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AN INFRARED SPECTROSCOPY METHOD FOR MEASURING THE
BASE NUMBER OF OVERBASED LUBRICANTS

FIELD OF THE INVENTION

[001] The present invention relates to a method for measuring a lubricant's basicity. More specifically, the present invention relates to a spectroscopic method for measuring the total base number (TBN) of overbased lubricants.

BACKGROUND OF THE INVENTION

[002] As is known, the total base number (TBN) of a lubricating oil is an important indicator of oil condition. For example, during combustion of fuel in an engine, sulfur in the fuel is ultimately converted to sulfuric acid which if not neutralized will significantly increase the wear and corrosion of the engine components.

[003] Lubricating oils are formulated to be highly alkaline in order to neutralize the acids formed during the combustion process. Indeed, lubricating oils are routinely "overbased" with calcium carbonate.

[004] The recommended range of an oil's TBN depends in part on the range of sulfur levels in the fuel being burned. Thus overbased lubricants are particularly important for marine and stationary power plant engine applications because high sulfur fuel is often burned in these engines.

[005] The ability to monitor the TBN of an oil is quite useful in evaluating whether the oil can continue to meet its intended function.

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[006] TBN is reported in terms of milligrams of potassium hydroxide (equivalent) per gram of lubricant (mgKOH/g), reflecting the acid neutralizing capacity relative to the strong base. Standard laboratory methods for determining TBN are ASTM D2896 and D4739. The conventional method used in the marine industry for both new and used oils is D2896.

[007] In WO 03/073075 A2 there is disclosed a method for determining the TBN of an oil by measuring one or more selected infrared absorption bands of the oil and correlating the measured bands with the TBN. While this technique is useful in determining an oil's TBN without knowing the TBN of a fresh oil, its accuracy has a lower limit of 20 mgKOH/g.

[008] It would be advantageous to provide a TBN measuring method that is amenable to onsite, online and inline measurement of lubricating oil and that is accurate over the entire range of TBN levels for overbased lubricants, nominally 0 to 100 mgKOH/g.

SUMMARY OF THE INVENTION

[009] Broadly stated, the present invention comprises measuring one or more pre-selected infrared absorption bands of an oil using attenuated total reflectance infrared spectroscopy (ATR IR) and correlating the absorbance measured bands to the TBN, either at a single frequency or integrated over multiple frequencies. Specifically, the bands measured are those due to the carbonate or sulfate species in the oil.

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BRIEF DESCRIPTION OF DRAWINGS

[010] Figures 1 and 2, which show the correlation of carbonate IR absorbance with TBN, and Figure 3, which shows the correlation of sulfate IR absorbance with TBN, illustrate the invention.

DETAILED DESCRIPTION OF THE INVENTION

[011] By way of overview, attenuated total reflectance infrared spectroscopy is utilized in the present invention to monitor the presence of carbonate or sulfate species in a lubricant which then is correlated to the TBN of the lubricant.

[012] The present invention may be applied to fresh or in-use lubricants although their respective calibration lines may be different. The method is suitable for use in a laboratory and importantly in the field and is readily adaptable for use online.

[013] It has been discovered that carbonate infrared absorption bands in the frequency range at $1524\text{--}1400\text{ cm}^{-1}$, at about 863 cm^{-1} and at about 683 cm^{-1} correlate with TBN. Thus in one embodiment of the present invention, the TBN of a lubricant is determined by measuring the infrared spectrum of the lubricant using ATR IR. At least one of the absorption bands for the carbonate species is then selected. The measured absorbance (single or multiple frequencies) at the selected band is then correlated to the oil's TBN. Correlation lines are developed by comparing the absorbance for this selected band for samples on which TBN has been measured by a standard method and finding the best linear fit through the data. Again, calibrations for fresh and in-use lubricants may be different.

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[014] In another embodiment of the invention, the sulfate absorption band at a frequency of $1279\text{-}1022\text{ cm}^{-1}$ also shows good correlation with TBN for in-use lubricants and hence can be used in the same way as the carbonate bands described above for measuring an oil's TBN.

[015] Lubricating oils used in marine and stationary power plant engines are overbased with carbonate. Therefore, it is particularly preferred in the practice of the invention to determine the TBN of those oils by measuring a carbonate band, and it is most preferred to measure the band in the range of $1524\text{-}1400\text{ cm}^{-1}$.

[016] The carbonate absorption band in the $1524\text{-}1400\text{ cm}^{-1}$ region has within it ($1475\text{-}1400\text{ cm}^{-1}$) a strong band due to hydrocarbons which remain substantially constant at all TBN levels. Consequently, the carbonate band can be easily integrated by summing the absorbances over the frequency range.

[017] Optionally, infrared filters may be used, for example, to exclude the hydrocarbon band at $1475\text{-}1440\text{ cm}^{-1}$ or to monitor only a portion of the broad carbonate band in the $1524\text{-}1400\text{ cm}^{-1}$ region. In instances where filters are used for isolating the carbonate band, separate correlation lines are required for new and used lubricants.

EXAMPLES

[018] A series of scrapedown (used) cylinder oils and a fresh cylinder oil were analyzed by ATR IR. The TBN levels of the oils as measured by ASTM D2896 ranged from 5 to 71 mgKOH/g.

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[019] Carbonate bands were integrated at 1524-1400 cm^{-1} and at about 863 cm^{-1} and a sulfate band at 1279-1022 cm^{-1} was also integrated. Figures 1 and 2 show the correlation of carbonate IR absorbance with TBN. Figure 3 shows the sulfate IR absorbance with TBN.

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CLAIMS:

1. A method for determining the TBN of a lubricant comprising:
measuring one or more pre-selected infrared absorption bands of the lubricant using ATR IR; and
correlating the absorbance of the measured bands to the lubricant TBN.
2. The method of claim 1 wherein the preselected bands are carbonate or sulfate bands.
3. The method of claim 1 wherein the preselected bands are due to carbonate species.
4. The method of claim 3 wherein the bands are between 1524-1400 cm^{-1} .
5. The method of claim 3 wherein the band is at about 863 cm^{-1} .
6. The method of claim 1 wherein the preselected bands are due to sulfate species.
7. The method of claim 6 wherein the bands are between 1279-1022 cm^{-1} .