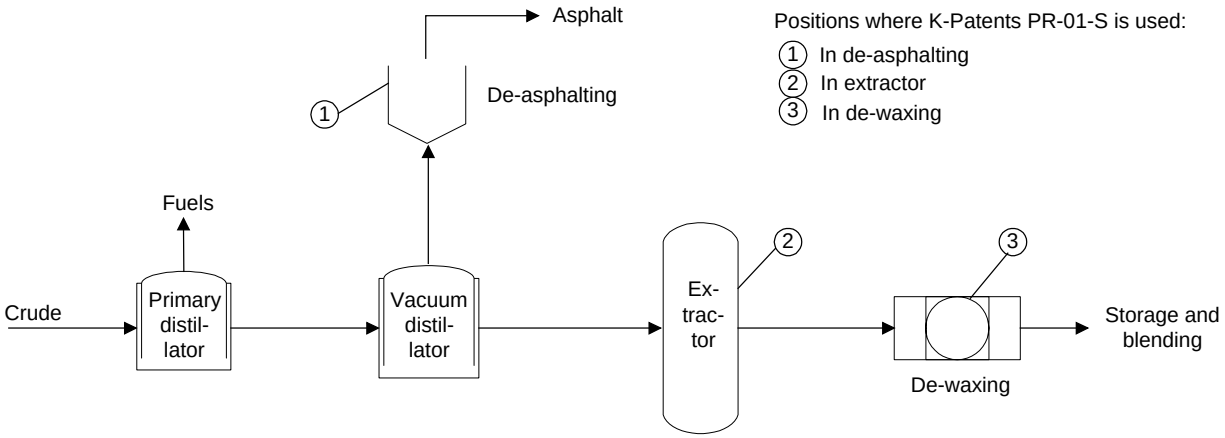
Lube Oil Refining Process



Lube Oil

Introduction

The continuous on-line measurement of the refractive index in lube oil plants allows the refining process to be better controlled. Before the development of K-Patents Process Refractometer, PR-01-S operators used to do waxy raffinates refractive index analysis by using a laboratory refractometer. This analysis is described in ASTM D 1747-89 Standard Test Method for Refractive Index of Viscous Materials.

For instance, when manufacturing different kinds of viscosity index (VI) oils, it is known, through laboratory experimentation, that the refractive index (RI) of waxy raffinates should be within known limits.

The unit operators adjust the temperatures of different catalytic beds so that the refractive index of the waxy raffinates is within limits.

Lubricant base oil processes

Vacuum distillation unit

The first step in the processing of lubricating oils is separation in the distillation units of the individual fractions according to viscosity and boiling range specifications. The heavier lube oil raw stocks are included in the vacuum fractionating tower bottoms with asphaltenes, resins and other undesirable materials.

The raw lube oil fractions from most crude oils contain components which have undesirable characteristics for finished lubricating oils. These must be removed or reconstituted by processes such as extraction, crystallisation, hydrocracking and hydrogenation. Vacuum distillation separates raw lube oil into two or three streams with increasing viscosity. The heavier stream is derived by removing asphalt from the residue in a de-asphalting unit. The lighter feedstocks are sent directly to a solvent extraction. This first stage determines the final base oil viscosity grades.

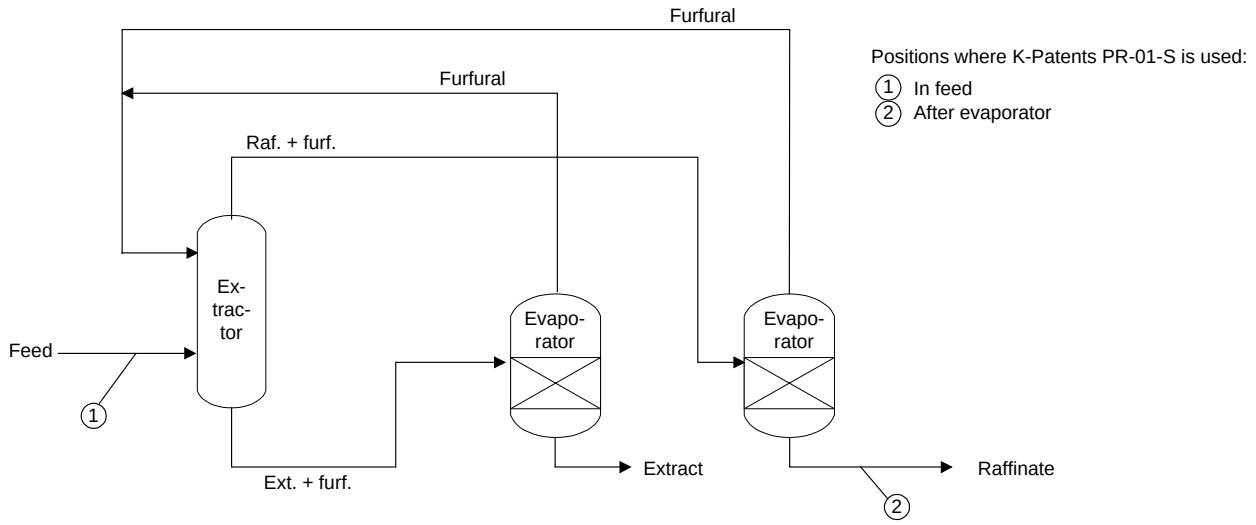
The further process sequence is usually in the order of de-asphalting, solvent extraction, de-waxing and finishing.

De-asphalting

Propane is usually used as the solvent in de-asphalting but it may also be used with ethane or butane in order to obtain the desired solvent properties. Propane has unusual solvent properties in temperatures from 40°C (104°F) to 60°C (140°F). Paraffins are very soluble in propane but the solubility decreases with an increase in temperature until at the critical temperature of propane (96,8°C/206,2°F) all hydrocarbons become insoluble. In the range of 40°C (104°F) to 96,8°C (206°F) the higher molecular weight asphaltanes and resins are largely insoluble in propane. Separation by distillation is generally by molecular weight of the components and solvent extraction by type of molecule structure.

Solvent extraction

There are three solvents used for the extraction of aromatics from lube oil feedstocks and the solvent recovery portions of the systems are different



for each. The solvents are furfural, phenol and N-methyl-2-pyrrolidione (NMP). The purpose of solvent extraction is to improve the viscosity index (VI), oxidation resistance, and colour of the lube oil base stock and to reduce the carbon- and sludge-forming tendencies of the lubricants by separating the aromatic portion from the naphthenic and paraffinic portion of the feed stock.

Furfural extraction

The process flow through the furfural extraction unit is similar to that of the propane de-asphalting unit except for the solvent recovery section which is more complex. The oil feedstock is introduced into a continuous counter-current extractor at a temperature which is a function of the viscosity of the feed; the greater the viscosity the higher temperature is used.

Phenol extraction

The process flow for the phenol extraction unit is somewhat similar to that of the furfural extraction unit but differs markedly in the solvent recovery section because phenol is easier to recover than furfural.

NMP extraction

NMP extraction uses N-methyl-2-pyrrolidone as the solvent to remove the condensed ring aromatics and polar components from the lubricating oil distillate brightstocks. This process was developed as a replacement for phenol extraction because of the safety, health, and environmental problems associated with the use of phenol.

De-waxing

All lube oil stocks, except those from a relatively few highly naphthenic crude oils, must be dewaxed or they will not flow properly at ambient temperatures. Dewaxing is one of the most important and most difficult processes in lubricating oil manufacture.

Hydrofinishing

Hydrotreating of de-waxed lube oil stocks is needed to remove chemically active compounds that affect the colour and colour stability of lube oils.

Installation

The typical sampling point for the on-line refractometer is the outlet of the heat exhanger where laboratory sampling usually takes place. The sampling line to the on-line refractometer should be insulated. It is recommended to reheat the sample to a constant temperature just before the sensor. The flow velocity 1,5 m/s (5 ft/s) or faster is recommended in the sampling loop.

As a conclusion, K-Patents Process Refractometer, PR-01-S replaces the time-consuming laboratory analyses and provides real-time in-line analyses of the process.