Synthetics: What's in a Name?

By Steve Swedberg

Here I go again, dating myself (as if the mug shot at the end of this column doesn't!):

When I was growing up, "synthetic" had a different connotation than it does now. My early memories were of the end of World War II and involved my mother making synthetic butter (also called Oleo). The method was to take a blob of something white and greasy and mix a dye into it. Then we pressed it into a mold and put it in the icebox. Pretty soon, we had butter. My unsophisticated palate didn't know any better, so I was happy. However, I'm sure my mom and dad had to swallow hard to get it down.

World War II was the genesis of the modern synthetics boom. It was the era that produced the miracle synthetic fiber, nylon. (Actually, it had been introduced prior to the war, but was pretty much devoted to making parachutes, etc.) Since rubber was unobtainable, there were synthetic materials used to compensate. Meanwhile, on the other side, the Germans had developed synthetic crude through the use of the Fischer-Tropsch process and had been able to produce millions of tons of products to fuel and lube their war machine.

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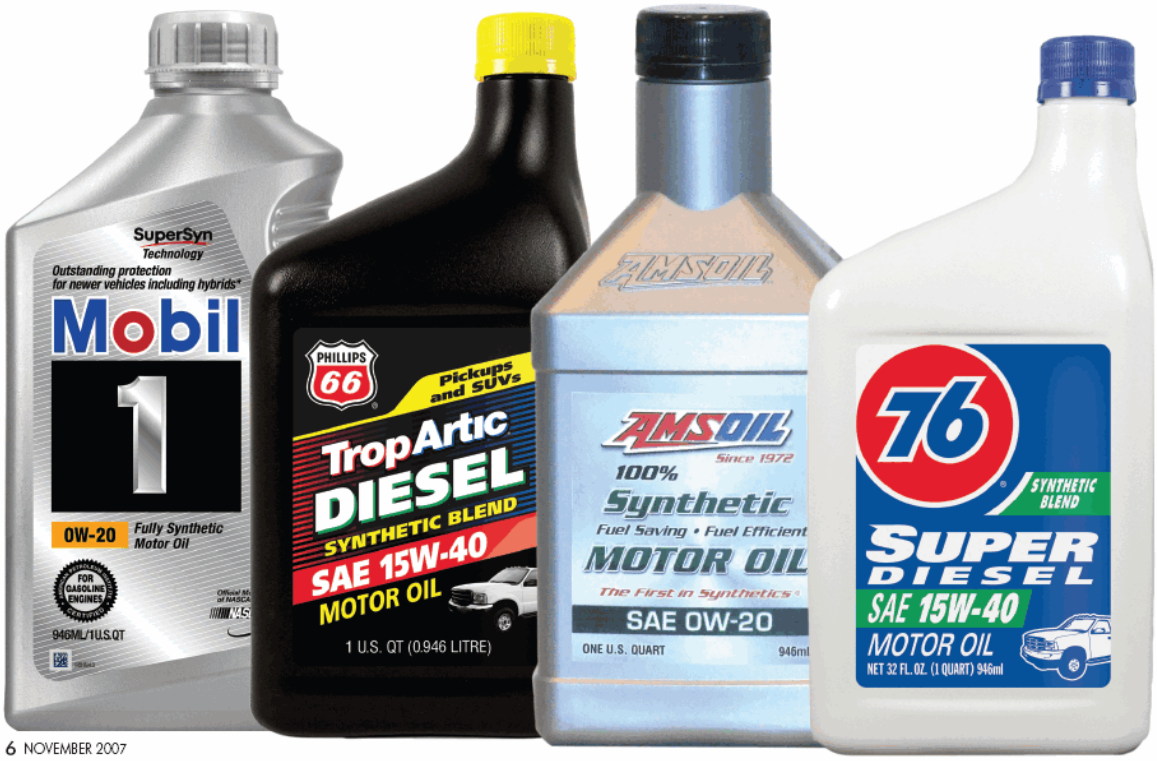

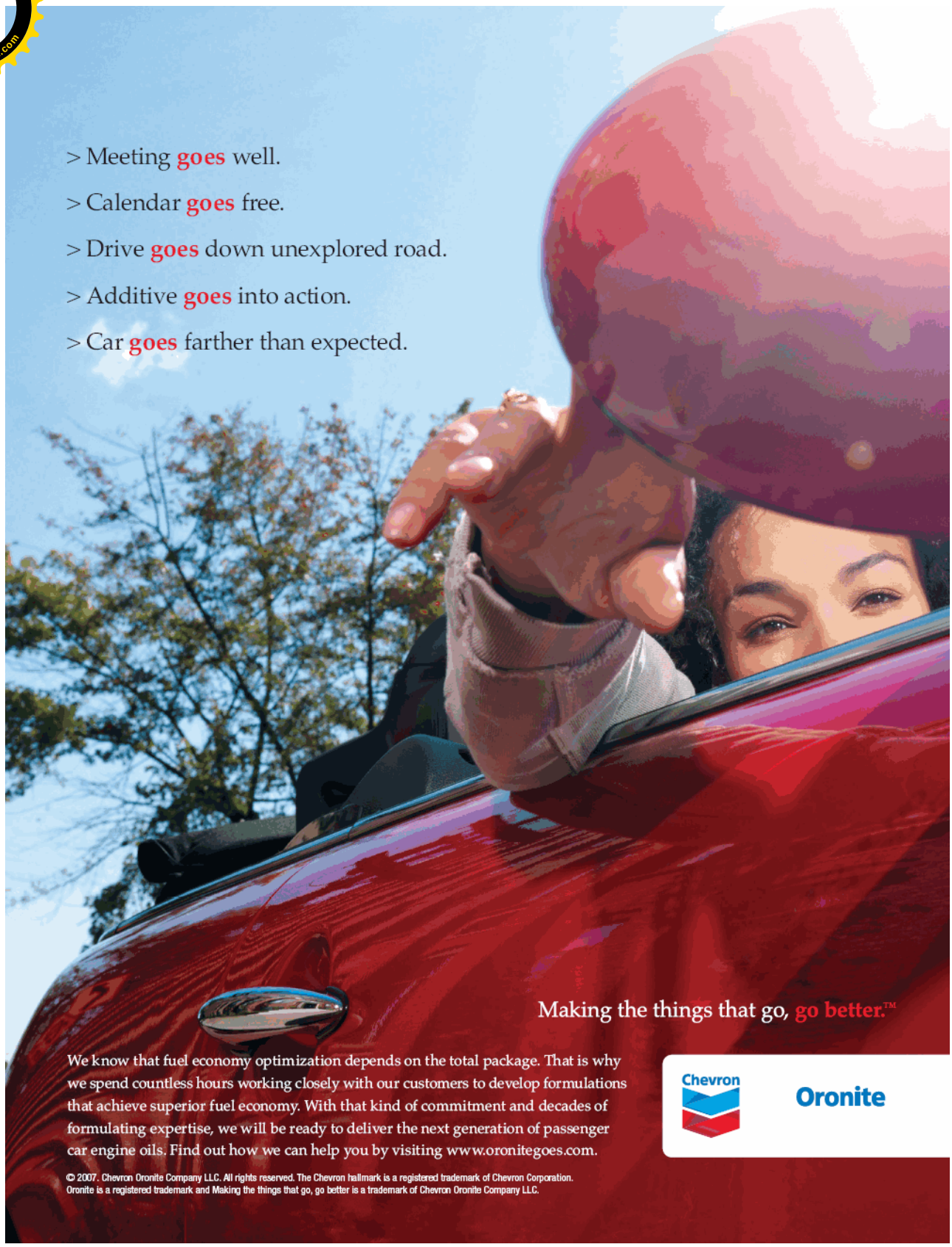

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So, what's a synthetic anyway? To define synthetic, let's go to the dictionary for starters. Of course there are several definitions but the ones that are pertinent to our discussion are "not natural or genuine; artificial or contrived" and "prepared or made artificially." The common denominator in these definitions and many more is the word "artificial."

There are several materials that have found use as synthetic lubricants, such as esters and polyalphaolefins. Some were developed for the war effort while others were the result of the need for products to meet requirements that could not be met by mineral oils. An example would be the introduction of diester based fluids as jet engine lubricants.

Cracking the Door

In the early 1970s, the first engine oils based on synthetics were introduced in the marketplace. The most recognizable of these was Mobil 1. Amsoil was also introduced at this time. While both products, as well as others, performed well, most consumers were reluctant to spend the extra money. Conventional engine oils were selling for about 90 cents a quart, while Mobil 1 was listing for $3.95/quart.

Up until the mid 1980s, the oil industry definition of synthetic was very clear. Anything that did not occur naturally, but was synthesized, was a synthetic. The oil industry was quite happy to operate with this definition. Materials such as PAO and esters were commonly used in synthetic formulations.

Everything changed with the development of cracked wax processes to create very high viscosity index (V.I.), very saturated cuts. Shell and BP were both pushing ahead with these products but were having a difficult time justifying the additional cost versus more conventional products. A strategy which emerged was to call these materials synthetic since they were essentially chemically identical to Fischer-Tropsch products such as those made by the Germans in WWII.

At about the same time, SAE Technical Committee 1 on Engine Oils was in the process of updating a seemingly innocuous information report, SAE J357 — Properties of New and Used Engine Oils. Within that report is a section on base stocks. The then-current document defined synthetics in the same way that the industry had for years. In the update, the synthetic definitions, as proposed, were to be essentially unchanged. Shell and BP objected and started a round of discussions at committee meetings that went on for two years. In the end, the section on synthetics became more generic without giving anyone what they wanted.

The Floodgates Open

Meanwhile, the American Petroleum Institute and the automotive OEMs were looking for some way to define base stocks. This was necessary, to qualify products under the API Engine Oil Licensing and Certification System. If every additive/base stock combination had to be fully tested, the cost to license would be prohibitive to the industry and oil products would not be available. But how to assure that key requirements were met, if a formulator substituted one base oil for another?

Eventually, API and the OEMs agreed on a series of groups defined by certain physical and chemical properties, and established interchange guidelines for engine testing. The groups included the traditional base stocks while recognizing differences in refining processes as well as synthetic types. PAOs — the synthetics most widely used until then in engine oils — received their own grouping (Group IV) while other synthetics wound up in a catch-all known as Group V.

Synthetic engine oils began to expand, with a number of major and minor oil companies marketing synthetic oil based formulations. Chevron, Pennzoil, Quaker State, Shell and others got in on the action. In 1992 Castrol began marketing a formulation which was labeled as synthetic, based on Shell hydrocracked base stocks. In 1999, after a number of charges and counter-charges about what is and is not synthetic, the National Advertising Division of the Council of Better Business Bureaus ruled that hydrocracked base stocks may be called synthetic. Now the floodgates were open.

As the number of synthetic oil brands grew, volumes began to increase. In 2003, there were about 50 million gallons of synthetic based engine oils being sold in the United States for both passenger car and heavy-duty vehicle applications. By 2005 the number had grown to 57 million gallons.

Measuring the Appeal

So, why does anyone want to use synthetic engine oil

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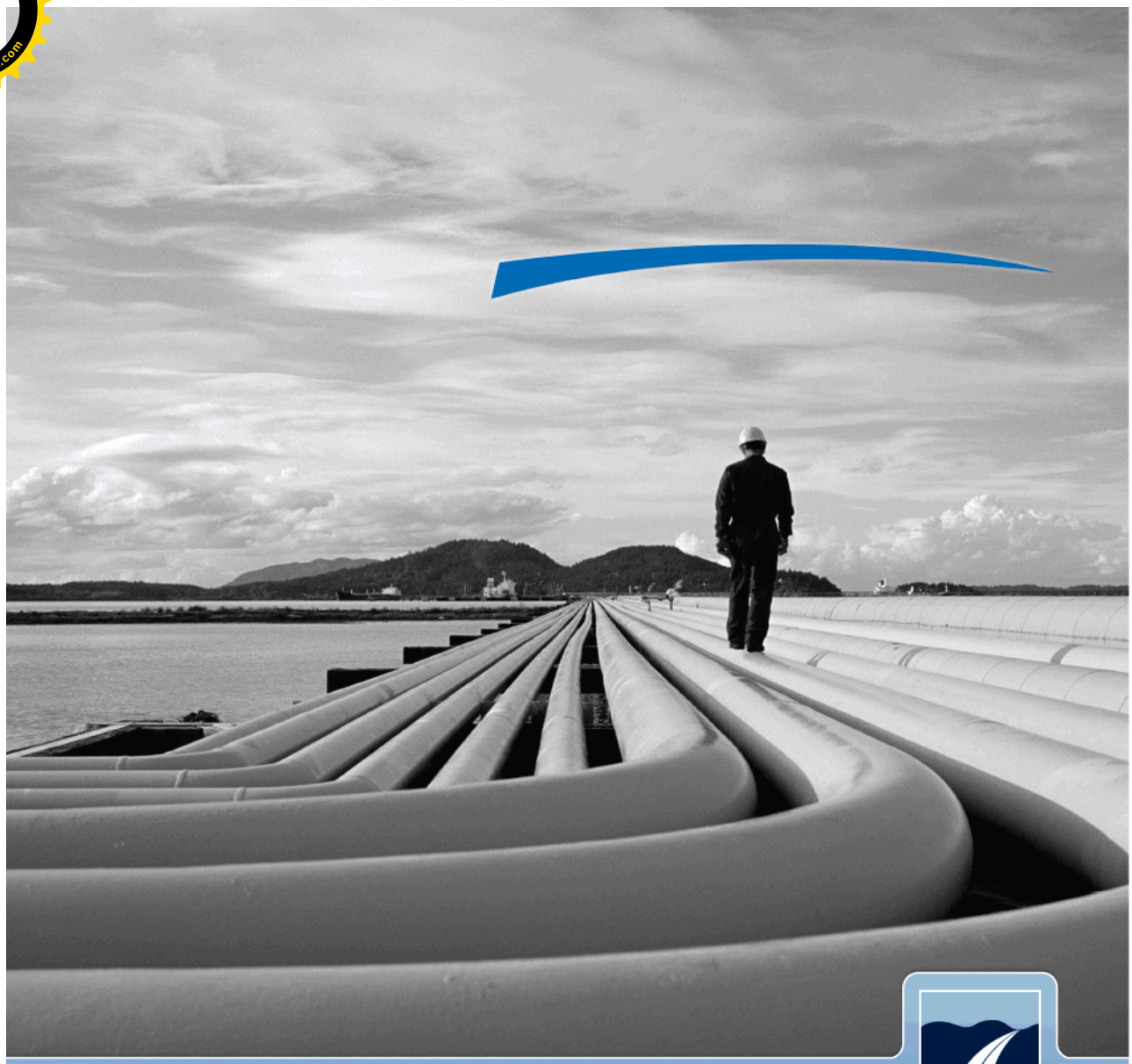

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as opposed to traditional products? There are lots of reasons. Here are just a few:

• There is a segment of buyers in any market category who just have to have the best. Most market researchers think that this number is about 5 percent of the buyers for that category. The ultimate would be the Porsche driver with kid-leather driving gloves, Armani driving togs, and the very best synthetic engine oil.

• There is the owner who wants his vehicle's engine to last forever and believes that synthetic engine oil will protect it better than conventional products. "If it is used in jet engines, it must be better than regular engine oil," this buyer thinks.

• There is the driver who doesn't want to change his oil as frequently as recommended by their owners manual. While 3,000 miles has been the mantra for years, most owners change oil about every 4,500 to 5,000 miles. The automakers have recognized that this is the real world and are trying to increase performance of engine oils to cover this extended drain. Some oil marketers — ExxonMobil's "high endurance" products come to mind — are also beginning to promote products for longer drains without the use of synthetics.

• There is the mechanic who has been educated by some extremely persuasive sales personnel, and believes that synthetics impart some mysterious properties to engine oils. There are a number of automotive writers found in newspapers across America who are convinced that synthetics are superior and recommend their use regularly.

The facts are sometimes at odds with perception. Synthetics do offer superior low-temperature flow characteristics — but mainly due to their lower viscosity and high V.I. Since synthetics are relatively tailored molecules, they don't contain the higher molecular weight components that form waxes at low temperatures. In effect, they cease to flow only because their viscosity gets too high. This property makes the selection of a properly formulated synthetic engine oil for extremely cold climates a wise choice. However, for the majority of engines in service, conventional engine oils will provide satisfactory performance.

Synthetics also offer some advantage in terms of volatility versus conventional base stocks. Because of

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their very narrow range of chemical species, synthetics tend to volatilize at higher temperatures than do conventional materials produced by any of the currently available refining techniques (with the possible exception of the so-called "low volatility" Group II neutrals of similar viscosity).

Synthetic base stocks offer some oxidative and thermal advantage. However, the use of a properly designed additive package will give conventional base stock formulations similar performance. Certainly, in very extreme cases, synthetics might offer an edge but for the large majority of applications, conventional is more than adequate.

Synthetics, particularly PAOs, are not good solvents and need some help — usually the addition of ester materials — in order to solubilize the additive components needed to produce a satisfactory engine oil. Antiwear agents, antioxidants, detergents and dispersants all need some polarity of the base fluid in order for the whole thing to hang together.

Dazzling Claims

One of the claims for synthetics that I find rather amazing is that, without any clarification, "synthetics will add from one-half to 1 mile per gallon to fuel economy." That may be true if one were to compare an SAE 10W-40 for instance with a synthetic SAE 5W-30. You'd probably get the same improvement even if the SAE 5W-30 were made from conventional base stocks. Let's face it: Fuel economy is driven more by viscosity and frictional characteristics than by base stock chemistry. Admittedly, esters used in synthetics for solubility purposes may provide some frictional advantages. The feature that works here is "frictional characteristics" though, not "synthetic."

For heavy-duty diesels, the major synthetic engine oils are mostly SAE 15W-40. Here too, the lower viscosity probably is responsible for any fuel economy benefit, since experience has shown that fuel economy is better with the use of SAE 15W-40 compared to SAE 30. However, there is no standard test for the degree to which oils affect fuel economy in heavy-duty engines, so claims are easier to make since the oil marketer gets to set the test parameters.

Another claim that is made without support is that synthetics are preferred for severe-duty operations, such as passenger car diesel engines. Again,

the claim cannot be supported merely by the fact that synthetic base stock is being used. For diesel engines, the additive package makes a major difference in performance. Many synthetic products have first-rate additive packages so their performance will be acceptable, but again, it's not the synthetic base stock, it's the whole product.

There have been a number of occasions where claims of superiority have been made using extended-length engine tests or by highlighting specific test parameters which are well within test limits. Claims such as "double-length sequence test results" or "test values of only 10 percent of maximum" while appealing, are not really meaningful. Engine test sequences are pretty crude tools and results can vary greatly, even with the same oil in multiple tests. Field test data has some merit but the results are subject to a lot of variability. Very large field test fleets must be used to gain statistical validity, and test length can be quite long, years even. Duty cycle has a significant impact on field test results so fleet tests must be designed very carefully.

So here's what I think. A well-formulated and tested conventional engine oil will provide excellent protection for any engine. Maintenance practices and duty cycle are a major influence on engine life and oil selection. Engine oil serves as an integral part of the whole and should be selected with care. Blindly accepting that synthetic oils will provide additional protection is not good business. Synthetics might well be of use in some applications but that, too, must be evaluated along with price, availability and performance. ▮

Clarification: In September's issue, the table on page 8 used the same volume units (000 gallons) as the bar graph on that page.

Steve Swedberg has over 40 years experience in the lubricants industry, most notably with Pennzoil and Chevron Oronite, including in products research, development, marketing and technical service. 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@qwest.net