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GF-3 IMPACT ON THE BASE OIL MARKET

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ABSTRACT

New engine oil specifications, crude price swings, and other industry factors have made life interesting for base oil manufacturers and customers in 2001. In this paper we take a look at some of the technical factors that might be contributing to recent movements in the base oil market.

Over the past five years, virtually all the major base oil manufacturers have invested heavily in Group II technology. About half of the base oil volume in North America has now been transformed to Group II quality. Such rapid transformations are rare in the base oil industry.

These changes have triggered rapid changes in finished lubricant technology. Engine manufacturers have taken advantage of the abundant supply of Group II oils by proposing and/or introducing tougher specifications for oxidation stability and volatility in new engine oils. GF-3 quality is not required for PCMO until the end of 2001, but its effects are already being felt in the base oil market.

Although Group II stocks are widely available; a price differential has appeared between Group I and Group II stocks - for the first time in history. What is driving the current price differential? How will the OEMs, additive companies, and base oil manufacturers respond? What are the implications for the base oil market?

This paper discusses in more detail some of the technical factors that could swing the markets either way.

TRADITIONAL MARKET FORCES

Over the years, traditional market forces have had a similar influence on the Group I and Group II markets. Crude prices and classic supply and demand have historically played important roles. For example, falling crude prices had a big impact on base oil prices from 1996-1998 (Figure 1). Oversupply from several new Group II plants further depressed the market. In 1999-2000 the opposite occurred as crude increased and several high-cost base oil plants shut down. Most of those plants were Group I plants, but one old Group II plant also shut down this year due to outdated technology and a lack of infrastructure to convert fuel byproducts into finished fuels.

Historically, Group I and Group II prices have traced the same path through these movements. But in 2001 Group I and Group II prices began to diverge. Apparently the market was responding to some new forces that are described in this paper.

CURRENT GF-3 MARKET FORCES

GF-3 Volatility

The new GF-3 category for automotive engine oils may be the primary market force driving a wedge between Group I and II markets. Over the last five years Chevron, Shell, Conoco, Texaco, Petro-Canada, Pennzoil, and ExxonMobil have all made major investments in Group II technology. More than half of the paraffinic base oil volume in North America is now Group II (Figure 2). Engine manufacturers observed this trend and decided to develop tougher specifications to take advantage of these higher-purity, lower-volatility base oils.

For the first time in history, Group II or II+ quality is a necessity for factory fill and 5W oils. It is also a necessary component, if not the major component, in most mainstream 10W engine oils.

The GF-3 specifications call for a new 15% Noack volatility limit while maintaining the old Cold Cranking Simulator (CCS) limit. The base oil requirements needed to meet these specifications depend on the additive package, but blenders may have a base oil CCS that falls between 2400-2800 cP at –20°C (SAE J300 APR97) when they blend GF-3 10W oils. Group II oils blended in this CCS range typically fall below the 15% Noack volatility limit. Group I oils typically fall above the 15% limit (Figure 3). Therefore typical Group I oils may require 10-30% Group II+ to bring the volatility down to the GF-3 specification.

The blender can do the math. Group II+ sells at a premium to Group I and Group II. The percent of Group II+ required multiplied by the premium defines the value gap between Group I and Group II for 10W engine oils. This is important because about half of the entire engine oil market is 10W. In this way, the Group II premium is actually linked to the Group II+ premium.

Oxidation Stability

GF-3 engine oils must pass the tough Sequence IIIF engine test. This test is even more discriminating than its predecessor, the Sequence IIIE. GF-3 engine oils made with Group I require a significant uptreat of oxidation inhibitors relative to Group II. This translates to lower additive costs for Group II blenders which enhances the value of Group II oils.

Oxidation stability is also important for meeting new specifications on partially spent oils. Fuel economy savings after 4000 miles is a new requirement for GF-3. Cold flow pumpability testing (MRV TP-1) after the 80 hour Sequence IIIF is a new “test-and-report” for GF-3 and may become a specification for GF-4.

The inherent oxidation stability advantage that Group II stocks have for passing these tests is apparent in today’s engine oils. For example, Cummins and Chevron found that some commercially available engine oils consistently passed the MRV TP-1 after a 400-hour double-length Cummins M-11 test while others failed[1]. Subsequent analysis showed that the oils that passed were formulated with Group II. The oils that failed were formulated with Group I. A more recent study showed that Group I formulated oils stayed in grade only about a third as long

as Group II (125 hours for Group I vs 400 hours for Group II) in heavy-duty engine oils formulated with the same non-optimized general offering package.[2]

Oxidation stability also adds value by allowing the additives to last longer. For example, when base oils oxidize, they consume dispersants. Group II oils have an inherent soot dispersancy advantage in CH-4 heavy-duty engine oil tests because they oxidize more slowly than Group I oils. This allows Group II blenders to use less dispersant in their CH-4 additive package.

Optimized Additive Packages

Additive manufacturers have known about the formulating advantages of Group II oils for many years. But some were reluctant to develop optimized packages specifically for Group II oils because new packages were expensive to develop and Group II represented such a small fraction of the base oil market. Furthermore, many customers appreciated the convenience of using the same package with Group II in the West and Group I in the East.

Today, the Group II market has reached critical mass and several major engine oil blenders are using Group II stocks exclusively. Therefore, the major additive companies responded and developed optimized additive packages, which can lower the blender's total formulated cost and/or can provide step-out performance.

The differences in additive appetite among the Group II oils is small to nil. Therefore, optimized additive packages can be developed without a significant performance penalty for going to the lowest common denominator (typically done when one additive package is used with multiple base oils). Hence, the uniformity among Group II oils adds value in optimized additive packages and it reduces complexity for blenders. This brings us to the concept of fungibility.

Fungibility

When compared to the family of Group I oils, Group II oils made today are quite similar (Figure 4). The impurity levels (sulfur, nitrogen, aromatics) are low – much lower than the limits set by API 1509 for engine oil read across. Their blended viscometrics and volatility tradeoff in engine oils are also very similar as defined by their CCS vs Noack curves (Figure 5).

All three major domestic Group II manufacturers now make a 100 SUS and a 600 SUS oil. Two out of three now make a 220 SUS oil. The same can be said about Group II+. All of the major Group II+ manufacturers make a 4.7 cSt oil with very similar VI, CCS, and volatility.

The interchangeability of these oils and their widespread availability greatly simplify formulation for blenders who blend coast-to-coast. Common formulas, common additive packages, and easy interchange add value for these Group II blenders.

Product Mix Impacts

The incremental value of Group II oil for each blender may also vary with their specific product line mix. Group II performance is more important for most engine oils, transmission fluids, and high-performance industrial oils. But the advantage is probably small for products such as fighting-grade hydraulic oils and railroad oils.

Therefore, the incremental value of Group II oils over the entire product mix could vary greatly from blender to blender. Blenders who must choose between a single Group I supplier and a single Group II supplier probably consider the average incremental value over their entire product mix. Blenders that can stock both Group I and Group II oils probably consider the incremental value in each individual product.

The final equilibrium differential between Group I and II may reflect the sum total of the decisions made by all blenders. Therefore, product mix impacts may be difficult to predict and may take some time to fully unfold.

OTHER MARKET FORCES

Base oil markets may continue to be affected by traditional market forces such as crude price and supply and demand. But the Group I and Group II markets may follow separate paths dictated largely by the rate of change in finished oil specifications.

Specifications could drive the differential independently in each base oil viscosity grade. For example, light neutral markets may be impacted more by passenger car specifications such as GF-4. Medium neutral markets might be impacted more by new heavy-duty engine oil specifications such as PC-9. Heavy neutral markets may be impacted more by non-engine oil applications such as compressor oils, white oils, and process oils.

Environmental forces continue to influence the market as a whole. Base oil purity standards are appearing in industrial oils. New low-sulfur limits and volatility limits may occur for engine oils. The desire for improved fuel economy should continue to drive base oil CCS viscosity downward and VI upward. All of these trends favor Group II and III.

Some engine manufacturers are going one step further and putting even stricter specifications on top of the ILSAC specifications. Ford 5W-20 and Honda 5W-20 are a good examples. Extrapolating on this trend, the North American market could eventually look more like the European market where OEM-driven specs are the norm. In Europe, Group III and IV are the premium performance base oils commonly used to hit tough OEM specs. In North America, Group II and III may be the preferred base oils for meeting tougher specs.

Extended drain intervals could be another powerful market force imported from Europe. Despite the implications to our industry, it is very popular with the customer. Customers are willing to pay for convenience. Again, Group II and III may have a performance advantage over Group I because they exhibit better oxidation stability.

New performance requirements on partially spent oils may continue to emerge. MRV testing after 75 hours in the Mack T-10 is a new specification for PC-9. MRV testing after an 80+ hour Sequence III test will probably be a new specification for GF-4.

Foreign competition is another market force that could affect Group I and Group II markets differently. Most base oil imports into North America are Group I oils from Europe. Group I oils are also occasionally exported to balance supply and demand. Competition between Europe and North America is greater for Group I than Group II because Group II oils are not currently manufactured in Europe. The first Group II plant in Europe is not due to start up until 2004 (Petrola Hellas, near Athens, Greece). But, Group II imports from Asia could impact the North American market particularly when new planned capacity comes on-stream. These counteracting forces could drive the Group I/II differential in either direction.

New, improved additives could allow blenders to formulate more cost effectively with Group I base oils and still meet the required specifications. Additive companies are working hard to invent improved antioxidants that could cost-effectively level the playing field for oxidation stability. Oxidation stability remains the biggest point of performance differentiation between Group I and Group II. Other additive improvements might include lower-viscosity dispersants that could permit the use of higher volatility Group I stocks in GF-3 engine oils by reducing the CCS performance penalty of additive packages. Improved dispersant viscosity modifiers and metallocenes could also have the same effect. Low-sulfur additives could permit the use of some Group I oils after ultra-low sulfur limits are imposed in PC-10.

Blenders may convert selected products from Group II to Group I if it helps the blender cut costs. The forecasted base oil savings, however, must be balanced against the incremental cost for tanks, inventory, freight, and complexity.

New base oil technologies are likely to emerge. Pennzoil Quaker State has proposed new routes for manufacturing PAOs that use cheaper feedstocks such as ethylene and propylene rather than 1-decene[3]. Several major oil companies including ExxonMobil and Shell have announced mega-projects to make high-VI base oils out of Fischer-Tropsch wax derived from natural gas. Abundant supplies of these high-VI Group III base oils should initially impact mainly the Group III and Group IV (PAO) markets. But as the volume grows, lower performing Group II and Group I markets could also be impacted. High-cost producers may be impacted the most.

POSSIBLE MARKET RESPONSE

Regardless of the new technologies that may emerge, the market forces may operate to maintain balance between Group I and Group II production. For example, Group I manufacturers can shrink the value gap by modestly raising VI and lowering volatility. Companies like ExxonMobil apparently have been doing this for years in Europe. At least one domestic manufacturer, Marathon-Ashland, has recently moved its Group I product line in this direction.

Group I manufacturers may convert more Group I plants to Group II using processes like ExxonMobil RHC or Bechtel Hy-Raff/Hy-Starting technologies. Or they could build new

Group II plants like Excel Paralubes, Motiva, and Petro-Canada.

Established Group II manufacturers could continue to expand production. Despite the massive buildup of Group II capacity over the last five years, most Group II manufacturers have further debottlenecked their plants in the last three years.

Additive companies may redouble their efforts to invent new additives to improve the bottom line for their Group I clients.

Blenders may reduce Group II demand by substituting Group I oils whenever it is economic (e.g. hydraulic and railroad oils).

On the other side of the coin, buyers could decide to lock in more Group II volume now in anticipation of future specifications such as PC-9. PC-9 may prove to be an insurmountable challenge for Group I oils due the enhanced soot dispersancy required in the Cummins M-11 with Exhaust Gas Recirculation.

CONCLUSIONS

Traditional market forces such as crude price and base oil supply and demand have probably been at the center of most of the major movements in the base oil market over the last few years.

This year the lube market was also nudged by GF-3, a major category upgrade in automotive engine oils. New GF-3 specifications probably triggered the recent divergence between the Group I and Group II markets. Additive requirements and Noack volatility in engine oils help define the current performance gap between Group I and Group II. For the first time in history, Group II markets have tightened and responded to the performance differential. Customers are now evaluating and moving to their lowest cost options.

Where the market goes next is anyone's guess. The answer may depend on the complex interaction of market responses from base oil manufacturers, blenders, and additive companies.

We are quite certain, however, that crude price swings, GF-3, and other industry factors have made life interesting for base oil manufacturers and customers in 2001. And PC-9, GF-4, and PC-10 are bound to make life even more interesting in the future.

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Figure 1

Base Oil Prices – US Gulf Coast 100N – Group I and Group II

Source: ICIS-LOR Website, August 31, 2001

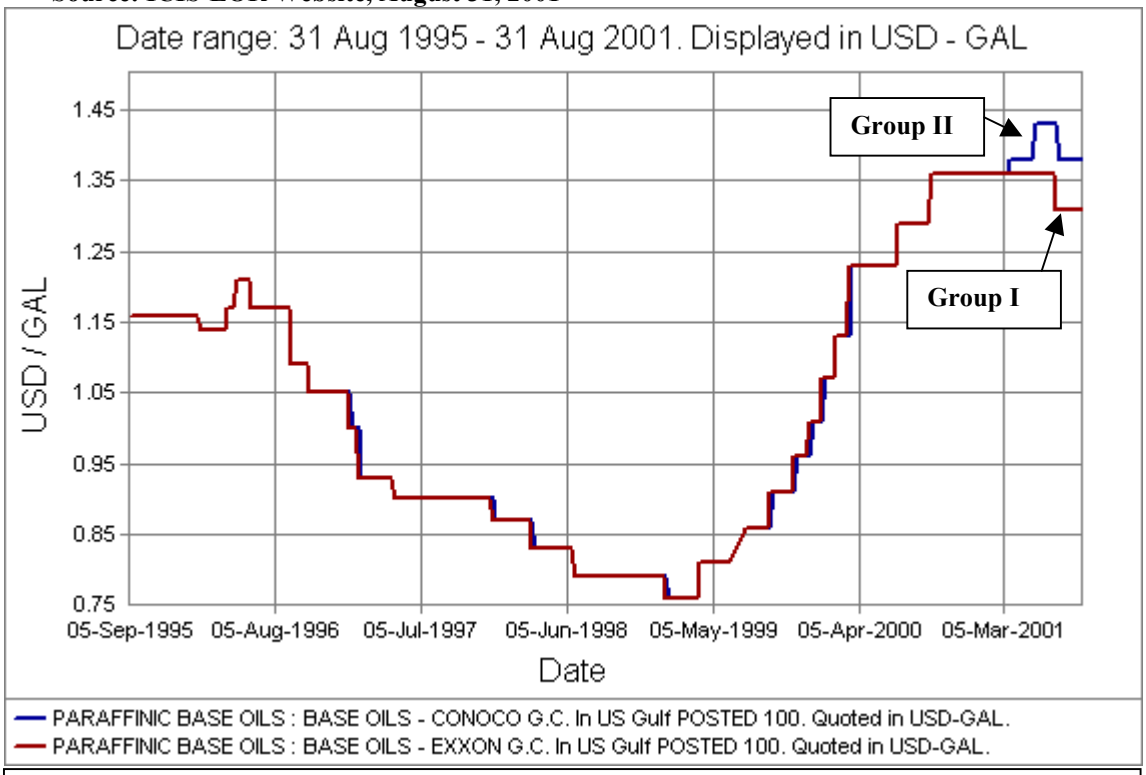


Figure 2

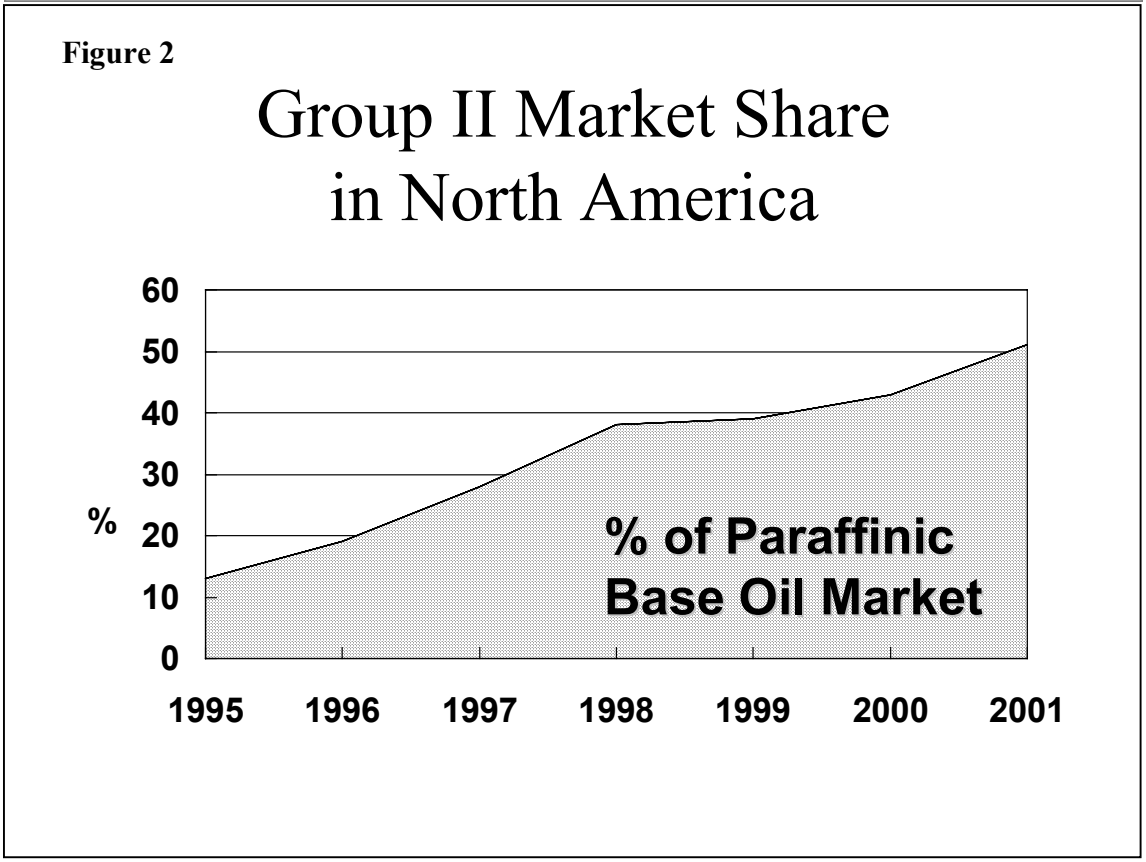


Figure 3

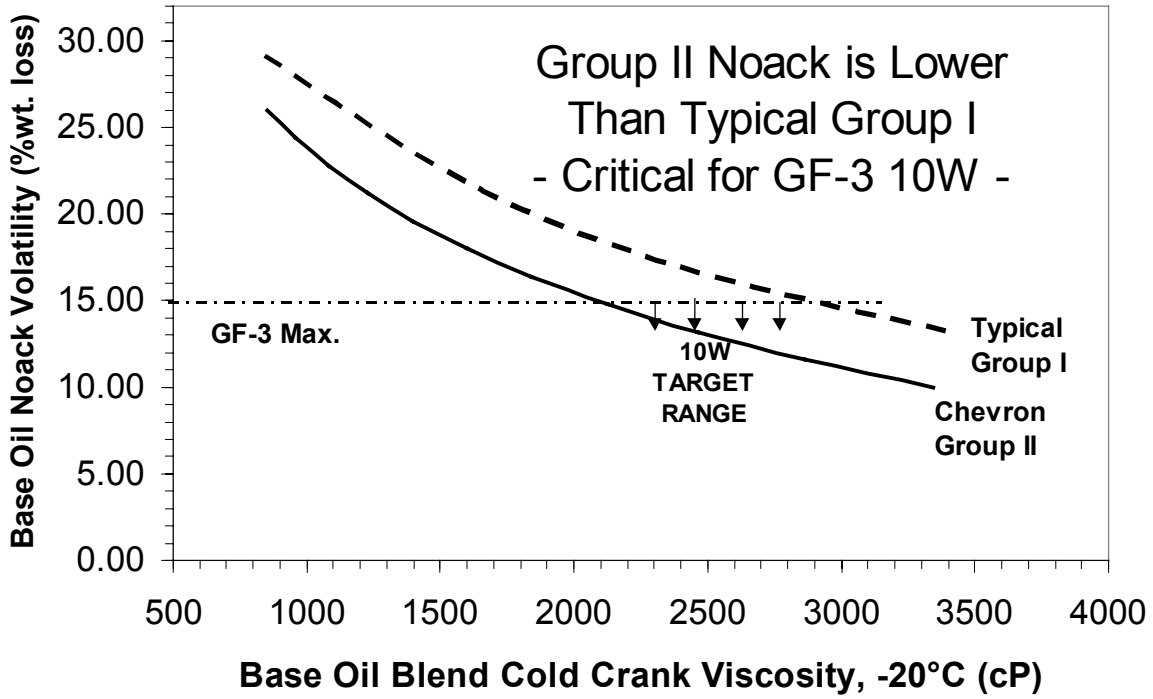


Figure 4

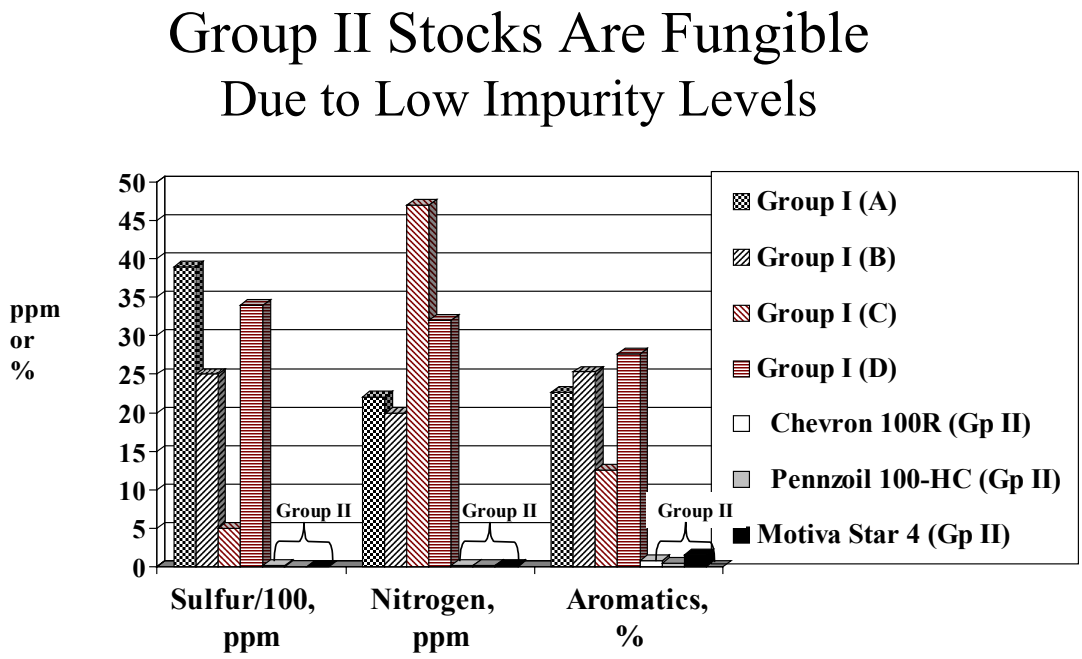
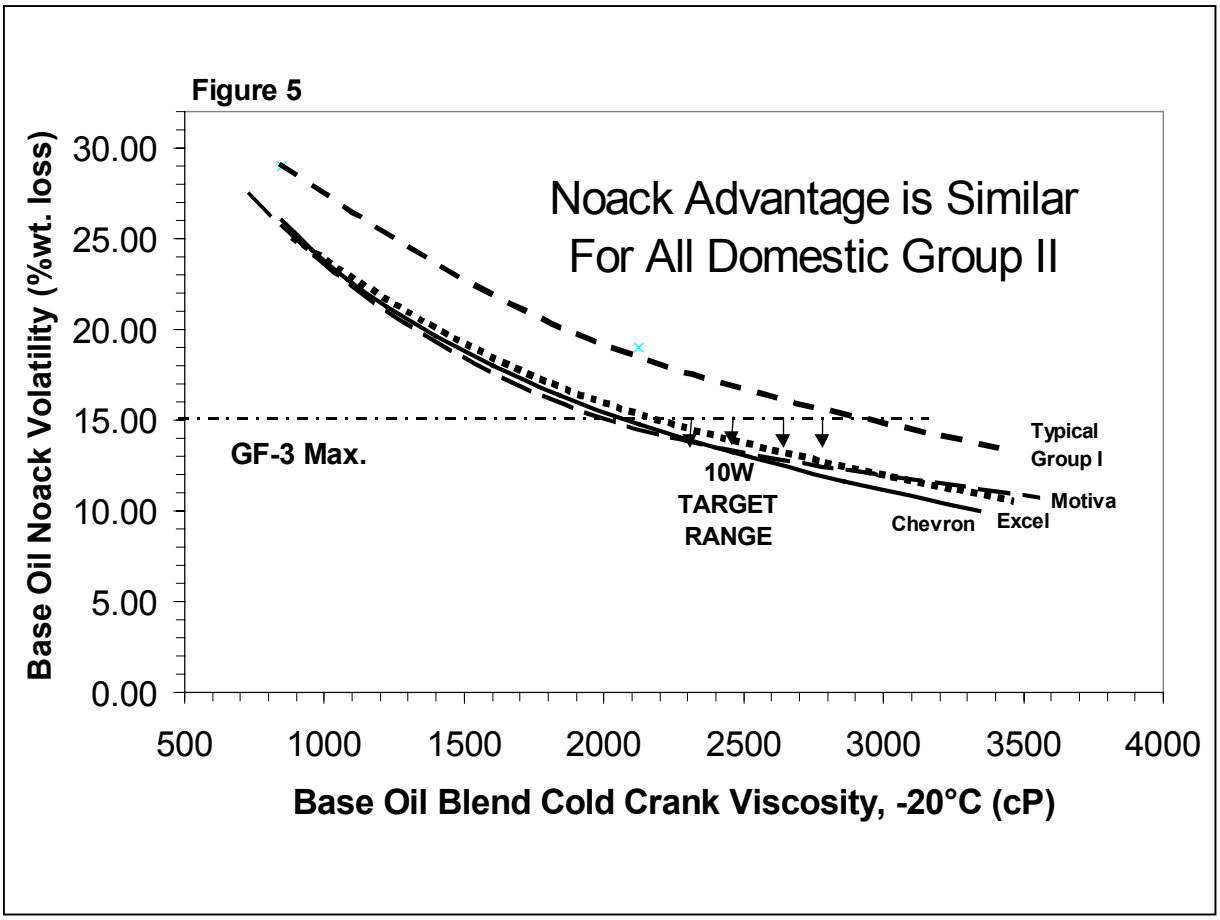


Figure 5


Noack Advantage is Similar
For All Domestic Group II
Base Oil Noack Volatility (%wt. loss)
30.00
25.00
20.00
15.00
10.00
5.00
0.00
GF-3 Max.
10W
TARGET
RANGE
Typical
Group I
Motiva
Chevron
Excel
500
1000
1500
2000
2500
3000
3500
4000
Base Oil Blend Cold Crank Viscosity, -20°C (cP)