


TRENDS
2019

BASE STOCKS

- Move Towards Lower Viscosity
- Base Stock Evolution
- Changes in Capacity
- Group II Supply
- Group III Perspective
- Perspectives on Sustainability

Performance you can rely on.





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Global Trends

- ~45 MT finished lubes demand in 2019
- Supply demand imbalance persists
- Group II/III/PAO capacity additions
- Electrification & drain extensions dampen demand over time
- Latest performance needs demand higher quality base oils
- More competition between API groups

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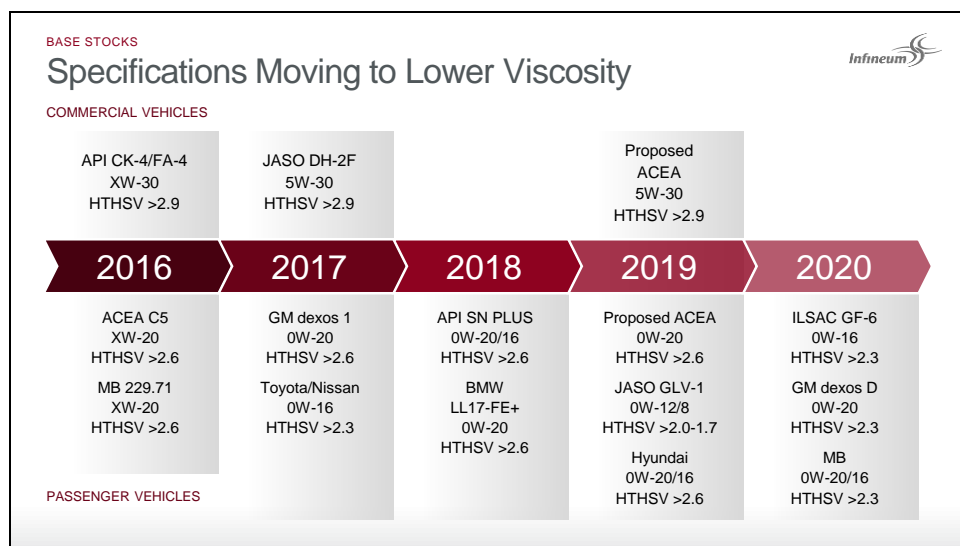
Challenges persist & complexity increases in global base stock industry

The base stock industry continues to face challenges.

Fairly low growth in the finished lubricant market means new base stock supply is outpacing demand.

With automotive lubes accounting for more than half of the finished lubes demand, the drive for sustainability is impacting the market, while impacts from vehicle electrification remain off in the future. Right now, it is legislation that is driving demand for higher performance products and hence higher quality base stocks.

The market faces more inter-API Group competition as blenders explore options to optimize their costs and explore new marketing strategies.



Sustainability's influence can be felt in base stock market as the trend to lower viscosity fluids, to reduce hydrodynamic friction, is reflected in more industry and OEM specifications.

Providing the optimum balance between hardware protection, extended drain interval and outstanding oxidative and deposit control performance in thinner SAE 0W-20 viscosity grades, will continue to drive up demand for higher quality base oils.

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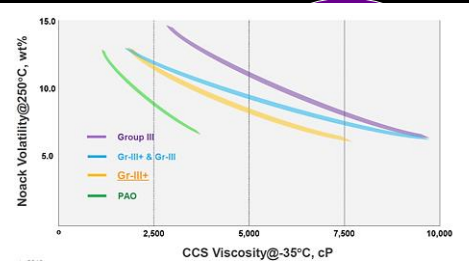
Moving to Even Lower Viscosities

Passenger car OEMs look for SAE 0W-16 and below

- Volatility & HTHS limiting factors

Base stocks are looked at for:

- Lower viscosity cuts
- Lower volatility
- High VI
- Oxidative resistance
- Lower friction, improved fuel economy
- Improved heat removal
- Longer drain intervals
- Meet sustainability desires



TRENDS 2019 Base stocks play a role in every aspect of the advancement of lubricants

Chart Source: SK Lubricants

Japanese OEMs first started using these lower viscosities and now the trend is creeping towards European and American OEMs.

Ten years from now, we expect SAE 0W-xx grades to account for some 30% of the passenger car lubricant market.

Since the limits on lowering the lubricant's viscosity grade are tied to the properties of the base stock and as OEMs continue to push viscosities down to SAE 0W-16 and below, Volatility and HTHS viscosity will be limiting factors.

As the trend to very low viscosity expands beyond Japan, concerns about volatility have been increasing in both passenger car and commercial vehicle formulations, and may ultimately drive up the demand for high quality base stocks, such as PAO and Group III.

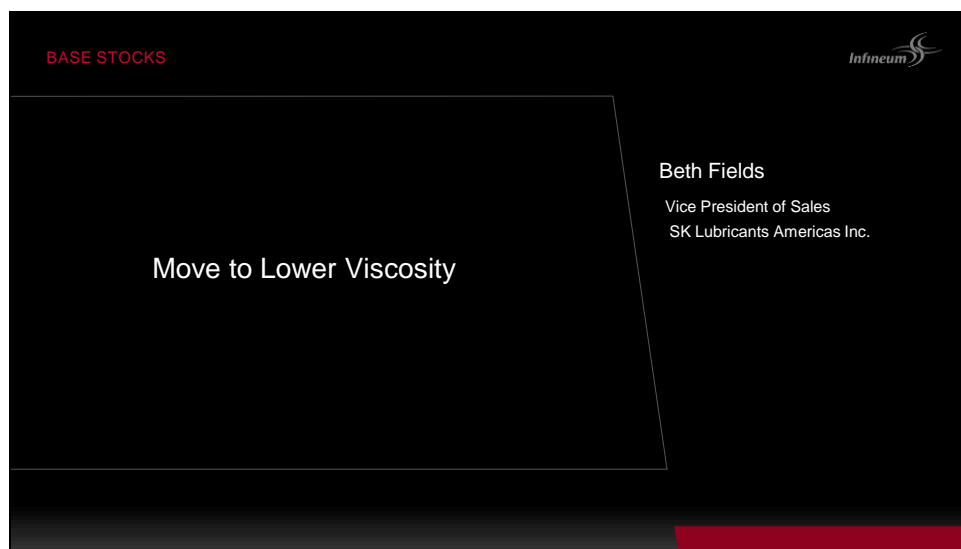
With so many wants, base stocks are playing a role in every aspect of the advancement of lubricants.

BASE STOCKS



Further Low Viscosities?

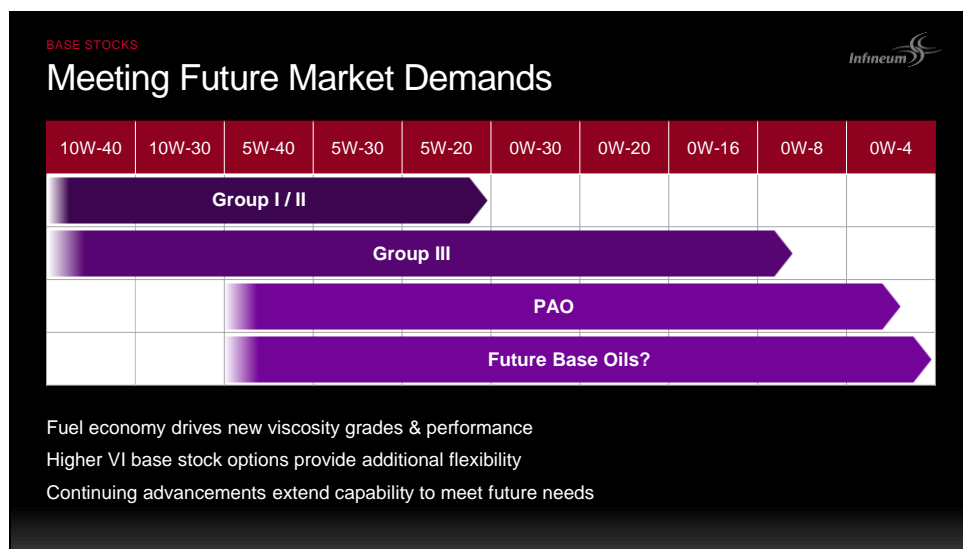
Sagawa Takumaru
Deputy General Manager
Nissan Motor Co., Ltd



Jeff Brown of Novvi and Beth Fields of SK explains how base stocks are enabling the move to lower viscosities.

BROWN-BASESTOCKS-7 “High-quality base stocks are going to be mandatory as vis grade specs evolve. If you look at the requirements to get to fuel economy, you're lowering your vis of your oils. In the base oil world, this drives towards volatility performance. These high-performance base oils will provide a volatility that meets these specs, as well as giving your retain performance in use to meet the demands of the future.”

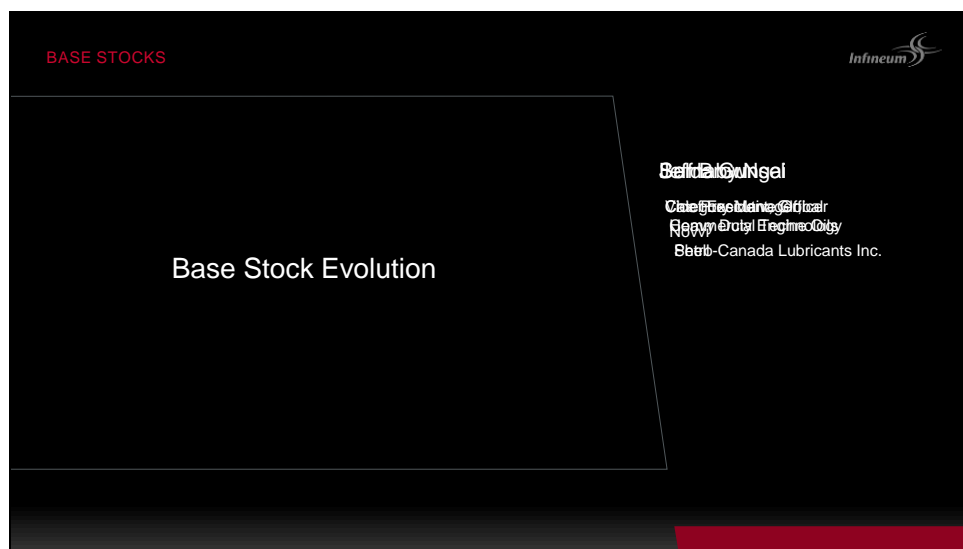
FIELDS-BASESTOCKS-2 “So, the key benefits of the higher quality base oils are the low temperature performance and lower volatility. So, as we see our industry evolving towards lighter vis oils, the balance between CCS and volatility becomes critical, as well as even more stringent requirements expected from OEMs. So, what we see evolving over time is the Gp 1&2 base oils that previously satisfied our industry standards are being replaced by the higher quality base oils.” 00:50



As lubricants move to lower viscosity grades, the formulator needs to decide on the most appropriate base stock route based on cost and performance to ensure the finished lubricant meets the market requirements.

Higher VI base stocks offer flexibility to reach the performance requirements of new low viscosity grades.

And, continuing advancements in base stocks will further extend their capability to meet new viscosity grades and specifications.



As sustainability and regulations drive higher efficiency, OEMs are requiring more performance from the lubricant and the base stock mix is evolving.

Here again with their views are Selda, Barnaby and now Jeff Brown of NOVVI.

GUNSEL-BASESTOCKS-7 "The global demand for high quality base stocks has been rising steadily in recent years, as the lubricant applications focus more and more on energy efficiency and sustainability. If we look at the PCMO segment in particular, the market share of OW grades is expected to increase significantly over the next ten years. This is because of the outstanding fuel economy & carbon footprint reduction benefits OW delivers versus heavier grades. In general blending OW products require the use of Group III. To meet the even more stringent OEMs requirements for fuel economy and NOACK volatility, the oils need to be formulated with higher quality Group III stocks, such as Shell's GTL base oils. Overall, the market is using more higher quality base stocks. Meanwhile, we'll continue to see further performance differentiations among Group III base oils."

NGAI-BASE STOCKS-5 "So, really the way we look at it is in general, the use of higher-quality base stocks are going to be driven by the demands that are required of the lubricant. So, if you think about the specification changes, if you think about the equipment design, they typically demand for a more robust formulation. And as we know, base oil is a key component as part of that formulation. So, do we see the base oil slate improving in terms of the use of higher-quality base oils? I mean, absolutely. I think that that's going to be definitely part of the future."

BROWN-BASESTOCKS-4 "If you ask yourself what makes the best engine oil bar none, at Novvi this means your CCS performance, your VI, volatility, durability, and long-term stability of the product. These aspects cannot be met with conventional technologies today, and will be enabled by tomorrow's sustainable non-conventional products."

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Infineum

Future is Also Electrified

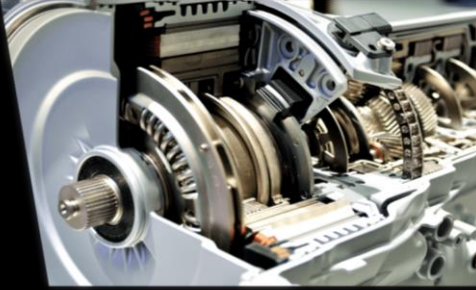
Hybrid transmission fluids will need high quality base stocks

- Wear protection at low viscosity
- Electrical compatibility
- Thermal conductivity

PAO/Group III can offer high volume resistivity

Hybrids: careful balance essential

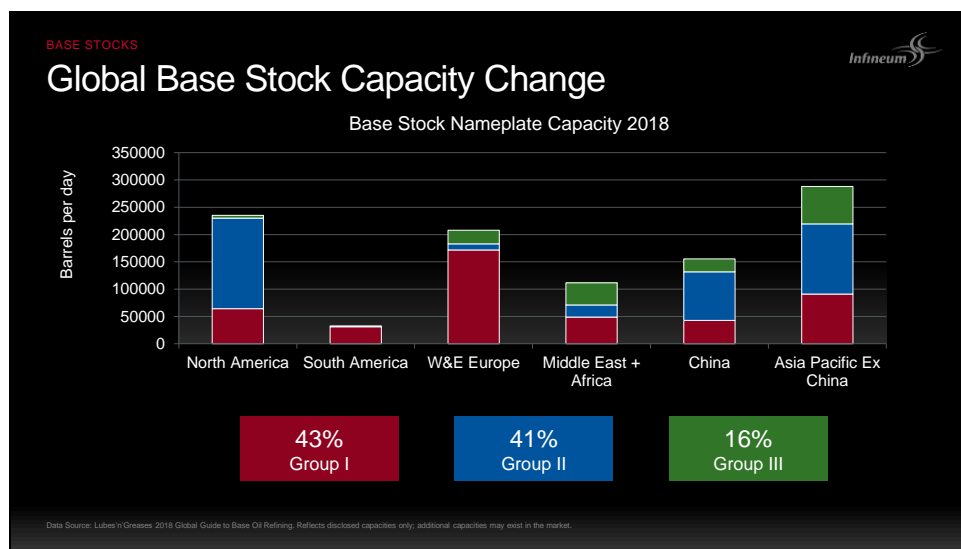
- Electrical properties
- Gear protection
- Materials compatibility



Electrification may impact the base stock market as more of the powertrain is electrified and OEMs look for longer oil drain intervals.

New hybrid transmission fluids need to ensure wear protection at extremely low viscosities and electrical compatibility, in a high speed, high temperature, operating environment.

The need for enhanced electrical properties is likely to drive the use of higher quality, less polar base stocks, such as PAO and Group III, and formulators will need to work hard to strike the right balance between all the attributes required in transmission fluids for these specific applications.



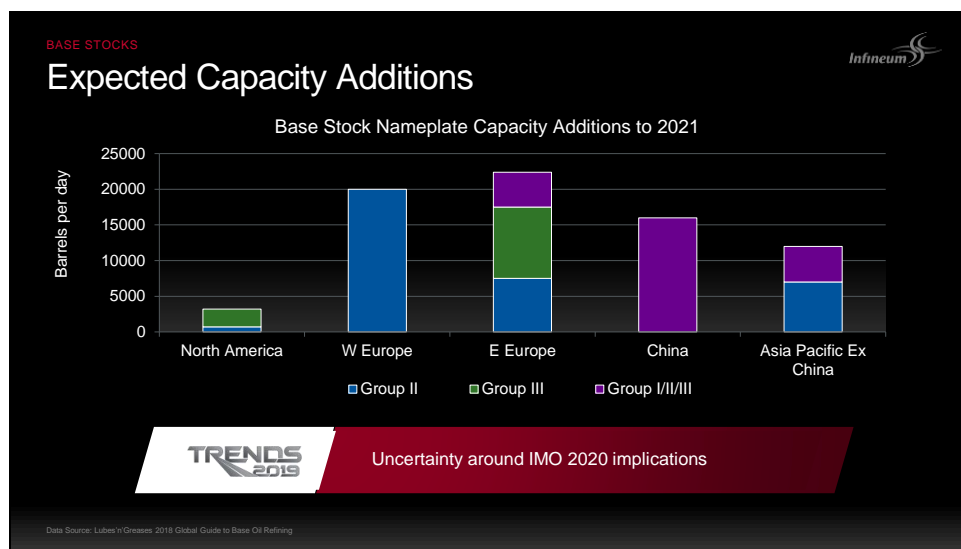
With so many needs, how is the market responding?

Worldwide base stock capacity for Groups 1, 2 and 3 topped 1 million b/d in 2018.

China had new Group 2 & 3 additions, the latest from Hengli Petrochemical Co. adding over 10,000 BPD.

Although Group 3 suppliers are readying for further capacity increases to meet emerging demand,

over the past 5 years the biggest capacity increases worldwide have been in Group 2, which many still regard as the heart of the market.



Even more high-quality base stock capacity is on the way, with over 70,000 b/d expected to be added before 2021 via new projects, expansions and upgrades.

The demand for lower sulfur fuels to meet IMO 2020 is expected to have an effect on base oil plant profitability, while the significant addition of Group 2 in Europe will change base oil choices globally.



Ted Walko of ExxonMobil offers his perspective on the impact of IMO2020.

WALKO-BASE STOCKS -1 “At ExxonMobil we're paying close attention to the impacts from IMO 2020. Those changes on the marine industry will introduce multiple fuel options for marine shippers. Those fuel options will have a significant impact across the lubricants industry, particularly in the area of base stock manufacturing.”

WALKO-BASE STOCKS -2 “Although we anticipate significant impacts from the IMO 2020, we believe Group 1 demand will continue to be strong and will have a solid place within the marine shipping industry. On the supply side, that's where things may change. You see, this production of this lower sulfurized fuel will challenge the economics of many refiners, particularly the low-complexity ones. They'll have tough decisions to make. Will they invest to de-sulfurize and destroy resid? Or, will they choose to get out of base stock production moving forward? That's where we believe the biggest impact is going to be.”



Next, let's hear from Sylvie Houry of ExxonMobil which announced the start-up of its Group 2 plant in Rotterdam this February.

HOURY-BASE STOCKS -1 "On the supply side, today, as you know, in Europe Group 2 base stocks are primarily coming from North America, imported from North America, imported in a smaller extent from Asia, as well. Now of course, the fact that new production is starting as we speak in Rotterdam, will change the supply pattern. Our expectation is that Rotterdam production will, of course, replace most of the products currently imported from other regions."

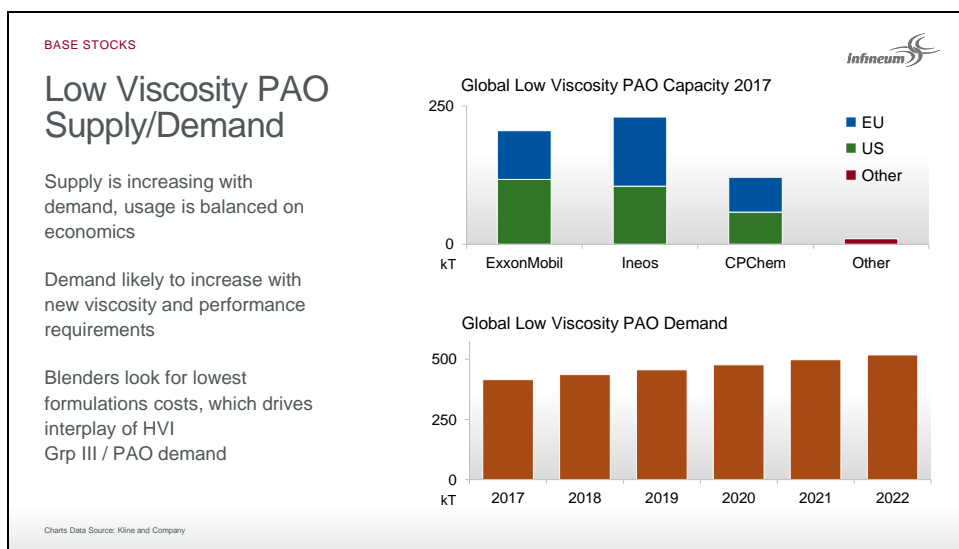
HOURY-BASE STOCKS -2 "We expect the demand for Group 2 base stocks to grow, to continue to grow worldwide and to significantly grow in Europe in the coming years. This is primarily driven by the automotive industry. Finished lubricants in automotive applications have different requirements than in the past."



Beth and Jeff provide a Group III manufacturers view on supplying the global market.

FIELDS-BASESTOCKS-9 “Group 3 base oil will continue to grow in demand in each region of the world. Certainly within the Americas market we have a significant amount of demand and very little capacity. So, we're a current net importer and could utilize additional capacity within our region. As it relates to new capacity and how different companies may invest in that, it's really on a case-by-case basis. SK for example, has effectively used a joint venture model with three different partners globally. However, we've also seen in our industry that not all joint ventures are successful. So, it really depends on the company, their investment strategies, resources, and assets, as to how they achieve that.

BROWN-BASESTOCKS-6 “From Novvi's perspective, there will be ample supply of these sustainable non-conventional base oils to meet the demand of the industry. What we need to remember about these new technologies is we have different supply chains. In Novvi's case, our capital expenditure and plant build-out model is substantially different. We're more efficient and can more organically grow with the market to ensure that supply and demand always stay in check.”



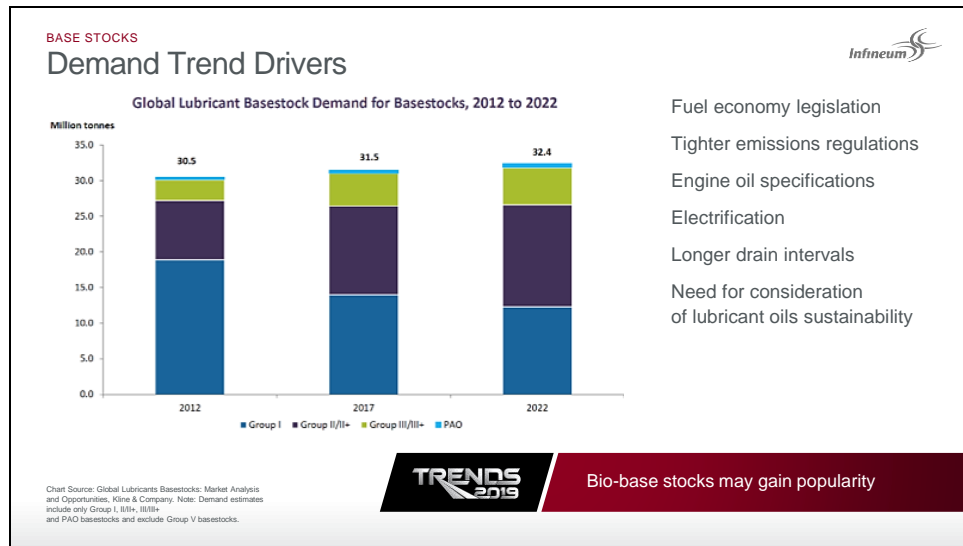
In low viscosity PAO, the main players are Ineos, ExxonMobil and Chevron Phillips Chemical.

Over 5 years, expansions will add 20% to the production of NAO, which is used as a PAO feed stock.

Supply is increasing with demand, which looks set to grow with the trend of lower viscosities and higher performance requirements.

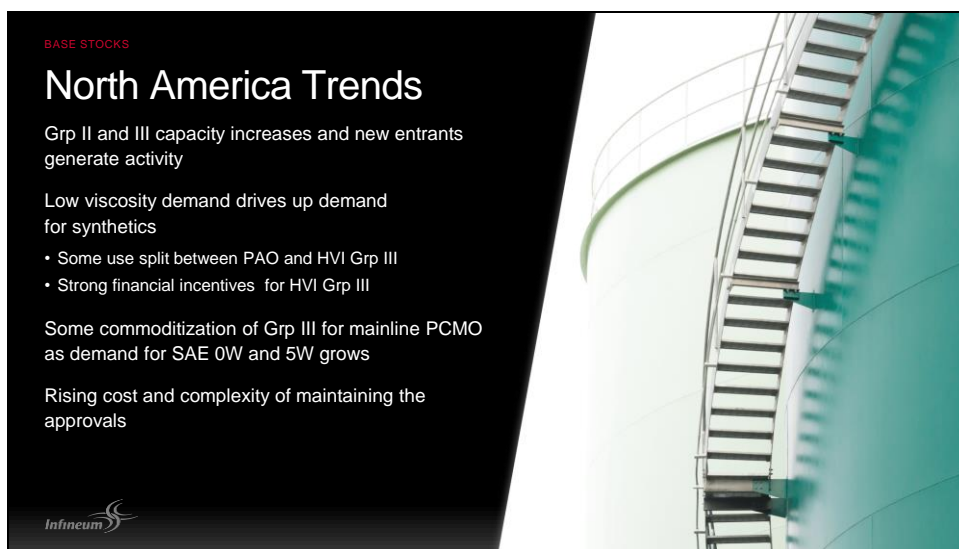
However, blenders continue to strive to minimize PAO use, for the lowest formulation cost.

It will be interesting to see the Interplay of High VI Group 3 and PAO demand as it develops.



Demand trend drivers will continue to shape the market. With a limited increase in demand from the lubricants market expected, supply levels across all base stock groups will be more than adequate.

We should not lose sight of bio-base stocks, with the added benefits of biodegradability and strong environmental credentials, they could also see some uptake, especially in Asia Pacific.



BASE STOCKS

North America Trends


Grp II and III capacity increases and new entrants generate activity

Low viscosity demand drives up demand for synthetics

- Some use split between PAO and HVI Grp III
- Strong financial incentives for HVI Grp III

Some commoditization of Grp III for mainline PCMO as demand for SAE 0W and 5W grows

Rising cost and complexity of maintaining the approvals



Let's look a little closer at the market in North America, where Group 2 & 3 capacity increases and new entrants have provided increased activity as customers look for the most cost-effective formulations.

The growth of low viscosity grades has driven up overall synthetic demand.

Some use is split between PAO and High VI Group 3 but financial incentives are strong for Group 3s, if oil approvals allow their use.

We are also seeing some commoditization of Group III base oils as SAE 0W and 5W grades are increasingly required in passenger car applications.

And as the number of new base oils grows so do the costs and complexity of gaining approvals.



We close the base stocks section with Jeff providing some food for thought on who will lead sustainability in to the future.

BROWN-BASESTOCKS-5 “Public policy does not play a large role for lubricants, and we're unclear how this will change in the future. The interesting thing about this question is we've seen corporations and small governments stepping in and taking the lead. The B2B market values sustainability. Corporations realize sustainability is important and they play a large role in protecting the environment. There's real monetary value behind this. The policy void has created a realm where corporations can step in and make a difference.”