King Industries has actively pursued the alkylation of naphthalene since the early 1950s, primarily as an intermediate for the preparation of alkylated naphthalene sulfonic acids. Several years ago we became interested in extending our technology to custom design alkyl naphthalenes for a variety of specialty lubricant applications. It has been well known for some time that alkylated naphthalenes offer advantages over other synthetic fluids useful as base oil modifiers, especially in the area of thermo-oxidative and hydrolytic stability. Hence, the advent of King's NA-LUBE KR Series of alkylated naphthalenes.

Alkylated naphthalenes have the general structure shown in Figure 1. The core naphthalene system consists of two fused six-membered rings with an electron rich, conjugated p system. It is this extended aromatic system that presumably imparts much of the unique thermo-oxidative stability to this compound class.

However, the alkyl groups attached to the naphthalene also can make an important contribution to the characteristics of the compound. In particular, the alkyl groups control most of the physical characteristics of the compound, such as viscosity, pour point, and volatility. The physical properties of the material will primarily depend on the length of the alkyl group, as well as the number of alkyl groups on the naphthalene ring.

The alkylation of naphthalene with an alkylating agent, such as an olefin, typically results in the production of several different components. This is illustrated in the Gas Chromatography (GC) trace of an alkyl naphthalene composition shown in Figure 2. The GC shows several groups of components of different molecular weight. The groups can be identified as monoalkynaphthalene (MAN) and polyalkylated naphthalenes (PAN).

These components can be separated to some degree through various process purification techniques to achieve specific physical properties. For example, KR-015 has very low volatility for high temperature applications and KR-023 has extremely low volatility for higher temperature and vacuum applications.

Physical Properties of Alkylated Naphthalenes

The physical properties of alkylated naphthalenes depend primarily on two major factors:

- the length of the alkyl groups
- the number of alkyl groups attached to the naphthalene (degree of alkylation).

The KR series of products are typically prepared from higher MW alkylating agents.

Viscosity and Volatility

The viscosity of an alkylated naphthalene will generally increase with increasing alkyl chain length, degree of alkylation, and chain branching. Thus, the mono-alkylated naphthalenes have significantly lower viscosities but higher volatility than polyalkylated naphthalenes.
**Pour Point and Flash Point**
The pour points of the alkylated naphthalenes increase with increasing substitution on the naphthalene ring. Monoalkylated naphthalenes in general have lower pour points and flash points than the higher alkylated derivatives. Linear alkylated naphthalenes have lower pour points than the corresponding branched derivatives.

**Performance Advantages**
The KR Series of alkylated naphthalenes offer a wide range of performance advantages over petroleum based and other synthetic base stocks, including:
- Excellent thermo-oxidative stability
- Excellent hydrolytic stability vs. esters
- Better solubility characteristics than PAOs, Group II and III base oils
- Good additive response – less surface competition vs. esters
- Lower volatility with higher chain length and substitution
- Good pour point
- Excellent lubricity/film thickness
- Seal swelling properties.

**Aniline Point and Additive Solubility**
Aniline point is an indirect measure of the polarity of a substance and its ability to solubilize polar materials. The aniline point is defined as the temperature where a 1:1 mixture of aniline and the test fluid exist as a single phase. A low aniline point is indicative of a fluid with higher polarity and good solubilizing characteristics.

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**KR-Series Performance**

**Excellent Thermal Stability (FTM 3411)**

**Excellent Thermal Stability (Cincinnati Milacron)**

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**Thermal Stability (FTM 3411) - 274°C - 96 Hours**

**Thermal Stability (Cincinnati Milacron) 7 Days - 150°C**

**Thermal Stability (Cincinnati Milacron) 7 Days - 200°C**
Summary

The NA-LUBE KR Series of mono and poly alkylated naphthalenes are unique synthetic base oils/base oil modifiers that can offer performance advantages, including:

- Excellent thermo-oxidative stability
- Improved solubility properties
- Excellent hydrolytic stability
- Excellent lubricity/film characteristics
- Good seal swell properties.

For additional information, please e-mail: smg@kingindustries.com