded graphical and numerical clarifications. Rare food grade vegetable oils were subjected to viscometer measurements of viscosity at shear rate and temperature ranged from 3 to 100 rpm, and 40 to 100 degree Celsius, separately. Effects have shown that vegetable oils performed as pseudo plastic. While none of these of models deliver a complete representation of oils performance, some models' amounts could be used to explain the characteristic of the oils.

4. PROBLEM IDENTIFICATION AND PROPOSED SOLUTION

3.1 Problem Identification

Many syntactic oils are in the market and in usage for more than 8 to 9 periods; they are all mostly extracted from cured oils and or syntactically formed from chemical solvents. Since their afterlife effect is worry for global climate and environmental disorder, the Tribology sector of research is in utmost necessity of making bio lubricants which will be the next generation eco-friendly lards. Literature reviews showed lots of syntactic oil application into lubrication with dissimilar behavior, this shows it is theoretically a problem identification which can be taken for additional measures.

3.2 Proposed Solution

Majority of lubrication oil is used in automotives and rotating components consumes most of the oils and it is vital to understand the properties of rice bran is inevitable and in this present research work a comparative experimental investigation is proposed to find out the rotational cycle vs viscosity degradation of synthetic oil and rice bran oil. This experiment performed with rotational viscometer for a specific number of rounds, next the experiment viscosity of oils calm and evaluated to find cycle dependent viscosity curve which shows the empirical relation between the oil viscosity and number of cycles

5. LUBRICANT OILS

4.1 Automatic Transmission Fluid - ATF

Automatic transmission fluid (ATF) is a special lubricant used in spontaneous gearboxes, hydraulic-power-assisted routing systems and in the transfer cases of 4WD systems of cars and trucks. Certain manual transmissions also use this liquid. As healthy gear lubrication, the liquid is designed for optimal functioning of all transmission parts like the force converter. ATF is not oil but a mixture of various chemical compounds containing a large number of flavours. It necessity fulfil many specifications. Other than lube oils, ATFs are colored (red or green) to distinguish them from other liquids used in a motor vehicle. ATFs are quantified mainly according to vehicle constructors' directives, common are DEXRON (General Motors) or MERCON (Ford).

Table 4.1 – Temperature Dependent Properties

Temp. [°C]	Dyn. Viscosity [mPa.s]	Kin. Viscosity [mm²/s]	Density [g/cm³]
0	217.29	247.39	0.8783
10	118.06	135.42	0.8718
20	70.04	80.93	0.8655
30	44.70	52.04	0.8591
40	30.31	35.55	0.8527
50	21.53	25.44	0.8462
60	15.93	18.97	0.8398
70	12.18	14.62	0.8333
80	9.57	11.58	0.8269
90	7.71	9.39	0.8205
100	6.32	7.77	0.8140

4.2 Motor Oil

Motor oil is a lubricant used in internal burning engines, which power cars, lawnmowers, engine-generators, and many other devices. In engines, there are fragments which change alongside each other, and the resistance wastelands or else useful power by changing the kinetic energy to high temperature. It also wears away those hunks, which maybe will lead to lower efficiency and poverty of the engine. This growths fuel consumption, falls power output, and can tip to engine debacle. Lubricating oil makes a unravelling film between surfaces of adjacent moving parts to minimize direct contact amongst them, decreasing heat instigated by friction and dropping wear, thus defending the engine. In custom, motor oil transfers heat through convection as it flows through the engine by means of air flow over the surface of the oil pan, oil cooler and through the build-up of oil gases evacuated by the Positive Crankcase Ventilation system. In petrol (gasoline) engines, the top piston ring can expose the motor oil to temperatures. In diesel engines the top compass can clarification the oil to temperatures over 315 °C (600 °F). Motor oils with advanced viscosity directories thin less at these higher temperatures. Erosion inhibitors may also be additional to the motor oil. Many motor oils also have cleaners and dispersants added to help keep the engine clean and minimize oil mud build-up. The oil is able to deception soot from burning in itself, moderately than leaving it placed on the inside planes. It is a arrangement of this, and some singeing that turns used oil black after some running.

Rubbing of metal engine parts inevitably produces some microscopic metallic particles from the wearing of the shells. Such particles might circulate in the oil and grind against moving parts, affecting wear. Since particles store in the oil, it is classically circulated through an oil filter to remove harmful particles. Oil pump, a vane or gear pump powered by the engine, forces the oil during the engine, counting the oil filter. Oil cleans can be a full flow or avoid type. In the crankcase of a vehicle engine, motor oil lubricates revolving or sliding surfaces between the crankshaft journal bearings (main bearings and big-end actions), and rods concerning the pistons to the crankshaft. The oil collects in an oil pan, at the bottom of the crankcase. In certain small engines such as lawn mower machines, dippers on the bottoms of connecting rods dip into the oil at the bottom and splash it around the crankcase as needed to lubricate chunks confidential. In contemporary vehicle engines, the oil pump takes oil from the oil pot and sends it through the oil filter into oil galleries, from which the oil lubricates the main bearings holding the crankshaft up at the main journals and camshaft bearings operating the valves. In typical modern vehicles, oil pressure-fed from the oil colonnades to the main manners enters fleabags in the main papers of the crankshaft. From these fleabags in the main papers, the oil changes through passageways inside the crankshaft to exit fleabags in the rod journals to lubricate the rod bearings and linking rods. Some simpler designs relied on these rapidly moving parts to splash and lubricate the contacting surfaces between the piston rings and interior surfaces of the cylinders. Though, in modern designs, there are also passageways through the rods which carry oil from the rod bearings to the rod-piston connections and lubricate the contacting surfaces between the piston rings and interior surfaces of the cylinders. This oil flick also serves as a seal amongst the piston rings and cylinder ramparts to single the combustion cavity in the cylinder head from the crankcase. The oil then drips spinal down into the oil pot. Motor oil may also help as a refrigeration agent. In certain structures oil is gushed through a nozzle private the crankcase in contradiction of the piston to deliver freezing of specific parts that suffer high temperature straining. On the other hand the thermal size of the oil tarn has to be occupied, i.e. the oil has to spread its considered temperature variety before it can defend the engine under high load. This characteristically takes lengthier than space heating the main cooling go-between aquatic or mixtures thereof up to its working temperature. In instruction to notify the motorist about the oil high temperature, certain elder and most high performing or competing engines feature an oil thermometer. Voluntary to its high viscosity, motor oil is not always the preferred oil for certain submissions. Selected applications make use of lighter products such as WD-40, when lighter oil is desired or honing oil if the desired viscosity needs to be mid-range.

4.3 Properties

Maximum motor oils are completed from a heavier, thicker petroleum hydrocarbon base from crude oil, with flavours to recover certain properties. The bulk of a typical motor oil contains of hydrocarbons with stuck between 18 and 34 carbon atoms per molecule.[7] One of the most significant belongings of motorized oil in preserving a lubricating film between moving parts is its viscosity. The viscosity of a liquid can be thought of as its "chunkiness" or a measure of its confrontation to flow. The viscosity must be high sufficient to uphold a lubricating film, but low sufficient that the oil can movement around the engine parts under all circumstances. The viscosity directory is a degree of how much the oil's viscosity deviations as temperature changes. A higher viscosity index indicates the viscosity fluctuations less with temperature than a low viscosity index. Motor oil necessity be able to flow adequately at the lowest temperature it is expected to experience in order to minimize metal to metal contact between moving parts upon starting up the engine. Another manipulated property of motor oil is its Total Base Number (TBN), which is a measurement of the reserve alkalinity of an oil, meaning its ability to neutralize acids. The resulting quantity is determined as mg KOH/ (gram of lubricant). Analogously, Total Acid Number (TAN) is the measure of a lubricant's acidity. Other tests include zinc, phosphorus, or sulphur content, and testing for unnecessary foaming. The NOACK volatility (ASTM D-5800) Test determines the physical evaporation loss of lubricants in high temperature service. A maximum of 15% evaporation loss is allowable to meet API SL and ILSAC GF-3 specifications. Certain self-propelled OEM oil specifications require lower than 10%.

4.4 Grades

The Society of Automotive Engineers (SAE) has established a numerical code system for grading motor oils according to their viscosity characteristics. SAE viscosity grading includes the following, from low to high viscosity: 0, 5, 10, 15, 20, 25, 30, 40, 50 or 60. The numbers 0, 5, 10, 15 and 25 are suffixed with the letter W, designating they are "winter" (not "weight") or cold-start viscosity, at lower temperature. The number 20 comes with or without a W, depending on whether it is being used to denote a cold or hot viscosity grade. The document SAE J300 defines the viscometrics related to these grades. Kinematic viscosity is graded by measuring the time it takes for a standard amount of oil to flow through a standard orifice, at standard

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temperatures. The longer it takes, the higher the viscosity and thus higher SAE code. The SAE has a separate viscosity rating system for gear, axle, and manual transmission oils, SAE J306, which should not be confused with engine oil viscosity.

The higher numbers of a gear oil (e.g., 75W-140) do not mean that it has higher viscosity than an engine oil. In anticipation of new lower engine oil viscosity grades, to avoid confusion with the "winter" grades of oil the SAE adopted SAE 16 as a standard to follow SAE 20 instead of SAE 15. Regarding the change Michael Covitch of Lubrizol, Chair of the SAE International Engine Oil Viscosity Classification task force was quoted stating "If we continued to count down from SAE 20 to 15 to 10, etc., we would be facing continuing customer confusion issues with popular low-temperature viscosity grades such as SAE 10W, SAE 5W, and SAE 0W," he noted. "By choosing to call the new viscosity grade SAE 16, we established a precedent for future grades, counting down by fours instead of fives: SAE 12, SAE 8, SAE 4

4.4.1 Single-grade

Single-grade engine oil, as distinct by SAE J300, cannot use a polymeric Viscosity Table Reformer (also referred to as Viscosity Transformer) improver. SAE J300 has recognized eleven viscosity evaluations, of which six are measured Winter-grades and given a W designation. The 11 viscosity evaluations are 0W, 5W, 10W, 15W, 20W, 25W, 20, 30, 40, 50, and 60. For single winter grade oils, the dynamic viscosity is measured at different cold temperatures, specified in J300 depending on the viscosity grade, in units of mPa·s, or the corresponding older non-SI units, centipoise , using two different test methods. They are the Cold Cranking Simulator (ASTMD5293) and the Mini-Rotary Viscometer (ASTM D4684). Based on the unkindest temperature the oil passes at, that oil is graded as SAE viscosity evaluation 0W, 5W, 10W, 15W, 20W, or 25W. The lesser the viscosity evaluation, the lesser the temperature the oil can permit. For eg, if an oil permits at the specifications for 10W and 5W, but nosedives for 0W, then that oil must be labelled as an SAE 5W. That oil cannot be branded as either 0W or 10W. For single non-winter evaluation oils, the kinematic viscosity is stately at a temperature of 100 °C (212 °F) in units of mm2/s (millimetre squared per second) or the equivalent older non-SI units, centistokes. Centred on the range of viscosity the oil falls in at that temperature, the oil is classified as SAE viscosity score 20, 30, 40, 50, or 60. In total, for SAE grades 20, 30, and 1000, a minimum viscosity measured at 150 °C (302 °F) and at a high-shear rate is also required. The advanced the viscosity, the greater the SAE viscosity grade is.

4.4.2 Multi-grade

The temperature range the oil is exposed to in most cars can be wide, reaching from cold temperatures in the winter before the vehicle is started up, to hot operating temperatures when the vehicle is fully warmed up in hot summer weather. A specific oil will have high viscosity when cold and a lower viscosity at the engine's working temperature. The change in viscosities for most single-grade oil is too big between the extremes of infection. To carry the modification in viscosities earlier composed, special polymer additives called viscosity index reformers, or VII’s are additional to the oil. The idea is to cause the multi-grade oil to have the viscosity of the base grade when cold and the viscosity of the second grade when hot. This allows one type of oil to be recycled all year. In statistic, as soon as multi-grades were originally advanced, they were normally designated as all-season oil. The viscosity of multi-grade oil still varies logarithmically with temperature, but the slope on behalf of the change is tapering. This grade on behalf of the alteration with temperature depends on the nature and amount of the additives to the base oil. The SAE description for multi-grade oils includes binary viscosity grades; for example, 10W-30 labels mutual multi-grade oil. The main number '10W' is the viscosity of the oil at cold temperature and the second number is the viscosity at 100 °C. The double numbers cast-off are separately clear by SAE J300 for single-grade oils. Therefore, oil considered as 10W-30 must permit the SAE J300 viscosity grade requirement for both 10W and 30, and all limits located on the viscosity results. Also, if an oil does not contain any VII’s, and can pass as a multi-grade, that oil can be labelled with either of the two SAE viscosity grades. For example, very humble multi-grade oil that can be effortlessly made with modern base oils without any VII is a 20W-20. This oil can be branded as 20W-20, 20W, or 20. Note, if any VII’s are used though, then that oil cannot be branded as a single mark. Breakdown of VII’s under shear is a concern in motorcycle applications; anywhere the show may share lubricating oil through the motor. For this purpose, synthetic oil is sometimes suggested. The requirement of higher-priced motorcycle-specific oil has also been challenged by at least one consumer organization

4.5 Synthetic Oil

Synthetic lubricants were first manufactured, or man-made, in important quantities as replacements for mineral lubricants (and fuels) by German scientists in the late 1930s and early 1940s because of their lack of sufficient quantities of crude for their needs. A important factor in its increase in popularity was the ability of synthetic-based lubricants to remain fluid in the sub-zero temperatures of the Eastern front in wintertime, high temperature which affected petroleum-based lubricants to coagulate owing to their higher candlewax contented. The use of man-made lubricants extended through the 1950s and 1960s owing to a property at the other end of the temperature range, the skill to lubricate aviation engines at temperatures that caused mineral-based lubricants to break depressed. In synthetic motor oils were expressed and commercially applied for the first time in automotive applications..

Synthetic oils are derived from Group III, Group IV, or some Group V cores. Synthetics comprise classes of lubricants like synthetic esters as well as "others" like GTL (Methane Gas-to-Liquid) (Group V) and polyalpha-olefins (Group IV). Higher purity and therefore better property control theoretically means synthetic oil has better mechanical properties at extremes of high and low temperatures. The molecules are made large and "soft" enough to retain good viscosity at greater temperatures, however divided molecular structures delay with solidification and therefore allow flow at lesser temperatures. Thus, the though the viscosity still decreases as temperature rises, these synthetic motor oils have a higher viscosity directory over the traditional petroleum vile. Their specially designed assets permit a wider temperature range at higher and lower temperatures and often include a lower pour fact. With their improved viscosity directory, synthetic oils need lower levels of viscosity directory reformers, which are the oil components most susceptible to thermal and mechanical degradation as the oil eternities, and thus they do not damage as speedily as out-dated motor oils. Conversely, they quiet fill up with particulate substance, while the material improved overhangs inside the oil and the oil filter still fills and clogs awake ended time. So, periodic oil and filter changes must still be done with synthetic oil; but some synthetic oil suppliers suggest that the intervals between oil changes can be longer, sometimes as long as 16,000-24,000 km (10,000–15,000 mi) primarily due to reduced degradation by oxidation.

Tests show that fully synthetic oil is superior in extreme service conditions to predictable oil, and may achieve better for longer under standard surroundings. Nevertheless in the vast mainstream of vehicle applications, inorganic oil based lubricants, encouraged with additives and with the benefit of over a century of development, continues to be the predominant lubricant for most internal combustion engine applications.

6. EXPERIMENTAL INVESTIGATION OF VISCOSITY

5.1 Experiment

The viscosity of the existing syntactic oil and proposed new bio lubricant rice bran oil, used and new are start over experiments. Then the target of the research is towards the lubricant in a 4 stroke single cylinder SI engine is taken for experiment. The viscosity of the oil is tested at occupied throttle with 20 min consecutively time. The results of the experiment are given below.

5.1.1 Viscosity Test

The fresh rice bran is used for this testing and its viscosity is measure at different temperatures. This test was showed with four states where the vehicle is kept at ideal, partial throttle, full throttle and moving a range from partial to full. The temperatures experimental with calculation are given below.

Temp (°C)	ρ(rt)	ρ-oil	A	B	Kv (cp)	Av (cp)
32	0.922	0.919	0.220	135	84.349	77.550
40	0.922	0.914	0.220	135	61.340	56.076
50	0.922	0.908	0.220	135	42.431	38.514
60	0.922	0.901	0.220	135	31.195	28.112

Table – 5.1 Fresh Rice Bran Oil Test

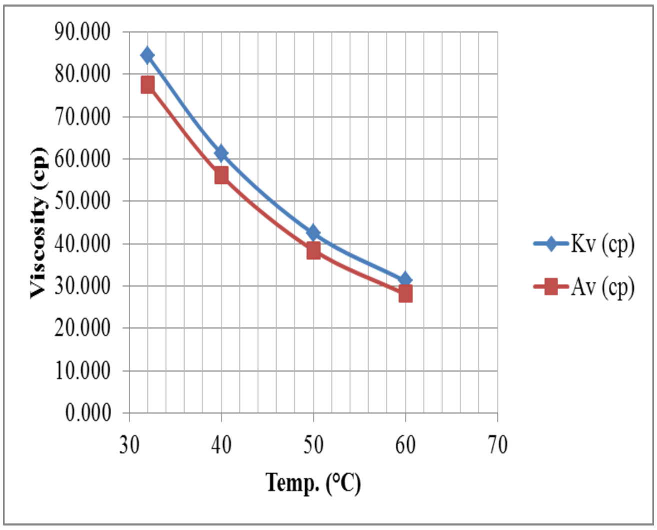

Chart 5.1 – Temp. Vs Viscosity (Fresh RB oil)

The second experiment is done for used rice bran oil, which is undergone 3 times of high brown cooking. The effect of that oil is presented below.

Temp (°C)	ρ(rt)	ρ-oil	A	B	Kv (cp)	Av (cp)
32	0.922	0.919	0.220	135	54.516	50.121
40	0.922	0.914	0.220	135	39.444	36.059
50	0.922	0.908	0.220	135	26.968	24.479
60	0.922	0.901	0.220	135	19.455	17.533

Table 5.2 – Temp. Vs Viscosity (Used RB oil)

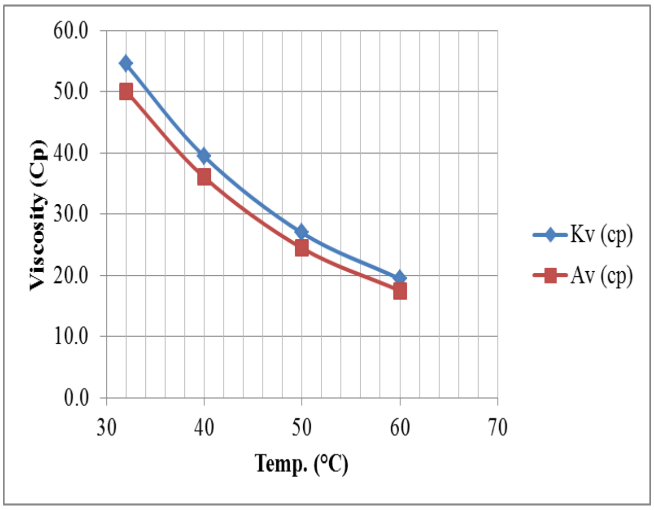

Chart. 5.2 – Temp. Vs Viscosity (Used RB oil)

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The final experiment is done for synthetic oil ,the result of that oil is presented below

Temp (°C)	ρ(rt)	ρ-oil	A	B	Kv (cp)	Av (cp)
32	0.860	0.857	0.220	135	37.336	32.012
40	0.860	0.852	0.220	135	26.751	22.797
50	0.860	0.846	0.220	135	17.873	15.115
60	0.860	0.839	0.220	135	12.399	10.405

7. Conclusion

The research work was concluded with the viscosity of used rice bran oil have been used as a bio lubricant. This bio lubricant is Eco-friendly. This experiment was conducted up to the temperature of 60°C. This bio lubricant cannot be used when the temperature of the engine is more than 100°C. For this the proposed work was carried out by addition of nano particles in a bio lubricant and compares the viscosity of existing synthetic oil and bio-lubricant in the form of rice bran oil with added nano particles . Fresh and used oils of rice bran will be compared.

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REFERENCES

8. Amit Kumar Jain, et. al. (2012), "Research Approach & Prospects of Non Edible Vegetable Oil as a Potential Resource for Biolubricant - A Review", Advanced Engineering and Applied Sciences: An International Journal -23-32-(2012).

9. Aman Paul, et.al.(2012). "Comparative analysis of heat degradation of oryzanol in rice bran oil, mustard oil and sunflower oil by microwave and pan heating" , International Journal of Food And Nutritional Sciences, Volume 01, Issue 01, Oct-Dec 2012.

10. Boris Zhmud, et.al. (2013). "Nano materials in Lubricants: An Industrial Perspective on Current Research", Lubricants 2013, 1, 95-101; doi: 10.3390/lubricants1040095.

11. Costas A. Charitidis, et.al.(2013). "Nano tribological Behavior of Carbon Based Thin Films: Friction and Lubricity Mechanisms at the Nanoscale", Lubricants 2013, 1, 22-47; doi: 10.3390/lubricants1020022.

12. Chia-Wen Chen, et.al.(2006). "A Rice Bran Oil Diet Increases LDL-Receptor and HMG-CoA Reductase mRNA Expressions and Insulin Sensitivity in Rats with Streptozotocin/ Nicotinamide-Induced Type 2 Diabetes". 0022-3166/06_ 2006 American Society for Nutrition, 2006.

13. Chauhan Prerna Singh, et.al.(2013), " Chemical Modification In Karanja Oil For Bio lubricant Industrial Applications", Journal of Drug Delivery & Therapeutics; 2013, 3(3), 117-122.

14. David W. Johnson, et.al. (2013). "Interaction between Lubricants Containing Phosphate Ester Additives and Stainless Steels", Lubricants 2013, 1, 48-60; doi: 10.3390/lubricants1020048.

15. David W. Johnson, et.al.(2013). "Phosphate Esters, Thiophosphate Esters and Metal Thiophosphate as Lubricant Additives", Lubricants 2013, 1, 132-148; doi: 10.3390/lubricants1040132.

16. S.G.E.Giap, Et.Al.(2009),"The Assessment Of Rheological Model Reliability In Lubricating Behaviour Of Vegetable Oils", Engineering E-Transaction (Issn 1823-6379) ,Vol. 4, No. 2, December 2009, Pp 81-89.

17. S.B.Glavatskih, et.al.(2004). "Influence of oil viscosity grade on thrust pad bearing operation", J05103, IMechE 2004.

18. Ivan Filipović, et.al. (2010). "Impact of Oil Viscosity on Functional Parameters of Journal Bearings in Internal Combustion Engines", Goriva-I-maziva, 49, 4: 334-351, 2010.

19. Javier Sotres, et.al.(2013). "Experimental Investigations of Biological Lubrication at the Nanoscale: The Cases of Synovial Joints and the Oral Cavity", Interactions between surfaces are ubiquitous phenomena in living organisms.

20. Leimei Lin, et.al (2013). "Assessment of Effects of Surface Roughness and Oil Viscosity on Friction Coefficient under Lubricated Rolling-sliding Conditions (Analysis of Lubrication Modes Based on EHL Theory), Komatsu Technical Report. Vol.59- No-66.

21. Mhmod Hamel, et.al.(2013)."Employing Acoustic Emission for Monitoring Oil Film Regimes", Lubricants 2013, 1, 61-74; doi: 10.3390/lubricants1030061.

22. Onanong Naivikul, et. al, (2008), National Innovative Agency, Ministry of Science and Technology, Thailand, "Technical Information Rice Bran Oil", I S B N: 9 7 8 - 9 7 4 - 2 2 9 - 5 3 6 - 3.

23. Sunil I. Patel, et. al. (2013). "Performance and Exhaust Emission Analysis of Thermal Barrier Coated Diesel Engine Using Rice Bran Oil Biodiesel", International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-2, Issue-4, April 2013.

24. R. Senthil Kumar, et.al.(2014). " Evaluation of a diesel engine using rice bran oil as a Bio-Diesel", International Journal of Science, Engineering and Technology Research, Volume 3, Issue 6, June 2014.

25. Yi-Hsu Ju, et.al.(2005). "Rice Bran as a potential resource for biodiesel: A review", Journal of Scientific and industrial research, Vol.64, November 2005, pp-866-822.

