Making the (Low-Viscosity) Grade

A colleague recently got me thinking about base oil grades when he was preparing a presentation for February's ICIS Base Oils & Lubricants Conference in London. He asked what flexibility API Group III manufacturers had to alter their output by grade.

This question was asked recognizing that for passenger car motor oils, the SAE 5W-30 viscosity grade is currently the principal factory-fill and fuel-economy grade of choice globally. However, to meet more exacting fuel economy requirements, SAE 0W-20 and even SAE 0W-16 will be at least the factory-fill grades of choice for the future. And more recently, at an original equipment manufacturer's request, SAE announced two still lighter grades, SAE 12 and SAE 8.

A differentiator of these new viscosity grades is the kinematic viscosity range span at 100 degrees C. However, the real underlying targets are the lower minimum values for high-temperature/high-shear viscosity because this is the principal parameter that correlates to fuel economy.

According to Kline & Co. consultants, low-viscosity engine oils will comprise more than 7 percent of total global passenger car motor oil volume by 2023. Currently, SAE 0W-XX viscosity grades makes up less than 5 percent of that market, so Kline's prediction represents a 30 percent increase.

Doing some back of the envelope calculations, I determined that 5W-30 motor oil requires predominantly 6-centiStoke base oil viscosity, and 0W-20 and 0W-16 require mainly 4-cSt base oil viscosity. Since Group III

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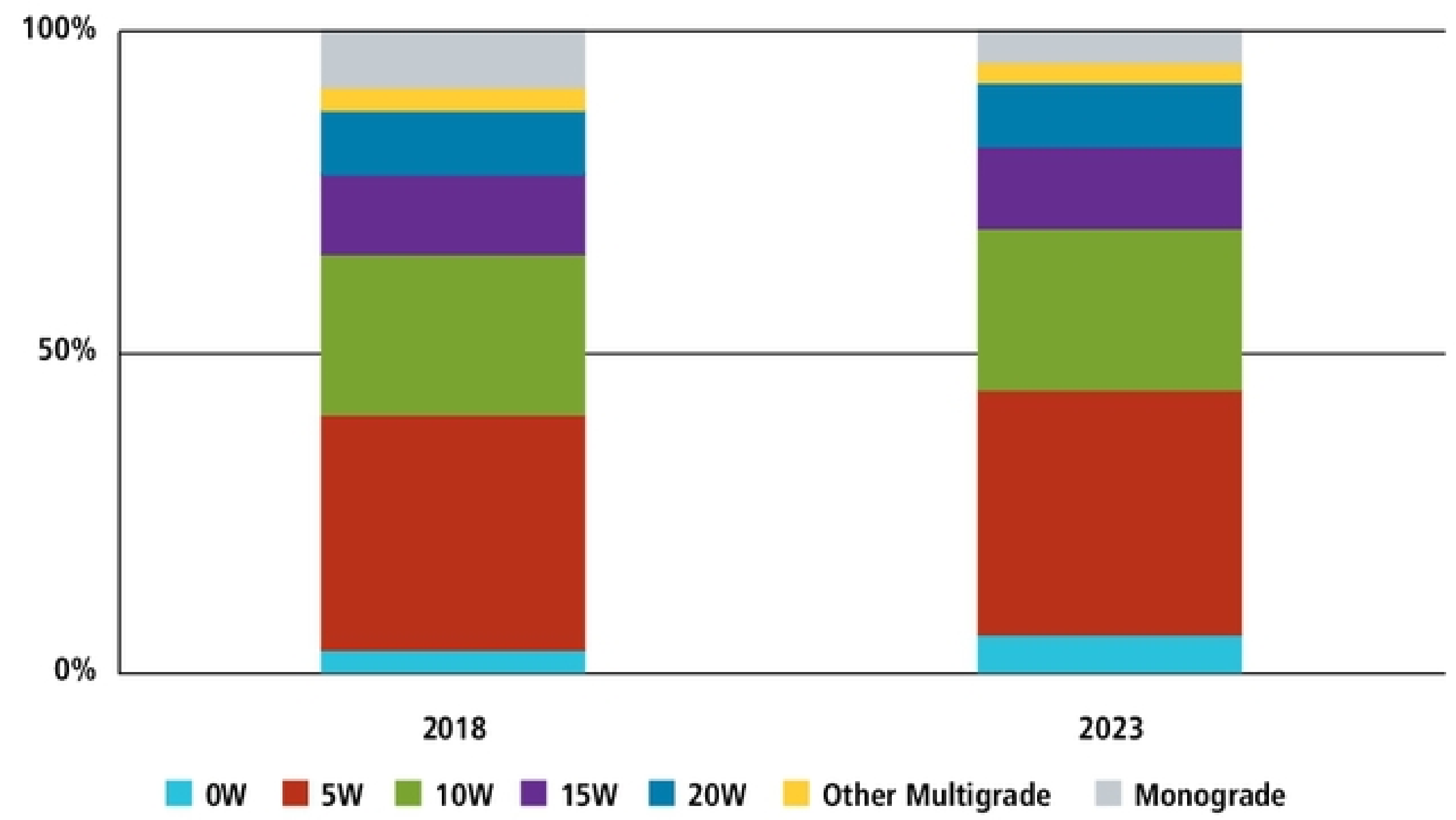
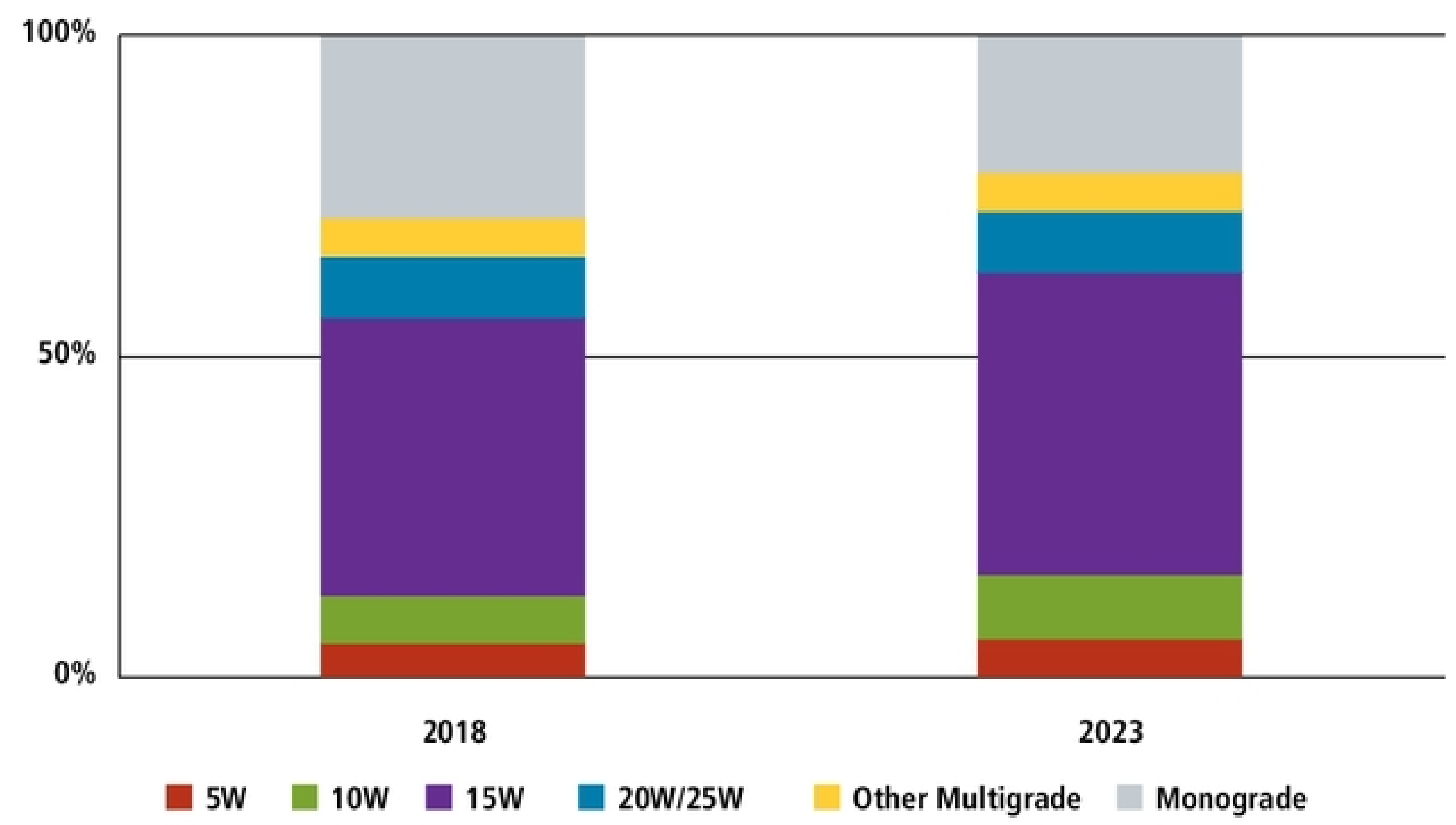
Passenger-Car Motor Oil Demand by Grade



Heavy-Duty Motor Oil Demand by Grade



Source: Kline & Co.

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is produced in a narrow range of 4 to 8 cSt, this means a quite radical shift for Group III base oil manufacturers as 0W-XXs increase market share.

All Group III manufacturers produce an incidental 3-cSt grade that often has a viscosity index of less than 120, which does not always meet the formal Group III definition. This VI falls between gasoil (diesel) and 4-cSt Group III in the distillation boiling range.

The 3-cSt grade currently cannot be used to blend conventional crankcase lubricants because of limitations in the Noack volatility achievable for such a light grade. It can't even be used to dumbbell blend a 4-cSt grade because of its Noack contribution. On the other hand, it could technically lubricate a well-designed engine with good tolerances because such grades already will lubricate some total loss (two-stroke) or dry-sump engines where Noack is not such an issue.

Another factor that has to be considered as viscosities go lower is fitting not only the base oil viscosity but also the additive package and viscosity modifier contributions into a narrower overall kinematic viscosity window. Although in some cases, such narrow-span 0Ws formulated with very high VI base stocks may not require a viscosity modifier, at least from a viscometric perspective.

The 4-cSt grade is currently cut in Group III manufacture to meet ever more demanding volatility requirements, particularly those of OEMs rather than API or ATIEL standards. The main lever to pull here is to adjust the cut-width or boiling point distribution. The narrower the cut-width, the lower the Noack, but also the lower the yield and the more expensive the product. Therefore, any simultaneous ratcheting down of Noack requirements is going to put even more pressure on available supply and the Group III base oil price.

A secondary lever to pull is to raise VI because higher VI correlates with a preponderance of higher boiling paraffinic components and a better achievable Noack at constant (lower) grade. However, the effect is small, and it is not always possible if there are simultaneous demands to improve extreme low-temperature performance. The more manufacturers have to isomerize Group III to produce good Brookfield or MRV viscosity, the more they harm VI.

So, what can be done to recast excess 6- or 8-cSt grades as 4 cSt? In theory, these grades can be cracked to the lower viscosity grade but would require very good process controls. Certainly, there is no point in simply increasing hydrocracking severity of a full range feedstock because all grades will receive some cracking – 6 to 4, 4 to 3, etc. – and you could end up with a zero-sum game. More sophisticated approaches involving recycles would be required in process line-ups.

It is here that polyalphaolefin can step up to the mark because hydrocracking is not part of the manufacturing process. Rather, controlled polymerization to provide precisely the required molecular weight range is relatively easy within current manufacturing set-ups. Both mid-boiling point and boiling range of oligomer ratios can be tweaked to deliver the required volumes-by-grade more easily and precisely but not necessarily more cheaply than with Group III.

While technical options are available to increase the supply of the lowest viscosity grade Group III, all come at a price in terms of yield, manufacturing complexity and compromises in other performance areas. Maybe the simultaneous recasting of preferred grades in both passenger car and heavy duty diesel engine oils, as commercial vehicles get more serious about fuel economy, will accommodate the available heavier Group III and its increasing supply.

Then, the issue becomes what happens to the Group II currently used in heavy-duty lubes. We'll worry about that later, meanwhile appreciating the overall improvement in lubricant qualities, technical edges and fuel economy. □

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