

Prospects of Vegetable Oils for Lubricant Formulations in Indian Perspectives

Amit Suhane, R.M.Sarviya, A.Rehman, H.K.Khaira

Abstract— Lubricants are used worldwide in numerous applications ranging from small unit applications to larger industrial machinery with different requirements and operating conditions. Mineral oil based lubricants has been in use globally for quite long due to its efficient and competitive characteristics over other forms. Deteriorating climatic conditions and elevated risk and health hazards due to the regular malpractices involved has raised severe concerns over the excessive use of toxic forms of lubricants. India is on path of commendable development with the sound framework provided by the transportation and automobile industry. The absence of any legal environmental policy and strict law waives off any restriction on such malpractices which could worsen the environmental conditions thus affecting the socio-economic health of countrymen. Therefore, time has come to look out for other alternative forms of lubricants that could reduce such fatal risks. India possess diverse soil and climate conditions comprising varied ecological regions making it rich in vegetation. Vegetable crops and derived oils possess enough potential to meet such demands owing to renewable form and competitive features thereby reducing the risks involved and dependency on raw mineral oil import from OPEC (oil and petroleum exporting countries) group. This paper highlights the prospects of vegetable oils to be utilized for lubricant formulations in Indian perspectives.

Index Terms— Lubricants, Mineral Oils, Vegetable Crops , Lubricant Statistics, Automobile Industry.

I. INTRODUCTION

Lubricants and lubrication techniques have been in use since invention of machines to ease out the interactions between the relative moving members of tribosystem. A tribosystem consists of relative moving members, layer of inter surface elements and atmospheric media like air or other fluid. Higher frictional forces are encountered in case of direct contact between the surfaces leading to elevated temperatures resulting in subsequent wear or failure [01]. Therefore to avoid such instances the relatively moving members are separated by inserting fluid like material (generally liquid) of lower viscosity and shear strength. In spite of an age old process, scientific approach towards lubrication and lubrication technology is relatively new. They are also termed the lifeline meant for effective operation and stands at par to the driving media termed fuel. Lubricants are basically used in open and closed applications. Those used in

open applications are called loss lubricants. These are often used in machinery outdoors and are directly emitted in to the environment. Common examples are concrete and mould release oils, chain saw oils, drilling oils, two stroke oils etc. The extent, duration and frequency of emissions depend upon the machinery, its usability and the surroundings. Lubricants used in closed applications are confined in their design and are called partial loss lubricants. These are subjected to partial loss upon evaporation, accidental leakage or act of negligence at operation or disposal like hydraulic oils, engine oils, transmission oils, gear box fluids etc [02]-[05]. Lubricants are designed for specific uses and applications ensuring system specifications and operating conditions. The lubrication needs for a given application can be identified by examining the effects of tribological system parameters on lubricant chemistry. Some of the most important properties necessary for a satisfactory lubricant performance are lower volatilities under operating conditions, higher lubricity, satisfactory viscosity characteristics in the temperature range of use, higher flash and fire points, superior oxidation stability characteristics etc. Some of these salient features are exhibited by vegetable crops and derived oils which are present abundantly in our country. Animal fats and vegetable oils were the earlier forms of lubricants used by human being since its discovery to smoothen out the relative motion. Stone age marks the cultivation of vegetable crops like linen, poppy etc. for oiling purpose [06]. Olive oil has been accredited with one of the very first oil crop to be used for lubrication purpose [07]. Ever growing demands poised to cater the needs of rising population worldwide shifted the paradigm from the natural forms to the much cheaper and superior mineral based lubricants [08]. But due to the excessive exploitation and malpractices involved posing severe threats to the health of socio-economic environment, there has been a consistent need for an alternative and vegetable oils can be an effective counterpart. Vegetable based oils are preferred as alternatives to mineral oils for lubricant formulations due to environmental benefits and being renewable source derivatives. Around 300 plus oil crops have been known globally but fewer of them have been explored and tapped for lubricant formulations. Mostly plants or crops contains oils, but certain major oil crops [09] along with dozen of minor oil crops [10] are widely used and traded. Traditionally, vegetable oils like castor, mahua, karanja, linseed, neem, coconut, palm etc. have been applied in food uses, but recent requirements suggest their economic usefulness in industrial and maintenance applications due to their better inherent qualities like biodegradability. Limited research has been done and much more has to be explored in this regard so that the growing concerns can be diminished to safer levels in the coming era.

Manuscript received December 22, 2014.

Prof. Amit Suhane- A.P., Mechanical Engineering Department, M.A.N.I.T., Bhopal, M.P. India-462051

Dr. R.M.Sarviya-Professor, Mechanical Engineering Department, M.A.N.I.T., Bhopal, M.P. India-462051

Dr. A. Rehman-Professor, Mechanical Engineering Department, M.A.N.I.T., Bhopal, M.P. India-462051

Dr. H.K.Khaira-Ex. Professor, Mechanical Engineering Department, M.A.N.I.T., Bhopal, M.P. India-462051

II. LUBRICANT STATISTICS

Although the use of lubricants is as old as mankind, scientific focus on lubrication technology started since 1985, which is relatively new. Development of lubricant has become an integral part of development of machinery and corresponding technologies. Statistically, lubricating oils which quantitatively accounts for 90% of lubricant consumption consists of base oils and remaining chemical additives formulated in different proportions. Globally, 1380 small and large companies are engaged in lubricant formulation, manufacturing and marketing. Of them 180 national and multinational oil companies are engaged in manufacturing lubricants and remaining 1200 independent lubricant companies are engaged in their marketing apart from formulating them. Top 1% of these lubricant manufacturer’s accounts for more than 60% of worldwide sales and the remaining 99% shares less than 40 % as shown in **Table I**[11,12].

Table I: World Ranking of Largest Manufacturers of Lubricants

S.No.	Lubricant Manufacturers	Country
1	Shell	UK
2	Exxon Mobil	USA
3	BP	UK
4	Petrochina / Sinopec	China
5	Chevron	USA
6	Lukoil	Russia
7	Fuchs	Germany
8	Nippon Oil	Japan
9	Valvoline	USA
10	Idemitsu	Japan
11	Conoco Phillips	USA
12	CPC	Taiwan
13	PDVSA	Venezuela
14	Repsol	Spain
15	Indian Oil	India
16	Agip	Italy
17	Yukos	Russia

About 1% of the total mineral oil consumption is used to formulate lubricants [13,14]. World lubricant market annual consumption is around 41.7 MMT (million metric tonnes), of which automotive use is about 53%. Global consumption quantity of lubricant is on rise due to the rising demand in various sectors and is becoming problematic due to limited available resources that are reported more for the developing nations. The global lubricant market in the past 10 years has undergone dramatic changes due to industry consolidation. The world demand for lubricants has been growing at 2.0-2.5% per annum for the last five years and is set to maintain the same pace annually [12,15].

III. LUBRICANT USAGE PATTERN IN INDIA

India is one of the world’s leading markets for base oils and lubricants. Today, India accounts for 5.3% of global demand. The demand is driven by several factors including growth in automotive industry, infrastructure and manufacturing industry etc. The automotive industry in India is one of the largest in the world and one of the fastest growing globally following economic liberalization. The Indian automobile Industry sixth in the world, manufactures over 11 million vehicles and exports about 15% each year. The

dominant products of the industry are two-wheelers with a market share of over 75% and passenger cars with a market share of about 16%. Commercial vehicles and three-wheelers share about 9% of the market between them. About 91% of the vehicles sold are used by households and only about 9% for commercial purposes [16]. India is the world’s second-largest manufacturer of two-wheelers and exported 12% of them in 2012–2013. Consequently, motorcycle oil is the largest product category in the consumer automotive lubricants segment, accounting for about 60% of the consumer automotive lubricants consumed. Overall, consumer automotive lubricants account for 13% of the total market [17]. India’s \$ 2.8 billion lubricant market stands third in the world with the annual consumption of 1.86MMT (million metric tonnes), of which automotive use is around 60 %. In India it is expected to consume more than 100 million tonnes per annum of mineral oil products before the dawn of the 21st century and this suggests consumptions of around 2.0 million tonnes per annum of lubricants [18,19]. The market share of lubricant manufacturing and marketing companies in India is shown in **fig.1**. Usage patterns of lubricants in india (**fig.2**) during researches have shown that around 50% of the lubricants (prominently automotive) goes in to the environment and thus disturbing the ecological balance of the system. The problem worsens further as there exist no rules or laws governing the safe disposable practices with in India unlike many foreign countries.

Thus, search for environment friendly substitutes to mineral oils in lubricant formulations has become a frontier area of research in the lubricant industry in the new paradigm of sustainable technology development caused by alarms of environmental degradations.

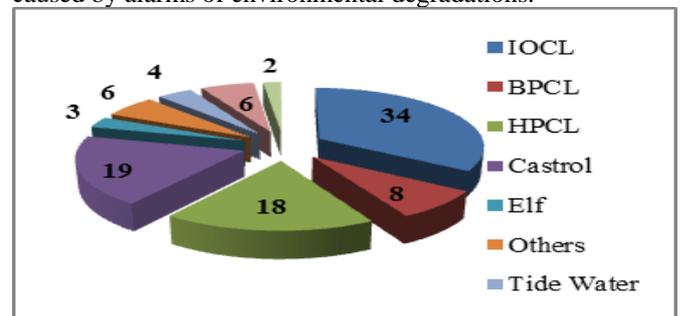


Figure 1: Indian Market Share of Lubricant Companies [12]

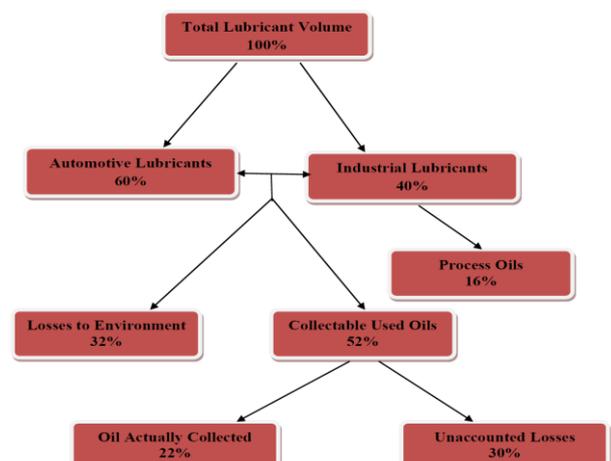


Figure 2: Lubricants Usage Pattern in India [18]

IV. CONCLUSIONS

The following conclusions can be drawn from the above literature:

(a) Lubricant makes the machinery and units work smoothly and efficiently.

(b) Conventional mineral oil based lubricants has been in use for long due to its superior lubricating properties but at the same time it's excessive usage and improper disposal practices pose threat to the climate and therefore raise serious concern over risk and health hazards.

(c) Vegetable crops and derived oils can prove to be strong contender in reducing the risk associated with the usage of toxic mineral oil based lubricants, they being renewable and biodegradable.

(d) India due to its rich vegetation possess immense potential to explore and harness the vegetable oil crops for lubrication purpose.

(e) The need for such alternative becomes more prominent in Indian perspective owing to absence of legal policy for the usage of such toxic lubricants and guidelines for the restrictions of malpractices, which is otherwise implemented in large number of environment friendly countries.

(f) The need of hour is to explore the full potential of Indian breeds of different vegetable crops as per application, usage and availability.

REFERENCES

- [01]Booser, E.R., Handbook of lubrication Theory and Practice of Tribology – Theory and Design Vol.II, CRC Press, LLC, 1983.
- [02]http://www.palco.co.in/historyof_lubricants.html.
- [03]Engineer Manual 1110-2-1424 CECW-ET, Engineering and Design Lubricants and Hydraulic Fluids, U.S. Army Corps of Engineers Washington, 28 February 1999.
- [04]Neale, M. J., Lubrication-A Tribology Handbook, Butterworth-Heinemann Ltd., Oxford.
- [05]Totten, G. E., CRC Handbook of Lubrication and Tribology, Application and Maintenance, 2006, Vol.1(2).
- [06]www.vfi.co.at/en/die_geschichte_des_oels.html
- [07]Carnes, K. Gresham, R. M., Canter, N., Anderson, M., The Ten Greatest Events in Tribology History, TLT Magazine, pp 1 –10.
- [08]Willing, A., Lubricants Based on Renewable Resources – An Environmentally Compatible Alternative to Mineral Oil Products, Chemosphere, 2001, Vol.43, pp 89-98.
- [09]Economic Research Service, 1995-2011, Oil Crops Outlook, Department of Agriculture, United States.
- [10]Axtell, B. L., Fairman, R.M., Minor Oil crops, FAO, 1992.
- [11]Caines, A., Haycock, R., Automotive Lubricants Reference Book, Society of Automotive Engineers Warrendale, USA, 1996.
- [12]Mang, T., Dresel, W., Lubricants and Lubrication, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2nd Edition (4), 2007, ISBN: 978-3-527-31497-3.
- [13]Bartz, W. J., Lubricants and the Environment, Tribology International, 1998, Vol.31(1-3), pp 35-47.
- [14]Global Lubricant Consumption and Demand, <http://www.worldenergy.com.cn/>.
- [15]Kuttickal, S. I., World Lubricant Demand to Grow 2.3% per Year, <http://www.icis.com/articles>, 2007.
- [16]Hoppit, J., The Nation, The State, and The First Industrial Revolution, Journal of British Studies, April 2011, Vol.50 (20), pp 307-331.
- [17]Ponnekanti, N., Kaul, S., Development of Ecofriendly / Biodegradable Lubricants: An Overview, Renewable and Sustainable Energy Reviews, 2012, Vol.16, pp 764-774.
- [18]www.envirotechindia.in / Mohanti S, Envirotech 2001 New Delhi
- [19]www.klinegroup.com/market_research/product_catalog/lubricant_stocks.