

Synthetics: Origin of the Species

BY STEVE SWEDBERG

Synthetics have been the hot topic in motor oils lately. The question is why all the buzz now, since they've been part of the motor oil marketplace for almost 50 years. I thought it would be interesting to look back at their origins and talk about what's driving their growth.

While stories about the use of non-petroleum products for motor oils go back a long way (castor oil for example), the development of modern synthetic lubricants is a direct result of World War II. Nazi Germany was unable to get petroleum based oils and was forced to develop synthetics. According to one old reference book (The Waverly Handbook of

1949), these German synthetics were "polyethylene" formed from ethylene produced from coal and biobased sources.

After the war and with the advent of high speed, high altitude aircraft, hydraulic oils needed to be able to operate over a wide temperature range. Minus-40 degrees F was set as a target for the hydraulic oil to remain fluid on the low-temperature side, and they also needed to have adequate viscosity when the temperature climbed to around 150 C (302 F).

In addition there was a need for engine oils to lubricate and protect jet engines. Products qualified for this use had to meet the military's MIL-L-7808 specification, and the preferred oil at the time was a diester, created by chemically reacting fatty acids and fatty alcohols.

There followed a number of industrial applications such as hydraulic oil, circulating oil, refrigeration oil, gear oil and grease which were synthetic based. All of these had the common need for products that could handle extreme temperatures or were in relatively inaccessible locations which demanded long operational life.

Early Adopters

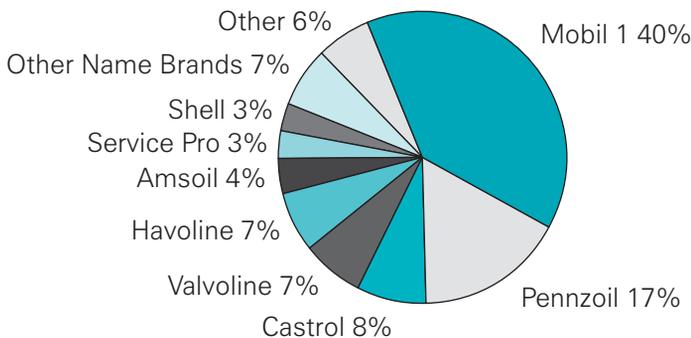
The first synthetic automotive engine oil was introduced by Superior, Wis.-based Amsoil Inc. in 1972. It met then-current performance levels for engine oil and was based on polyalphaolefin base stock, with some ester blended in to assure additive solubility and seal compatibility. Shortly thereafter Mobil Corp. introduced Mobil 1 which was similar in make-up. From that point forward a number of smaller oil marketers also introduced synthetic automotive engine oils, but Mobil 1 still claims the number one spot worldwide.

The strongest selling points for synthetic engine oils were their long-life potential and their low-temperature performance. That made them an easy sell in the Northern-tier U.S. states since it's tough to start a car at minus-40 first thing on a winter morning. Some marketers also promised consumers they'd be able to go much longer between drains; 12,000 to 15,000 miles between oil changes was being touted as the new normal for synthetics.

The major oil marketers (such as Pennzoil, where I

Continued on page 8

Featured Synthetic Motor Oil at Fast Lubes



Source: 2013 Fast Lube Operators Survey, by National Oil & Lube News (www.noln.net)

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Continued from page 6
 was working back then) responded that synthetics were way too expensive for normal use, and to be profitable, a once-yearly oil drain would have to cost four times as much as conventional 3,000-mile/three month drain intervals. That was likely to be unpalatable to most consumers. Mostly, big oil viewed it as a specialty product that would never capture a large share of the market — a novelty.

By the 1980s, the impact of synthetic automotive engine oils on the market was still pretty minimal. Customers buying synthetics usually had one or more of the following reasons for the purchase.

1) They had to have the best oil. One market research firm, which studied motorists' buying habits for items ranging from wheel rims to driving gloves, estimated that about 5 percent of buyers had to have the very best — cost was no object. Synthetic cost the most, ergo, it was the best one could buy.

2) They were technology enthusiasts and felt that "space-age" products were the right choice.

3) They wanted to go for the longest oil drains possible, and they felt that oils allowing 12,000- to 15,000-mile change intervals must be superior.

The OEMs liked synthetics because of the fact that they were lower in viscosity, showed good deposit control and oxidative stability, and offered fuel economy benefits versus conven-

tional oils. Unfortunately, automakers couldn't use synthetics for their engines' fuel economy certification programs; the oils failed the U.S. Environmental Protection Agency requirement that oils used to calculate fuel economy must be competitively priced and widely available.

Ramping Up

Throughout the 1980s synthetic engine oils remained a minor but highly profitable player in the overall market. There were small attempts to capture new customers with "semi-synthetic" oils that used a mix of conventional and synthetic base oils, particularly in Europe. Some of the early fuel economy oils were blends of this type. But so long as the cost differential between conventional and synthetic base oils remained at about five-to-one, there was no way that synthetics could make any great inroads into the mainstream market.

Things really got going in the 1990s with the introduction of the American Petroleum Institute's Document 1509, the Engine Oil Licensing & Certification System. One of the innovations included in API 1509 was a classification system for base oils, which now were divided into "groups."

Starting in 1991 and continuing for the next two years, a big debate went on in API's Lubricants Committee and in SAE International about how to define a synthetic.

Everyone agreed that PAO was a definite as well as the various esters (mono-, di- and tri-). The problem was the emergence of what came to be known as API Group III base stocks. These were very highly refined mineral oils with a viscosity index that approached that of PAO (which are often 140 V.I. or better). Group IIIs boasted high purity, light to water-white color and very little in the way of sulfur or unsaturates, just like PAOs — but they cost far less.

Having put so much marketing effort into their products, the folks who made PAO and other synthetics naturally didn't want to see Group III base stocks invading their turf. They argued that only "man-made" molecules should be called synthetics, not natural ones created by refiners. On the other side, Group III refiners (led by Shell and BP) claimed that their products could be made either by severe refining processes (like catalytic cracking, hydro-isomerization and catalytic dewaxing), or by polymerization processes — which would qualify them as "man made," i.e., synthesized molecules.

Finally in 1995, in an effort to head off any controversy SAE deleted "synthetic" as a definition in its Information Report J357, which describes the physical and chemical properties of engine oils. And API decided that the word "synthetic" would not appear in API 1509 either.

Continued on page 10

Continued from page 8

API had by then created the Group III niche to allow for highly refined oils to be included in API 1509's base oil categories; polyalphaolefins got their own niche, Group IV. (See Appendix E, "API Base Oil Interchangeability Guidelines for Passenger Car Motor Oils and Diesel Engine Oils).

Rubbing Along

Things continued to rub along, with occasional mutterings and uprisings at industry meetings, until 1998. Then Mobil, stung by advertising claims made by Castrol, asserted that Castrol Syntec Motor Oil was not really synthetic because it no longer contained PAO. Until December

Table 1: U.S. Passenger Car Motor Oil Sales by Viscosity Grade

(million gallons)

| SAE Grade | 1999 | 2006 | Change |
|-----------|------|------|--------|
| 5W-20 | N.A. | 65 | — |
| 5W-30 | 120 | 231 | 93% |
| 10W-30 | 388 | 245 | -37% |

Source: U.S. Lubricating Oil Sales Report, NPRA/AFPM

1997, Mobil charged, PAOs had been 70 to 80 percent of Syntec's formulation and esters another 7 percent; now Syntec used only hydro-isomerized mineral oil. (How did Mobil know that no PAO was being used? It analyzed Syntec after Castrol stopped buying PAO from Mobil Chemical, as it had since 1992.)

The two motor oil giants brought their donnybrook to the Better Business

Bureau's National Advertising Division. And in March 1999, NAD decided that synthetic motor oils could reasonably be made from Group III base stocks, not just PAO and esters. (For details, Google "Castrol Mobil NAD decision on synthetics" to see how it all went down.)

Now the marketing floodgates were open! In short order a number of oil companies introduced their own synthetics and syn-

thetic blends to the marketplace, as Group III base stocks became increasingly available and competitive. Using classic market segmentation strategies — good, better, best — most oil marketers were happy to position two more tiers of engine oils, synthetic and partial synthetic, alongside their conventional product on merchandisers' shelves. SKUs flourished!

Synthetic sales began to

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Table 2: Motor Oil Viscosity Demand at Quick Lubes

(% of PCMO Sales)

| SAE Grade | 2009 | 2013 |
|-----------|------|------|
| 5W-20 | 21% | 28% |
| 5W-30 | 49% | 46% |
| 10W-30 | 19% | 10% |

Source: National Oil & Lube News

grow in volume and OEMs now had the opening to use synthetic formulations for fuel-economy certification. The growth of Group III also made possible the development of lower viscosity engine oils. At the time of the NAD decision SAE 5W-30, 10W-30 and even 10W-40 still dominated the market. With engine oil volatility limits becoming more stringent, the use of more specialized base oils became the norm rather

than the exception.

A look at the NPRA U.S. Lubricating Oil Sales Report (the best data available at the time but now discontinued) confirms how rapidly the shift progressed. Table 1 shows viscosity demand in 1999, the year of NAD's decision, and again just seven years later.

The trend to lighter grades didn't stop after 2006, as seen in Table 2, which shows data from National Oil & Lube News'

annual survey of quick lube operators. Looking at the same three viscosity grades, the NOLN survey shows steady erosion for SAE 10W-30 and 5W-30, and gains for SAE 5W-20.

Finally, Infineum USA also has monitored the spread of SAE 5W-20. Virtually nonexistent in 2000, it's now 23 percent of the PCMO market and will top 40 percent by 2020, the additive maker says. Close behind will be SAE 0W-XX

grades, with another 20 percent of the market by 2020, Infineum predicts.

The critical point is that you cannot make SAE 5W-20 or 0W-XX without using synthetic base stock. And these two grades will be more than 60 percent of the PCMO market before the decade ends.

Foot on the Accelerator

Meanwhile the march of category upgrades goes on. From 1999 to now, we've gone from API SJ to API SN and from GF-1 to GF-5 with GF-6 hovering in the wings ready to make its commercial debut in 2017. In each case, volatility limits got more restrictive and fuel economy more demand-

Continued on page 12

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Continued from page 11

ing. The result is lower and lower viscosity — a natural for synthetics.

To cap it off, drain intervals are going up. The longstanding 3,000-mile/three-month recommendation is dying out in favor of yearly intervals, or whenever a vehicle's oil life system says it's time. That places a heavier burden on the oil to remain fluid and to retain its protective properties.

The market for synthetics has grown since 1999, to say the least, and in recent years NOLN has tracked the difference in sales of synthetic vs. conventional oils. In 2005 synthetics were not even mentioned in NOLN's surveys; by 2008 they represented 10 percent of quick-lube motor oil sales and semi-synthetics an additional 6 percent. NOLN's 2013 report pegged full syn-

thetics at 13 percent of quick-lube volumes, while synthetic blends were 20 percent.

So what are the takeaways from all of this? While synthetics have now established a firm position in the market, Group III base oils are the real volume driver here because they are more cost effective than PAOs (Group IV) or other synthetics (Group V).

The need for improvements in fuel economy and engine durability will continue to push viscosities lower. Witness the recent introduction of the SAE 0W-16 grade. Smaller displacement, higher compression, direct fuel injection, turbocharged designs will put even more stress on the oil.

Couple that with longer drain intervals — or, as an associate of mine who is the former lubricants guru with a major OEM calls it, "reducing customer requirements for maintenance" — and you have a burden on the oil that will push every product towards Group III type base oils with added doses of Group IV and Group V to reach volatility and performance targets.

I would say that synthetics are now an integral part of the business of engine oils, and will be with us for a long, long time — as long as we have the internal combustion engine. ■

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Industry consultant Steve Swedberg has over 40 years experience in lubricants, most notably with Pennzoil and Chevron Oronite. He is a longtime member of the American Chemical Society and SAE International, where he was chairman of Technical Committee 1 on automotive engine oils. He can be reached at steveswedberg@cox.net.