

"If refiners want to play in the top tier 0W and 5W engine oil markets, they need to produce at least 115 to 120 VI, and tomorrow will likely require 125 to 130 VI...."

HI-VI BASE

BY RICHARD BEERCHECK

Original equipment manufacturers want lighter engine oils with lower volatility to reduce emissions and provide better fuel economy. According to Amy Claxton of My Energy, this creates a real dilemma for refiners who wish to participate in today's low SAE J-300 engine oils, because these lubricants require base oils with a viscosity index in the range of 115 to 120 to meet the more stringent

volatility and viscosity requirements.

"If a refiner wants to play in the top tier 0W and 5W engine oil markets, they need to produce at least 115 to 120 VI, and tomorrow will likely require 125 to 130 VI," she told delegates at the ICIS Middle Eastern Base Oils and Lubricants Conference in Dubai in October. "Unfortunately, most base oil plants cannot produce this VI level."

The Three Vs

Claxton said that the key differentiators in today's market are the three Vs – viscosity, volatility and viscosity index. Key measurements for base oils used in low SAE J-300 engine oils include a kinematic viscosity of about 4 centistokes, low-temperature CCS (cold cranking simulator) viscosity and pour point. In addition, today's top tier low-SAE grade engine oils require a Noack volatility

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— AMY CLAXTON, MY ENERGY

OILS BRIDGING THE VOLATILITY GAP

Example Qualities of Major Group III/III+ Suppliers

Company	SK	S-Oil	Neste/Bapco	XOM PAO	SK-Pertamina	Petronas	Shell GTL
VI	122	123	122	126	130	132	135
Noack (%)	15.0	14.6	14.2	12.0	14.0	11.4	12.0
Pour Point (°C)	-15	-20	-18	-60	-18	-21	-30

Source: My Energy

of 15 percent (or even 13 percent) at 350 degrees C for a 4-cSt oil.

“The three Vs are partners,” said Claxton. “The viscosity index measured in the refinery tells me the

volatility for a given viscosity.” Therefore, refiners measure viscosity index to give them an idea of the other two values.

Generally, higher VI provides better volatility at

constant viscosity. Higher VI also provides lower CCS viscosity. Therefore, Claxton added, meeting today’s volatility and viscosity requirements requires a VI above 115 to 120

(with 120 VI designated as an API Group III oil). A few plants today produce VI levels above 130, the informal specification for Group III+. However, as noted above, most base

Moving from Group III to III+

Region	Yield (1,000 tons)	
	Group III	Group III+
Western Europe	850	450
Middle East	310	205
Asia	2,500	1,340

Source: My Energy

oil plants cannot produce this VI level because of processing or feedstock constraints.

Group III/III+ Market

Today's Group III/III+ producers comprise an exclusive list of companies. These ultra-high quality base oils from the major suppliers are differentiated by their viscosity index, Noack volatility and pour point characteristics.

"Today," Claxton said, "OEMs want even lighter engine oils with equivalent or lower volatility, lower CCS viscosity and lower high-temperature, high-shear viscosity."

She added that the recent introduction of new SAE J-300 engine oil grades and their next generation Noack specifications will not likely be met by 120 to 122 VI base oils. As a result, "future premium engine lu-

bricants may require 130+ VI base oils. And Group III+ VI levels will likely be required, if not for this cycle, then for the next one, to meet the requirements for these top-tier oils," she concluded. "This raises two questions. How will base oil refiners make even higher VI to meet lower viscosity and lower volatility requirements? Where are we likely to see new capacity for Group III+ base oils?"

Supply Scenarios

Claxton explained that "most paraffinic base oils are 95 to 100 VI for a reason." For example, the processes used to refine Group I base oils cannot produce higher VI without

a dramatic yield loss that renders the operation uneconomic. United States Group II feedstocks are constrained at current VI levels due to the crudes typically processed in U.S. refineries, along with fuels refining configurations. In the Middle East and Asia, Group II base oils could be boosted to Group III/III+ but at reduced yields. Similarly, Group III could be boosted to Group III+ but at reduced yields.

Claxton then reviewed refineries where VI could realistically be raised. She ruled it out for North American Group II or III base oils because of the aforementioned feedstock constraints. "In Western Europe and the Middle

save the date!

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"Today, OEMs want even lighter engine oils with equivalent or lower volatility, lower CCS viscosity and lower high-temperature, high shear viscosity."

East, the VI of existing Group II base oil cannot easily be raised without major crude swaps or refinery changes, but current Group III producers could increase their intensity to make Group III+," she said.

In Asia-Pacific (outside China), the VI of both Group II and III oils could theoretically be raised to required levels. However, she cautioned,

this analysis leaves open the question of what effect a 13 percent Noack volatility requirement for low SAE grades would have on refining capacity and capability.

To analyze this possibility, My Energy developed a yield model for Group III plants to produce Group III+ base oil. "The target was to maximize the output of 130 VI, 4-cSt base stocks," Claxton explained.

"The refining severity required to produce on-spec 4-cSt base stock sets both the yield and VI of lighter and heavier grades."

The analysis was based on the assumption of an improved crude slate in the Middle East because of the region's access to a few grades of waxier crudes. All other crude slates were held constant with primarily Arab Light running in Asia and Europe.

"The model showed that the total base oil output of 4- to 8-cSt material dropped by one-third in the Middle East and almost one-half in Western Europe and Asia," Claxton related. "The higher operating intensity also produced additional 2- and 3-cSt material at the expense of 4-cSt and heavier molecules." As a result, refiners would have to charge a premium for Group III+ to justify the yield loss.

Outlook for High-VI Supplies

Claxton explained that there are three possible sources of additional high-VI base stocks – upgrading more hydrocracker bot-

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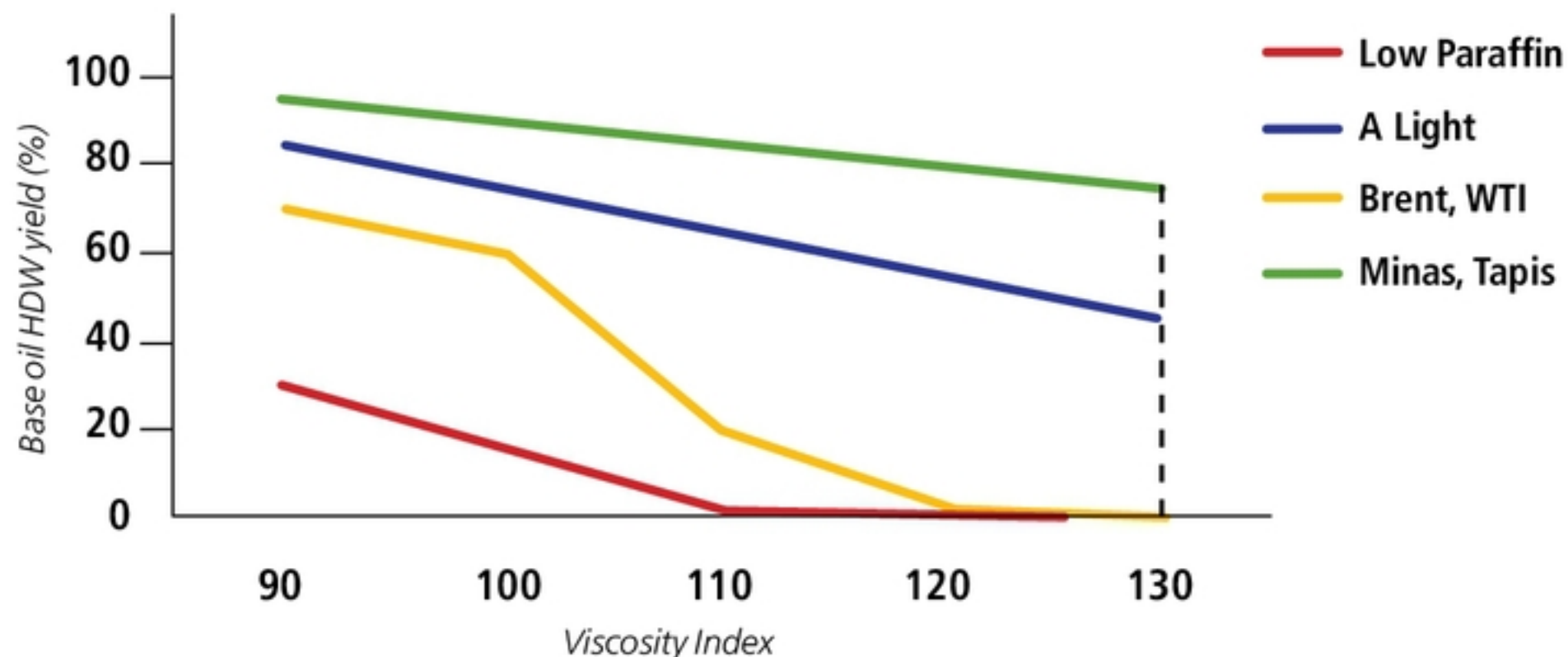
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Moving from Group III to III+



Source: My Energy

toms from waxy crude sources, additional GTL output and new sources of unconventional base oils.

Fuels hydrocracker bottoms (also called unconverted oil or UCO) can be segregated for

base oil manufacturing. Typically, about 20 percent of the material used as feedstock for fuels hydrocracking exits the process as unconverted oil, which is too heavy for fuel products. "This material

can be hydro-dewaxed to produce Group II, III, or III+ base oil, depending on the feedstock type and processing severity," said Claxton.

Hydrocracking unit bottoms can be used to produce Group III+ from high-wax crudes, and additional Group III+ could come from super-paraffin crudes. "However, supplies of these crudes are limited, and they are not easily transported," Claxton noted.

The potential for more GTL base oil is non-existent in the near term, according to My Energy. "Currently, no GTL projects are planned due to low crude cost versus other gas monetization alternatives," she said.

On a brighter note, My Energy found that the potential for new sources of unconventional high-VI base oils is more promising. "Ineos, ExxonMobil, ChevronPhillips and others have announced PAO expansions," said Claxton. However, the total capacity increase less than 200,000

tons, and most is not low-viscosity material. Therefore, the price of PAO will remain high due to the feedstock platform and competing industries using alpha olefins.

On another front, several companies are developing high-VI renewable, biodegradable base oils from plant-derived sources. For example, Novvi has products that are similar to PAO and can be used "neat" in engine oil formulations. However, while these sources benefit from low cost of capital and high qualities, large scale commercialization is still several years away.

Regional & Global Observations

"High-VI base oils are becoming more differentiated based on volatility, viscometrics and VI," Claxton noted. "However, Group III+ is limited by the lack of availability of waxy feedstocks." Specifically, the only Group III+ producers are SK-Pertamina and Petronas from high-wax Asian crudes and Shell from Fischer Tropsch waxy feeds.

So, two questions remain. How will existing high-VI base oil refiners make even higher VI to meet the lower viscometrics and lower volatility required by OEMs? Where are we likely to see new capacity for Group III+ base oils? At the moment, these questions have no satisfactory answers for three reasons.



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First, refiners face significant yield debits if today's Group III plants move to Group III+ production. Second, additional Group III+ could be produced from HCU bottoms from Asia's high-wax crudes; however, crude supplies are limited and logistics are complex. Third, new sources of 130+ VI base oil are limited.

GTL base oil projects are on hold because low fuel prices resulting from low crude prices render GTL economics less attractive than in prior years. "But GTL has the most attractive economics of all base oil options when fuel product economics for

Source: My Energy

GTL plants become more robust," said Claxton.

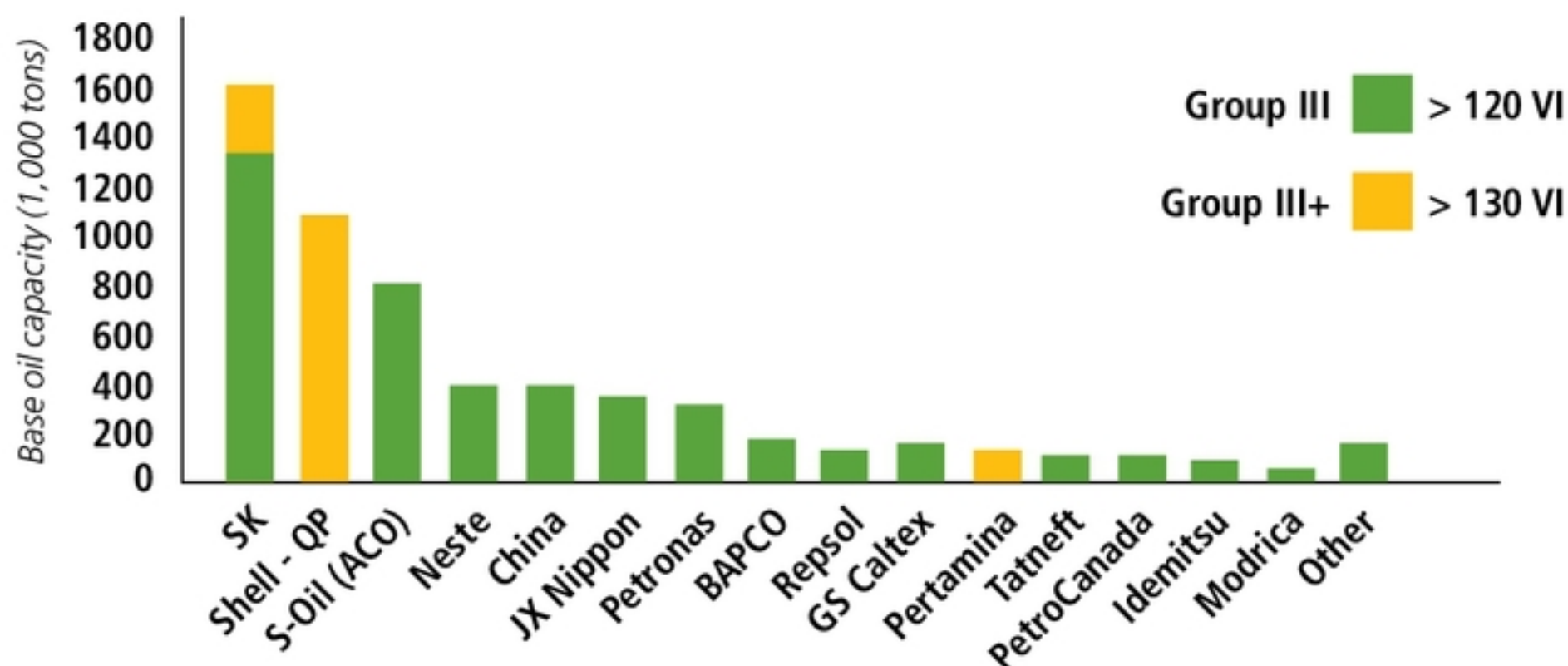
In addition, PAO is likely to remain a niche product. "PAO prices will remain high due to its feedstock platform and competition from other industries using

alpha olefins," she noted. And while biobased Group III+ capacity holds promise, large-scale commercialization is still several years away.

"For now, commercially viable options for addi-

tional base oils meeting more stringent OEM requirements are limited," Claxton concluded. "And base oil suppliers with Group III+ differentiation are in a coveted position in today's market." □

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