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Energy Conservation through Centrifugal Oil Cleaning System in Industrial Applications

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ABSTRACT
In India the industrial sector has the largest share of energy consumption accounting for about 47.6 percent of the total commercial energy consumption in the country in 2007-08. Present paper focuses on the energy savings potential in this sector with use of efficient lube oil cleaning. As the complexity of the machinery increases, the requirements for lubricants and metal process oils become more stringent. This paper deals with energy conservation by installing centrifugal oil cleaners for lubricating oil in industrial applications. The paper studies different industrial applications to identify potential for energy conservation and cost savings. Details how the physic-chemical characteristics of industrial application with reference to reduced efficiency . How such problems can be solved with innovative filtration techniques are presented. It discusses the concept of centrifugal filtration procedures to highlight its merits and demerits. It is stressed that centrifugal oil filtration system will conserve resources and help to preserve the environment.
Keywords – Centrifugal, Filter, engines, lube-oil, India.

I. INTRODUCTION

Global oil production would hit the highest point and begin its inevitable decline within a decade of the year 2000 as per Petroleum geologists. Furthermore, no renewable energy systems have the potential to generate more than a fraction of the power now being generated by fossil fuels [1]. Obviously oil cannot be used forever; it will eventually be used up. In the meantime, oil companies are carrying out research into new energy supplies and ways of saving energy. It is essential to improve the efficiency with the usage of natural resources, and develop renewable alternatives wherever possible to protect the resources on which the current and future generations depend [2]. Non-renewable or finite resources such as fossil fuels, minerals and metals can be used more efficiently.

There are three main types of fossil fuels, coal, oil and natural gas. Lubricating oil is the life-blood of a diesel engine. Clean oil is essential if an engine is to operate efficiently throughout its working life. Many of the key objectives in modern engine design are directly related to the condition of the lubricating oil. In response to changes in economic and environmental circumstances, conservation of engine lubricating oil is becoming increasingly important. Savings are being realized through reductions in oil consumption and the implementation of extended oil drain periods.

As a result, modern oils must work harder, resist degradation for longer periods and must retain greater volumes of total insoluble. Therefore, changes in both oil chemistry and filtration technology are required to meet these needs.

II. INDUSTRIAL LUBRICANTS

All moving parts on machinery and equipment require lubrication [3]. Although lubrication may be provided by dry materials such as Teflon or graphite, which are used in parts such as small electrical motor bearings, oils and greases are the most commonly used lubricants. As the complexity of the machinery increases, the requirements for lubricants and metal process oils become more stringent. Lubricating oils now range from clear, very thin oils used to lubricate delicate instruments, to thick, tar-like oils used on large gears such as those which turn steel mills. Oils with very specific requirements are used both in the hydraulic systems and to lubricate large computer-operated machine tools such as those used in the aerospace industry to produce parts with extremely close tolerances. Synthetic oils, fluids and greases, and blends of synthetic and petroleum-based oils, are used where extended lubricant life is desired, such as sealed-for-life electric motors, where the increased time between oil changes offsets the difference in cost; where extended temperature and pressure ranges exist, such as in aerospace applications; or where it is difficult and expensive to re-apply the lubricant.

III. CONTAMINATION OF LUBE OIL

Presence of contaminant in engine lube oil adversely affects its efficiency, increasing engine wear (fig.1).

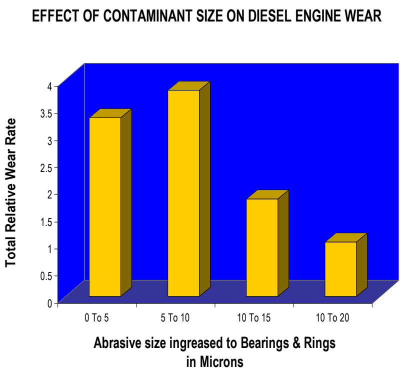


Figure 1. of contaminant in engine lube oil

The primary effect of new generation diesel engine design features, such as exhaust gas re-circulation (E.G.R.), is to reduce harmful exhaust emissions. The secondary effect of this is to increase the amount of contaminant, especially soot, finding its way into the lubricating oil. Engine designers regard soot reduction as one of their key objectives to meet future targets for reduced exhaust emissions, extended service intervals and increased engine durability To comply with these future requirements, improved methods of maintaining lube oil cleanliness are of great importance. Centrifugal sedimentation technology can provide a solution for this problem. A centrifugal oil cleaning system based on this concept can be fitted on original equipments, which have the ability to remove large amounts of harmful fine soot from lube oil and to store it for eco-friendly disposal (fig 2).

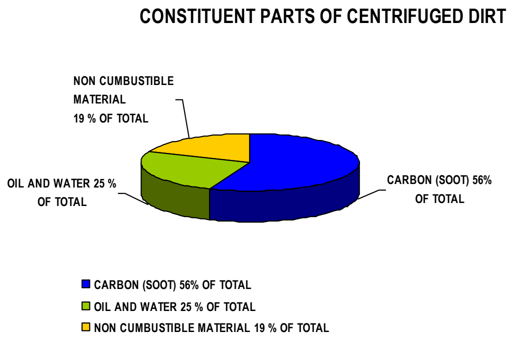


Figure 2. Dirt in Lubricating Oils

IV. Centrifugal Filtration.

Centrifuges have been used as bypass filtration devices to remove contaminants from engine lube oil for several decades [4]. This principle of computational fluid dynamics (CFD) was use several years ago to identify inefficiencies in traditional designs and develop a new design that would provide cleaner oil and reduced engine wear. Using the traditional approach of building machined or stereo lithography prototypes and evaluating them on a test bench would have taken several years to go through the 40 or so configurations that were simulated prior to reaching the final design. CFD made it possible to evaluate the same number of designs in less than three months with minimal prototype fabrication.

Inside the Centrifuge a twin jet rotor, powered only by engine oil pressure, rotates at speeds up to 6000 rpm. Forces 2000 times greater than gravity are created to literally force dirt and contaminants out of engine oil. Hard and sharp abrasive metallic particles are removed down to one tenth of a micron size.

Plus the rest of the dirt, which causes parts to wear and oil to deteriorate. Engines last longer. Far fewer lube oils drains and full-flow filter changes are needed. Maintenance costs go down. And you get the finest oil cleaning system in the world; a true centrifuge. Because element filters depend on rags or paper fibers for their cleaning action, they can channel though or block completely and leave your engine unprotected. The rotor never contains anything but the dirt it removes from the oil. Centrifugal cleaning action begins immediately and never stops. It keeps your oil clean - even after taking out up to five times of the dirt as an ordinary by-pass element filter. Oil additives last longer too.

V. Application

Wide variety of applications and markets, including: heavy-, medium-, and light-duty trucks; industrial equipment for construction, mining, agriculture, marine, and power generation applications. Increasingly stringent environmental requirements, coupled with increasing engine power density and customer expectations for long service intervals, are causing diesel engine lube oil to come under ever increasing chemical, thermal, and particle mass loads. With improvements in oil formulations and full-flow filtration technology reaching maturity, engine manufacturers are increasingly looking towards bypass centrifuges to reduce their oil particulate loads and improve engine life. A bypass centrifuge diverts a small percentage of oil pump output and cleans that oil to a higher level than the full-flow filter, before returning it directly back to the sump. These types of bypass systems are sometimes referred to as "kidney loops". Traditional centrifuges use a rotor that is typically driven in rotation by a free-jet Hero-turbine at speeds from 4,000 to 10,000 rpm. A centrifuge can remove very fine particles as shown the fig. 3.

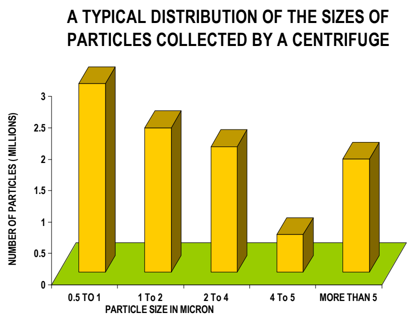


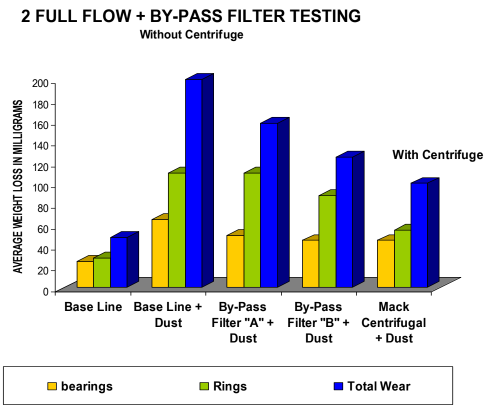
Figure 3. Dirt removing capacity

VI. BENEFIT

A centrifugal filter effectively removes soot and all wear metallic contaminant particles. It reduce critical component wear Lowering the cost of ownership, extend time for overhaul. The use of centrifuge results in the reduction of service costs using an off-line system with high capacity. Besides it reduce down-time Control increased oil contaminant effectively Controlling TBN, TAN, Oil viscosity. There are numerous other benefits like:

- Maintain oil cleanliness for longer periods of time
- Extend oil drain intervals beyond expectations
- Reduce oil consumption and top-ups.
- Extend existing filtration system life.
- Have a cleanable, environmentally friendly waste disposal system.
- Reducing oil and filter consumption cuts waste disposal costs.

Test results demonstrates its utility in the reduction of engine wear as shown in fig 4.



. Figure 4. Filter test results.

VII. ALUMINIUM WIRE DRAWING PROCESS

Wire drawing is a metalworking process used to reduce the diameter of a wire by pulling the wire through a single, or series of, drawing die(s) [5]. The engineering applications of wire drawing are broad and far-reaching, including electrical wiring, cables, tension-loaded structural components, springs, paper clips and spokes for wheels. Traditionally, aluminum wires are drawn with oil. Especially in rod breakdown processes relatively high-viscous oils have been the state of the art for a long time [6]. The use of such oils leads, however, to a contamination of machines and surroundings; since filtration of the used oil is possible to a limited extent only, processing residues and oil will stick on the wire

The Wire Drawing Process generates very high amount of metal sludge, which leads to an increased viscosity of oil and hence reduced die life. It result in choking of oil passages. The wires drawn not only have poor surface finish but the process also consume more power . Because of increased oil temperature the high viscosity oil sticks to the wire being drawn, increasing oil losses. In this whole process the life of the oil is substantially reduced and it requires frequent replacement. Besides in causes increased Wear & Tear of pumps. Centrifugal oil cleaner removes metallic sludge, minimizing these problems

VIII. QUENCHING OIL

Quenching oil and heat treatment fluids are designed for rapid or controlled cooling of steel or other metals as part of a hardening, tempering or other heat-treating process [7].Quench oil serves two primary functions. It facilitates hardening of steel by controlling heat transfer during quenching, and it enhances wetting of steel during quenching to minimize the formation of undesirable thermal and transformational gradients which may lead to increased distortion and cracking.

Oil has a major advantage over water due to its higher boiling range. A typical oil has a boiling range between 450ºF (230ºC) and 900ºF (480ºC). This causes the slower convective cooling stage to start sooner, enabling the release of transformation stresses which is the major problem with rapid water cooling. Oil is, therefore, able to quench intricate shapes and high-harden ability alloys successfully. During quenching, the oil becomes contaminated with scales, soot & degradation products, which interfere with the performance of the oil and may result in unsatisfactory, surface appearance or lower physical properties. Removal of these contaminants by filtration or centrifuging is necessary to restore the oil to a satisfactory condition for trouble free quenching and good product quality [8]. When selecting quenching oils, industrial buyers will need to consider the chemistry, properties, and features of the fluid that are needed for the application.

Straight oils are non-emulsifiable products used in machining operations in an undiluted form. They are composed of base mineral or petroleum oils, and often contain polar lubricants like fats, vegetable oils, and esters, as well as extreme pressure additives such as chlorine, sulfur, and phosphorus. Straight oils provide the best lubrication and the poorest cooling characteristics among quenching fluids. They are also generally the most economical.

Water soluble and emulsion fluids are highly diluted oils, also known as high-water content fluids (HWCF). Soluble oil fluids form an emulsion when mixed with water. The concentrate consists of a base mineral oil and emulsifiers to help produce a stable emulsion. These fluids are used in a diluted form with concentrations ranging from 3% to 10%, and provide good lubrication and heat transfer performance. They are used widely in industry and are the least expensive among all quenching fluids.

Water-soluble fluids are used as water-oil emulsions or oil-water emulsions. Water-in-oil emulsions have a continuous phase of oil, and superior lubricating and friction reduction qualities (i.e. metal forming and drawing). Oil-water emulsions consist of droplets of oil in a continuous water phase and have better cooling characteristics (i.e. metal cutting fluids and grinding coolants).

Synthetic or semi-synthetic fluids or greases are based on synthetic compounds like silicone, polyglycol, esters, diesters,chloro fluorocarbons (CFCs),and mixtures of synthetic fluids and water. Synthetic fluids tend to have the highest fire resistance and cost. They contain no petroleum or mineral oil base, but are instead formulated from organic and inorganic alkaline compounds with additives for corrosion inhibition. Synthetic fluids are generally used in a diluted form with concentrations ranging from 3% to 10%. They often provide the best cooling performance among all heat treatment fluids. Some synthetics, such as phosphate esters, react or dissolve paint, pipe thread compounds, and electrical insulation. Semi-synthetic fluids are essentially a combination of synthetic and soluble petroleum or mineral oil fluids. The characteristics, cost, and heat transfer performance of semi-synthetic fluids fall between those of synthetic and soluble oil fluids.

Micro-dispersion oils contain a dispersion of solid lubricant particles , graphite, and molybdenum disulfide or boron nitride in a mineral, petroleum, or synthetic oil base. Teflon® is a registered trademark of DuPont.

Cleanliness of the oil is an important issue, and it must be free of particulate materials such as carbon, sludge, and water. Carbon is formed after evaporation and fractionation under conditions of insufficient oxygen or is introduced by processes such as carburization. Oil breakdown on the part surface may occur if sufficient quenching agitation is not provided.

IX. GRINDING / HONING

Honing is often the last finishing in processing component manufacturing. The honing process is done to obtain a desired finish or close dimensional tolerance. This can be done by a precision abrasion process wherein several amounts of material are removed from the surface. The operation generates very large quantity of contamination which includes grinding wheel dust and metal particles. Centrifugal Oil Cleaning System removes contamination from oil which helps in improving grinding finish and increases grinding wheel life. Grinding wheel dressing frequency is also substantially reduces improving productivity

X. FURNACE OIL

Furnace oil is a Dark, viscous residual fuel oil which is obtained by blending residual products from various refining processes with suitable diluents usually middle distillates to obtain the required fuel oil grades. It is one of the cheapest fuels available for industrial use. It is a by-product of petroleum refineries. Typically it has a calorific value as 10000 cal/gm. The furnaces which are used mainly for heating or pre-heating a large quantity of metal, are the main users of furnace oil.

Furnace oil contains sludge & impurities which causes deposition in nozzles & burners and subsequently frequent cleaning of burners is required. Because of chocked burners the spray pattern gets distorted which results into inefficiency in heat-generation. In this operation furnace oil-consumption increases. The burning of impurities causes excess smoke which results into environmental and pollution issues. Centrifugal Oil Cleaner Operates on the Reaction Turbine Principle. Oil Enters the centrifuge Under Pressure and flows to the rotor thru hollow shaft. The Oil Pressure and flow is converted in rotational energy as the oil escapes through the jets, producing speed up to 6000 RPM.. The resultant centrifugal force removes dirt from the oil depositing it on the Inner wall of rotor in a dense cake form. Clean oil drains back by gravity to the oil tank

XI. CONCLUSION

Energy conservation in industrial sector has become a major topic with a wide range of products, technologies, and services being promoted to save energy in industrial and process plants that can be overwhelming. Industries in India use technologies, including sophisticated optimization to increase the energy efficiency of plants and processes, which can be complex and expensive. There is a need for sub-metering energy use, energy dashboards, and benchmarking that are useful tools and are being recommended as a first step in the present context. Industries should look into energy conservation from various perspectives and take every possible measure. In addition to the main processes operation and maintenance also affect energy consumption. This can be monitored and subsequent energy saving as well as economic benefits can be achieved. Use of centrifugal oil cleaning system has been found efficient in most of the industrial applications. Such systems and technologies should be promoted for not only for savings in cost but also to reduce energy consumption to achieve a sustainable future. .

REFERENCES

[1] R.W. Bentley, Global oil & gas depletion :an overview, *Energy Policy 30* , 2002, 1-3.
[2] C.J. Campbell, The status of world oil depletion at the end of 1995. *Energy Exploration and Exploitation 14 (1),* 1996, 63–81.
[3] Kenneth Bannister, Lubrication for Industry, *Industrial Press, Inc.2001, 12-14*
[4] A. N. Denisenko, Extraction of additives by centrifugal oil cleaners, *Chemistry and Technology of Fuels and Oils*, Volume 49, , Springer US, 2013, 419-420.

[5] *He S., Van Bael A., Li S.Y., Van Houtte P., Mei F., Sarban A., Mater. Sci and engineering A 346,2003, p.101- 107.*
[6] Roger N. Wrigh, Wire Technology: Process Engineering and Metallurgy, *Technology & Engineering*, Elsevier, 2010, 24-25.
[7] D.A. Wachter, , G.E. Totten, and G.M. Webster, Quenchant Fundamentals: Quench Oil Bath Maintenance, *www.getottenassociates.com, accessed on 12th August 2013.*
[8] *Daniel H. Herring, A Review of Factors Affecting Distortion in Quenching," Heat Treating Progress Magazine, December 2002*.
[9] *www.oilmax.com.*
[10] *www.autowin.com*