Lecture 24: Petroleum fractions from distillation units(Contd.)

Hello and welcome to the lecture number 24 of Petroleum Technology. In this lecture, we will learn about petroleum fractions from different distillation units. Let us concentrate on the re-refining of used lube oil. In the last lecture, we learnt about lube oil and then after lube oil is used in a machine, lube oil gathers lots of contaminants in it and the lube oil is not fit for the next application. So, without throwing the lube oil into the environment and making the environment polluted, it is advisable to re-refine the used lube oil. So, re-refining of used lube oil is an economically attractive recycling method in terms of resource conservation and environmental protection.

So, re-refining of used lube oil is highly recommended because of two reasons. First, it is for environmental protection. If you throw the used lube oil into the environment, as it is a mineral oil, it will pollute the environment. The next reason is that it is economically attractive. We are reviving the used oil, and reusing this lube oil, and at the same time, it is resource conservation. Instead of discarding it, re-refining allows the processing of hazardous material in a safe and effective way to recover high-quality oil products. Re-refining used lube oil removes all contaminants from the used lube oil and produces a distillate product, which is like vacuum gas oil or a high-quality lubricating oil-based product. This results in a strong economic incentive for re-refining, considering the increasing oil prices.

Used lube oil is generally a mixture of different types and grades of used lube oils coming from motor crankcases and industrial users. In fact, the efficiency of re-refining depends on the effectiveness of the collection process of the used lube oil and the availability of used lube oil. So, the efficiency of re-refining depends on two factors: the availability of the used lube oil, which relates to the quantity of used lube oil that people can gather or store, and the composition of the used lube oil, which relates to the quality of the used lube oil.

So, to what extent do we have to re-refine it? One example is that 2 liters of used lube oil gives 1.5 liters of re-refined oil. So, it is very clear how economically acceptable it is. This picture shows the lube oil life cycle.

In the beginning, lube oil production starts from the vacuum distillation unit where we obtain the lube oil base stock. After mixing the required additives, the lube oil is produced and goes to the market for marketing. Then it reaches the consumer, the lube oil user. After it's used, we get the used lube oil, which is collected from various sources. This collected used lube oil goes through the lube oil re-refining process. After re-refining, it goes back to the lube oil production process, completing the cycle. Advantages of re-refining of lube oil: Re-refining has a strong economic incentive for

environmental protection and energy saving. As mentioned earlier, it contributes to environmental protection by preventing the disposal of oil into the external environment, especially since lube oil is not biodegradable.

So, if we throw mineral oil into the environment, it's not good for the soil and also for air quality. Next, the energy consumption is lower than that for virgin-based oil production. When we start to produce the virgin base oil, it comes from the vacuum distillation unit as the side draw trays. So, vacuum distillation consumes lots of energy. Next, the base oil goes through different processing stages, and then additives are added to make it a marketable product of lube oil. However, the re-refining process is far less energy-consuming than this virgin base oil production process because we don't have to start from the vacuum distillation unit and can bypass many energy-intensive steps. Lastly, high-quality products and less dependence on imported oil.

After re-refining, the lube oil, which we obtain from used lube oil, goes through several steps to ensure it meets industry standards and marketable specifications. This results in a high-quality product and reduces dependence on imported oil. The re-refining process consists of several steps. First, lube oil is collected efficiently, and all collected oils are mixed and stored. From storage, the oil undergoes various pretreatment processes, including filtration, centrifugation, decanting, and sedimentation. These are physical treatment steps employed to refine the used lube oil. Next, heating is applied to make it a flowable liquid since used lube oil is typically heavy and needs heat for mobility. After that, it proceeds to regeneration processes.

The regeneration processes in re-refining used lube oil involve various chemical treatments to remove sludge, varnish, and carbon content, and improve color and color stability. These processes may include acid treatment, caustic treatment, activated carbon treatment, clay treatment, and solvent extraction. Solvent extraction, in particular, helps remove some asphaltene and heavy wax content. After the regeneration process, the oil proceeds to the base fractionation unit. Here, fractionation or distillation takes place, which may involve vacuum distillation or a sequence of vacuum and atmospheric distillation steps, depending on the requirements. Following distillation, the oil is of high quality and then undergoes the finishing process. This finishing process includes adsorption, neutralization, decanting, and filtration, all of which are used to produce the final refined oil that meets industry specifications.

The refined oil is blended with additives to create a new lube oil product that can be sold in the market. When it comes to engine lubricants or motor oil, it is used for the lubrication of internal combustion engines, whether they are spark ignition engines or compression ignition engines, such as gasoline and diesel engines. The primary functions of motor oil are to reduce friction and wear on moving engine parts and to clean the engine from sludge. In internal combustion engines, the engine lubricant is used in the

piston and cylinder areas. Lubricant flow typically occurs from the piston to the piston ring and then into the cylinder. This lubrication process helps reduce friction and wear, and it also absorbs and dissipates the heat generated by the friction in the engine.

Not only does this engine lubricant work within the piston cylinder, but it also dissipates heat generated in the cam and bearings. Additionally, it neutralizes acids originating from both fuel combustion and lubricant oxidation. When fuel undergoes combustion in an engine, sulfur oxide gases are produced, which then react with moisture to form acids. These acids are responsible for wearing out metallic parts and causing lubricant oxidation by generating hydroperoxide free radicals. Therefore, this engine lubricant must possess the quality to neutralize acids, enhance piston ring sealing, remove friction, and cool the engine by efficiently carrying heat away from the moving parts.

For effective operation, an internal combustion engine requires efficient sealing between the piston and piston liner. Lubrication is provided by an efficient lubricant from the piston to the piston ring and the cylinder liner. Furthermore, the lubricant serves as the primary source of cooling for the piston-cylinder arrangement. Lubricants also play a role in preventing deposits on the operating surfaces, thus averting leakage. Any contaminants generated during the lubrication or motion processes of the two connecting moving parts, such as sludges, acid sludges, carbon, or varnish, should be suspended by the lubricants. Lubricants should prevent the deposition of these unwanted materials on the operating surfaces.

Now, let's turn our attention to industrial lubricating oil. Industrial lubricants are essentially defined as compounds like fluids, greases, and oils. Industrial lubricants are fundamentally different from engine oil in that they do not have to resist high combustion chamber temperatures or contaminants, but they should last longer. They are used to reduce the wear and tear of materials while minimizing binding and friction. They perform similar lubricating actions, but industrial lubricants are reliable because they have the capacity to provide heat stability and do not break down even at the highest temperature ranges. Therefore, industrial lubricants should possess the property of maintaining their characteristics even under the most challenging conditions, including high temperatures and other severe conditions. From gear oils to greases, standard and high-performance lubricants can help essential equipment run smoothly.

So, whether it's gear oils, grease, or other industrial lubricants, they should maintain their properties exceptionally well. This allows for smooth lubrication procedures without interruptions, even in challenging environments and for extended periods. Quality and sustainability are essential, especially when working at high temperatures and for extended durations. Therefore, these lubricants should have a very high viscosity index to retain viscosity under adverse conditions. Light grades of lubricating oil typically have viscosities ranging from approximately 5.5 to 12.5 centistokes at 60 degrees Celsius.

Now, let's discuss hydraulic oil. Hydraulic oil is used in hydraulic systems to transfer power effectively. It provides satisfactory lubrication performance in various items and equipment, including hydraulic systems in brakes and excavators, ultimately improving pump efficiency. The key property that hydraulic oil must retain is its viscosity, even at higher temperatures. Next, consider turbine oil. Turbines are the primary equipment for generating electricity.

Turbine oil is a specific type of oil that is a blend of hydrotreated and solvent-refined base oil with carefully selected small quantities of various additives. It serves a critical role in turbines by providing a hydrodynamic oil film that supports the shaft and cools the bearings. Turbine oil must form a continuous and thin lubricating oil film on machine parts and facilitate cooling of the bearings. One of the primary requirements for turbine lubricants is longevity. Turbine lubricants are expected to remain effective for up to approximately 10 years. They typically consist of a mixture of base oil, corrosion inhibitors, oxidation inhibitors, deformation agents, and demulsifiers. These additives are used in relatively small quantities, much less than what is used in engine oil, but they play crucial roles in turbine oil performance.

Now, let's discuss gear oil. Gears are designed to transfer motion and power from one shaft to another by meshing gear teeth. The primary function of gear oil is to lubricate the critical contact points between gear teeth and associated gearing. This lubrication is essential for the smooth operation of gears, as there is close contact between the teeth of two gears.

Therefore, it's of utmost importance that gear oil maintains high quality. Gear oil serves several crucial functions: it cools gears and gearboxes, protects components against corrosion, and reduces energy losses. As a result, gear oil should possess all the properties of lubricating oil that provide lubrication, heat dissipation, cooling, and protection against corrosion. This helps minimize energy losses and extends the lifespan of machine parts, making it an economical choice.

Gear oil consists of two essential components: base oil and additives, both of which are critically important. It is imperative that gear oil remains thermally stable and does not oxidize at high temperatures, preventing the formation of sludge or varnish. Gear oil should retain its viscosity and other properties at high temperatures, resisting oxidation and the formation of free radicals. This resistance helps prevent the generation of undesirable contaminants such as sludge or varnish. Another vital role of gear oil is to combat contamination, especially water that may enter the system.

In the case of gear oil, it may sometimes be exposed to the atmosphere and can potentially come into contact with water. Therefore, it's essential that the oil has the

ability to demulsify water in an oil emulsion, allowing for the easy removal of water from the gearbox.

Now, let's discuss cutting fluids. Cutting fluids are specialized fluids used during machining operations. During these operations, tools and workpieces come into close contact, creating conditions of high pressure and heat. Therefore, a specific type of fluid or lubricating oil is required to sustain these conditions. Cutting fluids are primarily applied in various machining tasks, including drilling, milling, turning, and cutting, where there is close contact between parts, resulting in high heat generation and heavy pressure. These fluids are also known as coolants or lubricants because they serve to reduce the heat generated during metalworking operations, effectively cooling the cutting tools. This reduction in heat helps minimize cutting force and torque while preventing chips and tools from welding together.

At high temperatures and pressures, there is a risk that the chips produced during machining and the tools themselves may become welded together. Cutting fluids are used to reduce this possibility. There are mainly two categories of cutting fluids: straight-cutting oil and water-based fluids, which can be oil-based or water-based.

Now, let's discuss quenching oil. As the name suggests, quenching oil is used to rapidly cool machine parts or other components. It plays a crucial role in the fast cooling of steel during the steel manufacturing process. Steel is produced by mixing iron and carbon at different ratios, and the heating and cooling processes involved in steel production lead to the creation of various types of steel with different properties, such as tensile strength. Fast cooling with the right quenching oil results in the hardest form of steel known as martensite, and high-quality quenching oil ensures uniform quenching, leading to the production of the best quality steel. Quenching oils are heat treatment oils composed of solvent-refined base oil blended with specially selected additives. These additives facilitate fast quenching through controlled cooling and provide outstanding chemical and oxidation stability.

Quenching oils, also known as heat treatment oils, are a type of blended oil composed of solvent-refined base oil of high quality along with specially selected additives. These additives are chosen for their ability to facilitate rapid quenching, which is a unique property of quenching oil compared to other lubricating oils. Rapid quenching involves controlled heating and sudden cooling, and quenching oil must maintain outstanding chemical and oxidation stability throughout this process.

Since quenching oil is exposed to high temperatures and experiences rapid cooling, it must withstand the thermal stresses without losing its properties. It should retain its chemical and oxidation stability even after this rapid thermal cycling. Quenching oils also exhibit excellent thermal properties, including low volatility and high flash and fire

points. These thermal properties are crucial because quenching oil is used in high-temperature applications with significant heating and cooling ranges. To achieve the required cooling temperatures, quenching oil formulations often incorporate water-miscible products like polyethylene glycol, such as polyalkaline glycol, as an example. These additives help achieve the necessary cooling rates during the quenching process.

These are the references. Thank you for your attention.