A quick primer on engine oil

Engine oils are made up of basestocks, performance additives (detergent/inhibitor or D/I), low-temperature wax inhibitors (pour point depressants or PPD), friction modifiers (FM) and viscosity index improvers (viscosity modifiers or VM)
Basestocks - Traditional

- Mineral oils are derived from crude oil
- True synthetics are derived from chemical reactions
- About 1% of crude oil becomes lubricating oils – and the total volume is shrinking slowly
How Much Lubricant in a Barrel of Crude Oil?

Thanks to "processing gains" at today's refineries, a 42-gallon barrel of crude oil can make an average of 44.2 gallons of products. But very little of it is lubricants.

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Source: American Petroleum Institute
Basestocks are changing

- Separation process – select desirable components
- Conversion process – convert undesirable species into useful lube oil components
- Group I separation, II conversion, III severe conversion, IV true synthetic
- The FTC has ruled that oils made with Group III basestocks can be labeled synthetic
Detergent/Inhibiter

- Dispersants control sludge and varnish
- Detergents control carbon deposits and varnish on pistons and rust
- Antioxidants control viscosity increase
- Anti-wear/anti-scuff additives control wear
ZDP

- Zinc dialkyldithiophosphate
- Very low-cost and effective anti-wear/anti-scuff additive
- Also a good antioxidant
- Also controls copper/lead bearing bearing corrosion
- But, phosphorus in ZDP poisons catalysts
- How much anti-wear is really needed?
Other additives and VM

- Pour Point Depressants modify the growth of wax crystals
- Friction Modifiers come in two forms
  - Metallic… Molybdenum
  - Organic… Sunflower oil
- Viscosity Modifiers are long chain polymers that shrink when cold and expand when hot
Engine Oil Formulation

• The trick is to balance the components because most of the additives, while they help in one area, hurt in another

• All API licensed engine oils must pass “Sequence” tests developed by the auto industry
Sequence VG Test
Low Temperature Sludge and Deposit Test

ILSAC GF-3 / API SL –
Oil pickup screen
from a passing VG test

API SA completed only 168 of
216 hour test. Oil pickup screen
from a failing VG test
Market Share

• Sales are about evenly split between Do It Yourself and Do It For Me
• The big players are:
  - Pennzoil / Quaker State/ Shell
  - Castrol / BP
  - Valvoline
  - Texaco /Chevron
  - Mobil / Exxon
The really big news in engine oil is not “High Mileage” oils

High Mileage oils, SUV oils, etc. are all marketing gimmicks
High Mileage Oils

• Almost always contain a seal swelling agent
• Contain modified formulations that help support their marketing claims (legal action)
• Most of these oils do not carry the Starburst
• GM Powertrain does not see any need for recommending such oils
Now, on to the real news!
There’s a new motor oil in town!

Jointly developed by auto and oil industry experts, it represents a significant performance upgrade from previous oils. Oils satisfying the stringent new standard will begin to appear in the marketplace in the summer of 2004.

So, what’s so great about the new standard?
Well, compared to the oils being replaced, oils meeting the new standard will provide:

- Improved oxidation resistance (less oil thickening)
- Improved deposit protection (your engine won’t form those harmful deposits as fast)
- Better wear protection
- Better low-temperature performance over the life of the oil

And besides all of this, these new oils are designed to help protect our environment by extending the life of your emissions system and conserving energy.

How will you know if your oil meets the new performance standard?
It’s easy. Just make sure the oil you buy for your gasoline-powered vehicle is labeled with the Starburst Certification Mark.

![Starburst Certification Mark]

Most automobile manufacturers (see below) recommend only Starburst oils for both their current and older vehicles. Failure to use the recommended oil can result in vehicle damage not covered by your warranty. Please see your owner’s manual for details.

So, look for oils identified by the Starburst Certification Mark when recommended for your vehicle.
Benefits of ILSAC GF-4

Compared to ILSAC GF-3:

- Improved oxidation resistance (~100%)
- Improved high temp deposit control (~20%)
- Better cam & lifter wear discrimination
- Improved low temperature wear protection
- Improved low temp used oil pumpability (none previous)
- Reduced P (20%) to reduce catalyst poisoning
- S capped to reduce catalyst poisoning
- Improved fuel efficiency and retention (0.2-0.3%)
What actually changed in the oil?

• Increased ashless antioxidants
• Reduction in ZDP
• Increased use of more highly refined Group II+ and III base stocks
• Increased use of friction modifiers
• Pour point depressant tailored to used oil performance
• Rebalance of detergents, dispersants, and viscosity modifiers
Why do the standards change?

• Deficiencies in current standard identified – e.g., low temperature pumpability
• The engines used for testing go out of production – e.g., 3800
• New needs identified – e.g., sulfur limit
• The priorities change - engine protection, emission system compatibility, and fuel economy
• Take advantage of advances in additive and base oil technology
Short History of Modern Engine Oils

• There have been 12 upgrades of engine oil specifications since API MS was introduced in 1953
• These upgrades were made possible by improvements in additive technology and also base oil refining
• Today's oils are far from the oil your grandfather used
• The next upgrade is scheduled for MY 2009
• By then many of the old solvent refined lube plants will be closed and huge gas-to-liquid plants will be under construction in the near-east that will produce “synthetic” base stocks at low cost
Will this new oil allow longer drains?

• If the engines stay the same, the answer is yes
• However, the engines are not staying the same
• For example, the new engines with piston squirters degrade the oil faster
• The Oil Life System constants will be adjusted after we have more experience with the new GF-4 oils
Is there also a new GF-4 Mobil 1?

- Yes, and the old 15,000 Mile GF-3 version
- ExxonMobil has always positioned Mobil 1 above conventional motor oils in performance
- This is getting more difficult as the performance of conventional engine oils increases
- In our estimation, the performance advantage for “synthetic” oils over conventional oils has shrunk from 100% to something under 50%
Are European oils better?
(They cost up to $20/liter, so they must be better?)

• Most of the cost is due to multiple approvals - MB, VW, BMW, Opel, etc.
• Large variation in European oil quality
• Different engine tests that include light-duty diesel tests
• In general – they are higher in detergency and lower in fuel economy

North American oils are amazingly good at a very low price!
GM 6094M Approved Oils

- As of April 12, 2005:
  47 different oils
  All ILSAC viscosity grades represented
  4 of the top 5 oil marketers represented with the 5th pending approval.

- Updated list maintained at:
  www.gmtechlink.com
  Under: “Reference Guides”

### GM6094M Registered Products

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Viscosity Grades</th>
<th>ILSAC Grade</th>
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<tbody>
<tr>
<td>75 High Performance Full Synthetic</td>
<td>5W-30, 5W-30</td>
<td>GF-4</td>
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<tr>
<td>75 Super Synthetic Blend</td>
<td>5W-30, 5W-30</td>
<td>GF-4</td>
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<td>AC Delco</td>
<td>5W-30, 5W-30, 10W-30</td>
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<td>Agip Super</td>
<td>5W-30, 10W-30</td>
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<td>Agip Super ISO</td>
<td>5W-30</td>
<td>GF-4</td>
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<td>Castrol GTX</td>
<td>5W-20, 10W-30</td>
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<td>Castrol Syntec</td>
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<td>Castrol Syntec Blend</td>
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<td>Chevron Supreme Synthetic</td>
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<td>Conoco Super All Season Synthetic Blend</td>
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<td>Conoco Syntol High Performance Synthetic</td>
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<td>Esso Extra</td>
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<td>GF-4</td>
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<tr>
<td>Esso Uniflo</td>
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<td>GF-4</td>
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<td>Exxon Synthoil</td>
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<td>Formula Shell</td>
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<td>Formula Shell Synthetic Blend</td>
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<td>GM Goodwrench</td>
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<td>GM Goodwrench High Mileage</td>
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<td>GF-4</td>
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<td>GM Goodwrench Synthetic Blend</td>
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<td>Kendall GT-1 Full Synthetic</td>
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<td>Kendall GT-1 High Performance Synthetic Blend</td>
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<td>Mobil 1</td>
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<td>Mobil Clean 5000</td>
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<td>Northland MM Select</td>
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<td>Pennzoil Motor Oil</td>
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<td>Pennzoil Platinum Full Synthetic</td>
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<td>GF-4</td>
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<td>Pennzoil SAE 5W, Tack and Mineral</td>
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<td>Phillips Proline</td>
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<td>Petro-Canada Arctic Synthetic</td>
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<td>Petro-Canada Maximum</td>
<td>5W-20, 10W-30</td>
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<td>Petro-Canada Supreme</td>
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<td>Phillips 6T Tropic Full Synthetic</td>
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<tr>
<td>Phillips 6T Tropic Synthetic</td>
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<td>GF-4</td>
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<tr>
<td>Quaker State 4W &amp; SAE Synthetic Blend</td>
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<td>Quaker State Advanced Engine Full Synthetic</td>
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<td>Quaker State High/RPM Synthetic Blend</td>
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<td>Quaker State Peak Performance Motor Oil</td>
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<td>Texaco Havoline</td>
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<td>Texaco Havoline Synthetic</td>
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<td>Walmart SuperTech</td>
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<td>XHP2</td>
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<tr>
<td>XHP2 Synthetic</td>
<td>5W-20, 5W-30</td>
<td>GF-4</td>
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</table>
What is GM 4718M?

- Some GM Owner’s Manuals recommend “Starburst” oils that meet GM 4718M
- GM 4718M is General Motors’ high performance engine oil specification.
- Only a handful of oils are capable of meeting GM 4718M
GM 4718M Approved Oils

• As of February 4, 2005:
  3 different oils
  5W-30, 0W-30 and 10W-30 viscosity
  grades represented.

• Updated list maintained at:
  www.gmtechlink.com
  Under: “Reference Guides”
### TABLE 1—SAE VISCOSITY GRADES FOR ENGINE OILS

<table>
<thead>
<tr>
<th>SAE Viscosity Grade</th>
<th>Low-Temperature (°C) Cranking Viscosity, cP Max</th>
<th>Low-Temperature (°C) Pumping Viscosity, cP Max with No Yield Stress</th>
<th>Low-Shear-Rate Kinematic Viscosity, cSt at 100 °C Min</th>
<th>Low-Shear-Rate Kinematic Viscosity, cSt at 100 °C Max</th>
<th>High-Shear-Rate Kinematic Viscosity, cP at 150 °C Min</th>
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<tbody>
<tr>
<td>0W</td>
<td>6200 at -35</td>
<td>30 60 000 at -40</td>
<td>3.8</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>5W</td>
<td>6600 at -30</td>
<td>40 60 000 at -35</td>
<td>3.8</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>10W</td>
<td>7000 at -25</td>
<td>50 60 000 at -30</td>
<td>4.1</td>
<td>—</td>
<td>—</td>
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<tr>
<td>15W</td>
<td>7000 at -20</td>
<td>60 000 at -25</td>
<td>5.6</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>20W</td>
<td>9500 at -15</td>
<td>60 000 at -20</td>
<td>5.6</td>
<td>—</td>
<td>—</td>
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<tr>
<td>25W</td>
<td>13 000 at -10</td>
<td>60 000 at -15</td>
<td>9.3</td>
<td>&lt;9.3</td>
<td>2.6</td>
</tr>
<tr>
<td>20</td>
<td>—</td>
<td>—</td>
<td>5.6</td>
<td>&lt;12.5</td>
<td>2.9</td>
</tr>
<tr>
<td>30</td>
<td>—</td>
<td>—</td>
<td>9.3</td>
<td>&lt;12.5</td>
<td>2.9</td>
</tr>
<tr>
<td>40</td>
<td>—</td>
<td>—</td>
<td>12.5</td>
<td>&lt;16.3</td>
<td>2.9 (0W-40, 5W-40, and 10W-40 grades)</td>
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<tr>
<td>40</td>
<td>—</td>
<td>—</td>
<td>12.5</td>
<td>&lt;16.3</td>
<td>3.7 (15W-40, 20W-40, 25W-40, 40 grades)</td>
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<tr>
<td>50</td>
<td>—</td>
<td>—</td>
<td>16.3</td>
<td>&lt;21.9</td>
<td>3.7</td>
</tr>
<tr>
<td>60</td>
<td>—</td>
<td>—</td>
<td>21.9</td>
<td>&lt;26.1</td>
<td>3.7</td>
</tr>
</tbody>
</table>

**SAE J300**
What about the new SAE 5W-20 oils?

- Ford, Honda, and others are recommending SAE 5W-20 oils
- SAE 5W-20 oils offer about a 0.5% fuel economy advantage over SAE 5W-30 oils – about the same as SAE 5W-30 compared to 10W-30
- However, where the difference between SAE 10W-30 and 5W-30 is primarily in cost and not performance, 5W-20 really has lower viscosity
- Our engines are designed for SAE 5W-30
- Expect oil lights at hot idle conditions with 5W-20
Summary

• ILSAC GF-4 is the latest performance upgrade
• ILSAC GF-4 is better than ILSAC GF-3
  – Better overall engine protection
  – Longer oil life
  – Increased fuel efficiency
  – Increased emissions system protection
  – Equivalent or lower oil consumption
• GF-4 oils are fully backward compatible to applications in which GF-3 or earlier category oils were used
• GM continues to recommend SAE 5W-30 oils
What’s new in diesel engine oils?
API CI-4 PLUS

• New API CI-4 category introduced in 2002 for low emission heavy-duty engines
• These new engines produced a type of soot that increases the oil viscosity more than before
• The CI-4 category was changed on the fly to include a new, more demanding soot-viscosity test developed by Mack
• In creating CI-4 PLUS, API, EMA, and ASTM broke all the rules
What’s next for diesel engine oils?

• 2007 diesels will require particulate traps
• Traps can be contaminated with ash derived from combusted oil additives
• The trick with the next diesel category will be to reduce ash while maintaining the long drain intervals the truckers have become accustomed to
Modern History of Engine Oils
MS (Most Severe) Era

• 1953 API classifies detergent oils as MS replacing Heavy Duty
• 1958 In response to significant field problems, GM releases sequence tests to oil industry for identifying oils as MS, GM 4745-M specification released in July
• Chrysler develops Seq. IV, and Ford Seq. V
• 1962 MS based on Sequence I, II, III, IV, and V
• 1965 MS based on Sequence IIA, IIIA, IV, and V
• 1967 MS based on Sequence IIA, IIIA, IV, and VB
• 1968 MS based on Sequence IIB, IIIB, IV, and VB
Modern History of Engine Oils
API Service Category Era

• 1970 API establishes S performance classification system
  - SA describes non-detergent oil
  - SB describes non-detergent oils that contain ZDP
  - SC describes 1964 MS oils
  - SD describes 1968 MS oils

• 1972 API SE
• 1980 API SF
• 1989 API SG
  All have been declared obsolete by SAE
Modern History of Engine Oils
ILSAC Era

- 1987 Automakers establish International Lubricant Standardization and Approval committee
- “Starburst” symbol is evergreen, just as MS was
- 1993 “Starburst”, ILSAC GF-1 (API SH)
- 1997 “Starburst”, ILSAC GF-2 (API SJ)
- 2002 “Starburst”, ILSAC GF-3 (API SL)
- 2005 “Starburst”, ILSAC GF-4 (API SM)

ILSAC GF-1 and GF-2 are obsolete, GF-3 will be soon
API SH can only be licensed if preceded by a C category