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Development of Industrial Tribology in India

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Abstract: ***This paper deals with historical development of industrial Tribology in India. The Indian industry is facing tough challenges from various others countries in different areas. Environmental challenges, government pressure to improve efficiencies, urgent technological advancement requirement, emission cut from tribological and lubricating systems. A brief review of industrial development in India is outlined in this paper. Green Tribology and its benefit are also discussed in this paper. Industrial development is viewed and it is related with different organization. It is concluded that a new contract need to be worked out between industry and academic which guarantees development of new and fundamental knowledge while ensuring solution of technological problem which provides competitive edge to industry.***

Keywords: India, industrial tribology, green tribology, lubricating system, academic

1. Introduction

Tribological activities started in India after independence. In new India self reliance, especially infrastructure in fields of power, manufacturing, automobile, agriculture, mining, electricity, pharmaceutical and education was to be attained. A proper plan only leads to the point of achieving the proposed desire then the government worked out five year plan and implements it. First five year plan helps in achieving the desired result in agriculture. Second was for industry development. In this development all the visions were implemented simultaneously i.e. industrial development, development of laboratory for nation and research and development in education sector our approach was focused much on development of heavy industry, and that need great investment but due to 250 years of colonial rule our condition was not in good shape. International support was also minimal initially. So the whole focus was shifted towards maintenance work. It was how Tribology entered Indian arena. Thus first phase of industrial development of tribology in India consisted of committed work by shop floor workers, supervisors in various sectors such as railways and ordinance factory to keep machineries in good order and running [1].

The other aspect of industrial Tribology was lubrication in earlier phase. A major Tribology laboratory was set up in a nationalized oil industry. Over the years they have thus set up one of the finest lubricant testing facility so much so that today it is a vast interdisciplinary set up with subdivisions which include specialization in the field of synthesis and characterization in inorganic and organic chemistry.

BHEL was the first one to recognize it and started a department of tribology for analyzing its journal and bearings failure used in rotating machineries. The industry today synthesizes lubricant molecules and is a major player in this field in the world. But now certainly industries have to focus much on biodegradable lubricants. To initiate and boost the use of biodegradable products, government incentives and mandatory regulations are needed to put pressure on industries that releases lubricant into environment.

Today there are different types of industries involved in tribological development in India such as thermal power, aircraft, machine tools, automobile, lubrication synthesis etc. The practice of Tribology in industry has come a long way and perhaps one can summarise the problem and positive features which could help us to plan for the future [2].

2. Green Tribology

The basic objectives of tribology are “controlling friction, reducing wear, and improving lubrication.” Therefore, the saving of energy and materials is certainly one of the main objectives. Obviously, in this respect, tribology is much better able to meet the demands of a sustainable society. However, it did not consider the ecological balance and environmental impact. There upon, green tribology emerged to keep abreast of the sustainable developments of nature and society. “Green” is meant as a new mode of thinking that represents views on ecological balance and environmental protection, and so embodies the ideology of the sustainable developments of nature and society perfectly. The main task of green tribology is to study and develop the tribological theories, methods, and technologies with the new mode of thinking and a completely new angle of view as stated above. Green tribology is defined as the science and technology of the tribological aspects of ecological balance and of environmental and biological impacts [3−4].

The twelve principles of Green Tribology as laid down in green tribology by M. Nosonovsky and B. Bhushan [5].

- Minimization of heat and energy dissipation.
- Minimization of wear.
- Reduction or elimination of lubrication and self lubrication.
- Natural lubrication should be used.
- Biodegradable lubrication should be used.

- Sustainable chemistry and green engineering principles should be used.
- Biomimetic approaches should be used.
- Surface texturing should be applied to control surface properties.
- Environmental implications of coatings should be investigated and taken into consideration.
- Design for degradation of surfaces, coatings and tribological components.
- Real time monitoring
- Sustainable energy application.

3. ECO-Lubrication

Environmental impact and energy consumption have made the improvement of the fuel economy of engine systems an important issue. For this purpose, a number of new lubricants were developed, such as PAO (Polyalpholefin)-based lubricants [6] and new types of synthetic esters. In addition, DLC-Si coating with diesel fuel lubrication has a larger effect on friction reduction than coating with engine oil lubrication [7]. A super-low friction torque tapered roller bearing (TRB) applied to the rear axle differential for passenger cars was developed, which obtained a friction torque reduction of up to 75% compared with the conventional low friction torque TRB. A new nanoparticle-modified polyetheretherketone (PEEK) composite was used as the thin coating for hybrid bushings in automotive aggregates [8]. It exhibited a much lower coefficient of friction and specific wear rate in comparison to the commercial product, leading to a pronounced reduction in fuel consumption and a better engine efficiency.

The various biodegradable lubricants available are [9]:

- Highly unsaturated or high oleic vegetable oils (HOVOs),
- Low viscosity polyalphaolefins (PAOs),
- Polyalkylene glycols (PAGs),
- Dibasic acid esters (DEs),
- Polyol esters (PEs)

4. Technologies for Super-Low Friction and Wear Resistance

A novel fullerene-like hydrogenated carbon film was prepared by pulse bias-assisted plasma enhanced chemical vapour deposition, and its mechanical and tribological properties were investigated [10]. This film exhibited super-low friction and wear in both dry inert and humid ambient atmospheres and less sensitivity to H_2O and O_2 molecules in air. The mechanism responsible for excellent tribological properties in $AlMgB_{14}$-TiB_2 nano composite coatings was identified as oxidation of the TiB2 phase and subsequent reaction of the oxide with moisture to produce a surface layer of boric acid, $B(OH)_3$ [11]. These coatings show sustained friction coefficient values as low as 0.02 in water-glycol-based lubricants, and offer a unique combination of excellent wear resistance and low friction when combined with the high hardness of the mixed-phase composite (30–35 GPa). The wear behaviours of ultra-high molecular weight polyethylene (UHMWPE) coated with hydrogenated diamond like carbon (DLCH) layers were investigated [20]. It was found that the surface hardness and the wear resistance of coated materials were increased compared to that of an uncoated one. The DLCH coatings could be a potential method to reduce backside wear in modular implants.

5. Automobile Tribology

Recent study estimated that the cost of friction and wear in India is Rs.78.67 billion and 55-60 % of equipment damage is caused by poor lubrication and severe wear. India has grown as the fourth largest consumer of automobile in world. Vehicle population has reached 21 million in India in 2011. With this increase consumption of auto lubricant also increases. Better fuel- efficient vehicles and higher energy conserving engine oils will become increasingly important in the face of saving of natural resources and lowering of engine friction. The application of Tribological principles is essential for reliability of motor vehicle, in order to reduce friction and wear, with minimum adverse impact on environment. This task is not so simple taking in view the wide range of operating conditions of speed, load and temperature in an engine. Improvement in Tribological performance of engine can provide following benefits [2]:

- Increased engine power output
- Reduced fuel consumption
- Reduction in harmful exhaust emissions
- Improved engine durability and its life.
- Reduced maintenance requirements and longer service intervals.

According to a survey [2] 48% of energy consumption developed in an engine is done by friction loss. With such large number of engine in service in India, even a smallest change in engine efficiency, durability and emission level can have a great impact on the world fuel economy and environment. Therefore, it is in urgent need for advanced engine Tribological design and high performance and environmental friendly lubricants.

6. Conclusion

Indian industry is competent and reasonable self sufficient in Tribology in maintain the present level of technology. But the lack of a powerful research academic in India has bred lack of confident in industries to undertake innovative and risky steps in collaboration with the academia towards building up a long term perspective. A new approach perhaps needs to be worked upon where the industry is called upon to demarcate short and long term interests in its interaction with the academia. Figure 1 gives a systematic of such an approach which is been tried out by industry and academic institution.

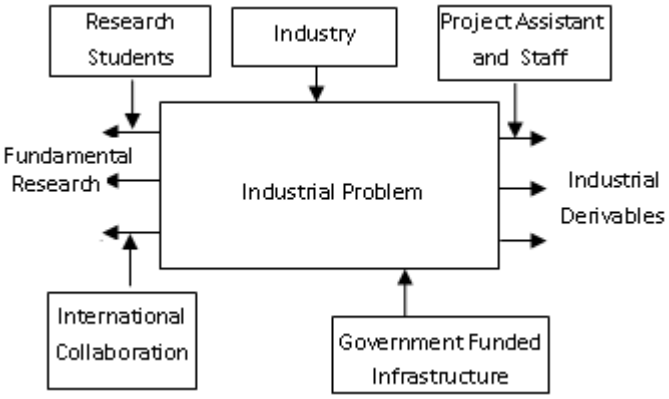

Figure 1: A New Approach [1]

Positive Features of Indian Industrial Tribology

- All tribo-testing equipments can be design and manufacture in India. The pioneering work of one industrialist has significantly reduced testing cost in India.
- Skill expertise and infrastructure are available for performance evaluation and testing of lubricants and greases.
- Full diagnostic skill and condition monitoring expertise and infrastructure are available for rotating machinery and machine tools.
- Increasing number of consultancy companies are now making appearance which provides diagnostic, design and turnkey solution to industry.

7. Future Trends

Industrial Tribology is now under development, and it will make great advancements in nearby future. Some of the most promising fields on the basis of present development are as follows.

- High-Tech IT field:-Tribology in technical components. There is a great scope due to their reduction in the size of components. As smaller components need more sophisticated process of lubrication and all.
- Advance and reliable tools:-Due to utilization of new materials and techniques new reliable tools are also needed to get reliable and accurate product.
- Green tribology: - Tribological investigation for the purpose of environment protection. Mitigating the pollution, solid waste, noise level are interesting areas to work on for future. Green tribology plays a unique role in developing a low-carbon economy, dealing with environmental pollution, the energy crisis, and climate change on a global scale. Therefore, it is one of the important ways forward to a sustainable society. Just as Jost pointed out, "…The cause of Green Tribology is indeed a worthy cause for all tribologists and their organizations to pursue, as it will help tribology to play its rightful part, not only for the benefit of science and technology, but much more importantly, for the benefit of mankind…" [12].
- Space Tribology:-In the era of high-tech communications, space Tribology is one the premium field of Tribology to work on.

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