Additive Reconstruction of Oils

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Introduction

Recently, 'additive reconstruction' has become a viable treatment method to increase lubricant in-service life. Today's analytical instruments operating on integrated software programs produce a comprehensive diagnostic of in-service lubricants. Whether commercial laboratories or in-house analytical equipment are used, integrating data generated from vibration, viscosity, metal wear, FT-IR, etc. can produce a reliable snapshot profile of a lubricant's condition.

Methodology

Understanding additive reconstruction requires a basic understanding of how lubricants are blended. Lubricant blending facilities may be set up for 'batch' (Fig 1) or 'continuous production line' operation. Each end product will be formulated from components targeted for specific applications.

Fig 1. 1500Kg Lubricant Blender. (courtesy Thermal-Lube Inc.)

With thousands of product blends available there are relatively few additives that comprise the matrices used to formulate industrial lubricants. The following list depicts some of these additive categories that are candidates for fluid reconstruction:

- Antioxidant (Phenol/Amine)
- Antiwear (ZDDP, Ashless)
- EP (SP, Ashless)
- VI Improver
- Pour Point Suppressant (PMA, OCP, etc.)
- Tackifier
- Defoamer
- Corrosion/Rust Inhibitor
- Dispersant/Detergent

For example: Antiwear (AW) hydraulic oil may be blended using ingredients:

- Base oil (blended to desired viscosity)
- Antioxidant
- Antiwear
- Corrosion inhibitor
- Defoamer

Analytical

Detecting targeted additive levels can easily be accomplished using FT-IR spectroscopy[1,2]. FT-IR spectroscopy is a very reproducible, non-subjective instrumental technique with high information content that provides a *snapshot* of the oil described by its distinctive additive package. The spectral data also provides information on contamination, and breakdown components. Fig 2 illustrates a desk-top FT-IR spectrometer with an integrated autosampler. This equipment is usually connected to a stand alone PC or an expert-type plant maintenance lubricant information management system (LIMS).

Fig 2. FT-IR Spectrometer. (courtesy Thermal-Lube Inc.)
Spectral data generated by the presence of performance additives are generally located in the regions shown in fig 3.

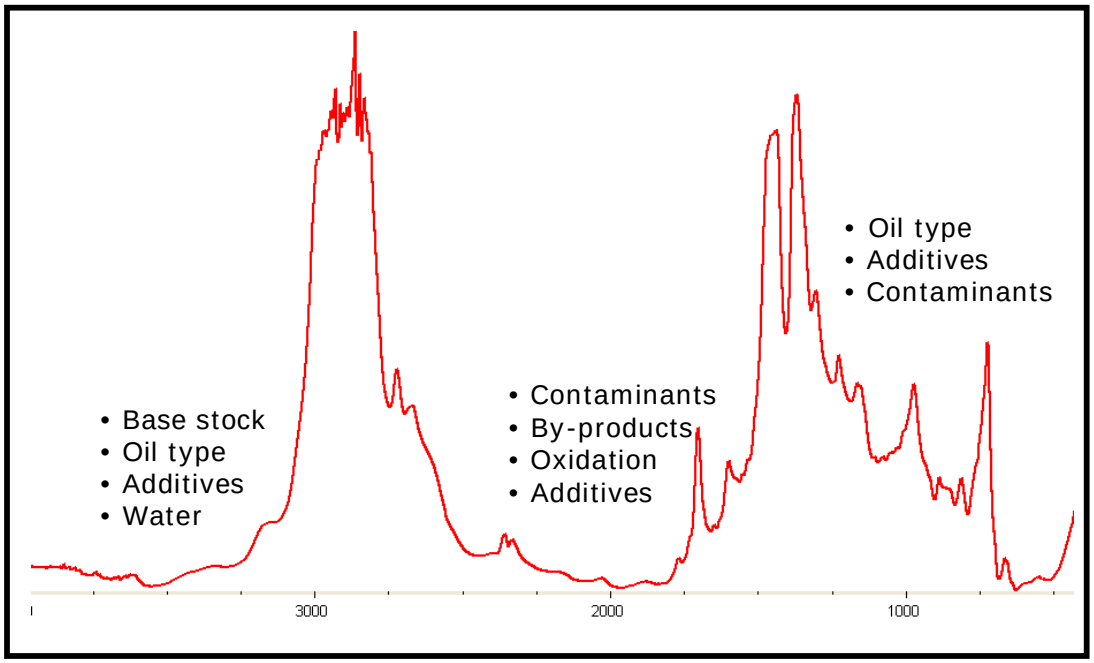

Fig 3. Additive indicative spectral regions.

Using software capable of spectral subtraction, additive depletion can be traced and tracked providing the operator with detailed analysis of the lubricant condition including AN, BN, and moisture contamination[3]. This information (along with additional analytical device information) can be readily integrated and used to determine whether a lubricant is a viable candidate for additive reconstruction.
Assuming in our AW hydraulic oil example below we detect the depletion of the antioxidant used in the product formulation (fig 4).

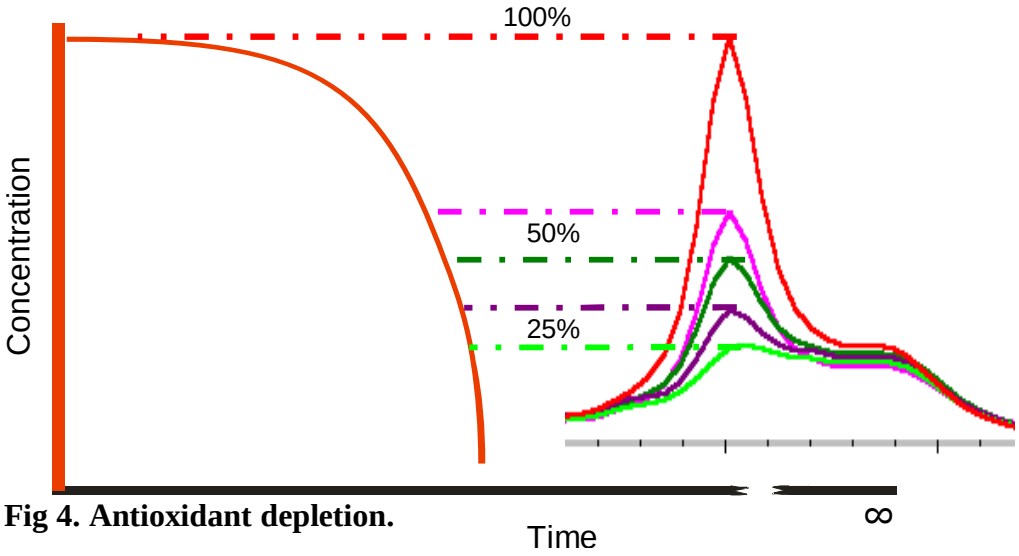

Fig 4. Antioxidant depletion.

While the antioxidant is depleting, other physio-chemical events simultaneously take place within the lubricant's structure. The Total Acid Number (TAN) will begin to rise as the fluid begins to oxidize, and so will the viscosity increase as molecules crosslink with one another. (Fig 5)

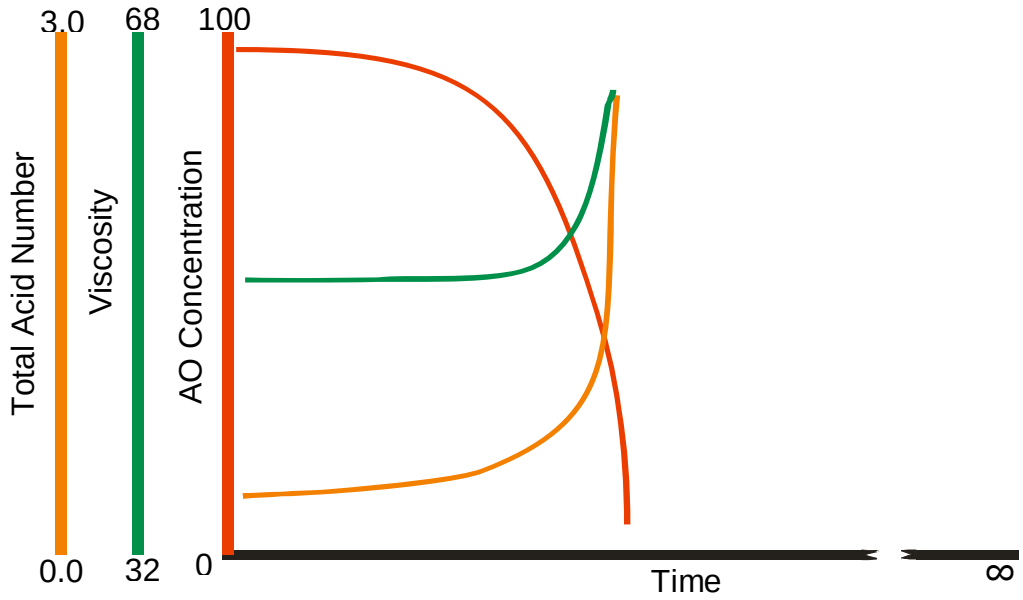

Fig 5. Physio-chemical reaction.

With scheduled proactive maintenance, we must assume that particle counts are monitored and filters changed, and attention is paid to vibration, top-off, and other pertinent parameters including water, fuel, and chemical contamination. With all this under control, additive reconstitution may be considered as the next step to fluid life extension.

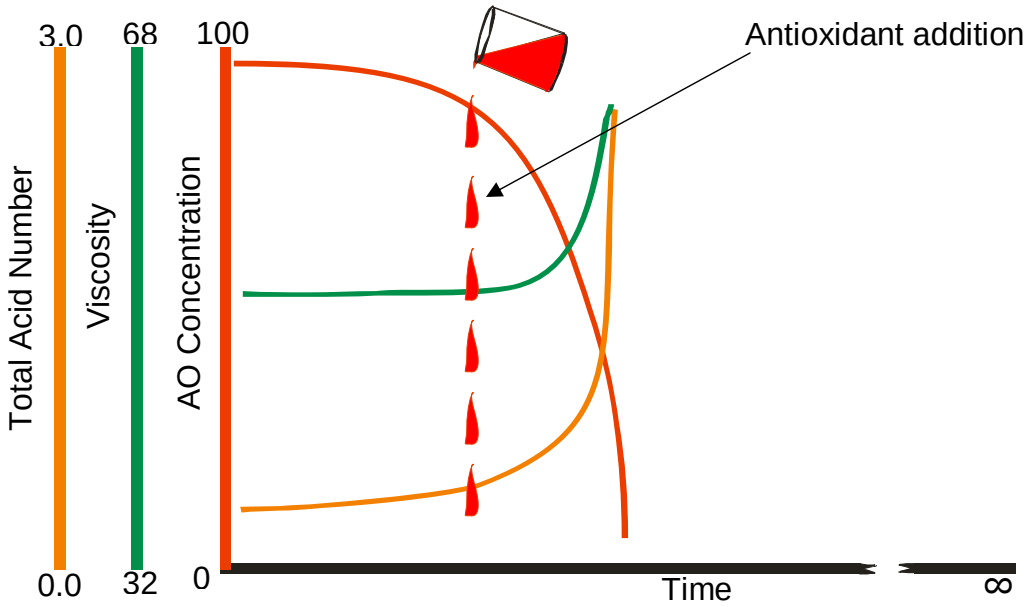

Fig 6. Antioxidant top-off.

Antioxidant depletion (Fig 5) was monitored by tracking spectral changes over time (Fig 4). The decision *when* to re-additise is predicated by the rate of increase of TAN & viscosity. These increases are exponential, and cannot be reversed by reconstitution. Care must be taken to choose the correct time (Fig 6) for re-additisation intervals. Fig 7 shows the extrapolated expected results of the reconstituted fluid.

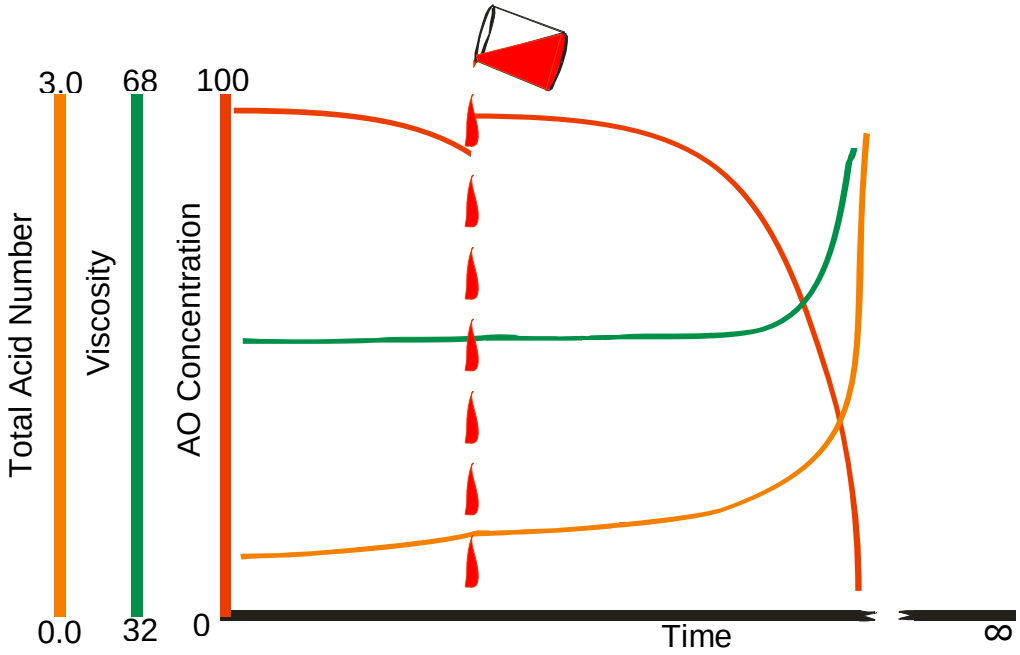

Fig 7. Reconstituted Fluid.

Conclusion

It is not unreasonable to conceive that fluid reconstitution is a viable choice to increase service life and an integral component of any root cause analysis (RCA) program[4]. Repeated re-additisation has been well documented and deemed cost effective[5] directly, and indirectly by reducing waste, and demand on primary resources. Expert software may be programmed to determine the exact amount of additives needed to reconstitute a particular piece of equipment.

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[4] G.J. Livingstone, D. Wooton, B.T. Thompson (Feb. 2007) Effective Test Methods Determine Root Causes of Fluid Degradation. Plant Services Magazine

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