A quick primer on engine oil

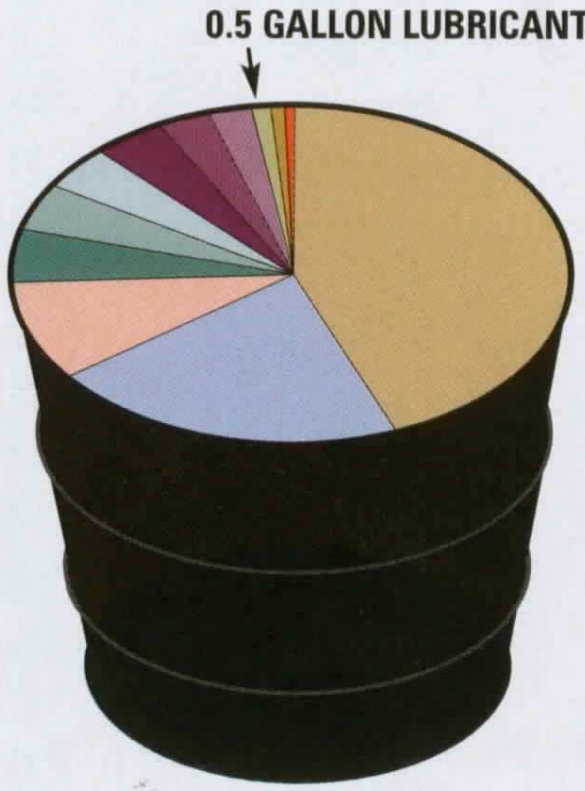
Engine oils are made up of basestocks, performance additives (detergent/inhibiter or D/I), low-temperature wax inhibitors (pour point depressants or PPD), friction modifiers (FM) and viscosity index improvers (viscosity modifiers or VM)

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?

19.5 gallons	gasoline
9.2 gallons	diesel/home heating oil
4.1 gallons	kerosene-type jet fuel
2.3 gallons	heavy, residual fuel oils
1.9 gallons	liquefied refinery gases
1.9 gallons	still gas
1.8 gallons	coke
1.3 gallons	asphalt and road oil
1.2 gallons	petrochemical feedstocks
0.5 GALLON	**LUBRICANTS**
0.2 gallon	kerosene
0.3 gallon	other



42-gallon barrel of crude

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.

—*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 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.

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

Revision Date: 12-Apr-2005

Current ILSAC GF-4 Products

Product Name	Viscosity Grades	ILSAC Grade
76 High Performance Full Synthetic	5W-30, 10W-30	GF-4
76 Super Synthetic Blend	5W-30, 10W-30	GF-4
AC Delco	5W-20, 5W-30, 10W-30	GF-4
Agip Super	5W-30, 10W-30	GF-4
Agip Super PC	5W-20	GF-4
Castrol GTX	5W-30, 10W-30	GF-4
Castrol Syntec	5W-30, 10W-30	GF-4
Castrol Syntec Blend	5W-30, 10W-30	GF-4
Chevron Supreme	5W-30, 10W-30	GF-4
Chevron Supreme Synthetic	5W-30, 10W-30	GF-4
Conoco Super All Season Synthetic Blend	5W-30, 10W-30	GF-4
Conoco Syncon High Performance Synthetic	5W-30, 10W-30	GF-4
Esso Extra	5W-20, 5W-30, 10W-30	GF-4
Esso Uniflo	5W-30, 10W-30	GF-4
Exxon Superflo	5W-20, 5W-30, 10W-30	GF-4
Formula Shell	5W-30, 10W-30	GF-4
Formula Shell Synthetic Blend	5W-30, 10W-30	GF-4
GM Goodwrench	5W-20, 5W-30, 10W-30	GF-4
GM Goodwrench High Mileage	5W-30, 10W-30	GF-4
GM Goodwrench Synthetic Blend	5W-30, 10W-30	GF-4
Kendall GT-1 Full Synthetic	5W-30, 10W-30	GF-4
Kendall GT-1 High Performance Synthetic Blend	5W-30, 10W-30	GF-4
Mobil 1	0W-30, 5W-30, 10W-30	GF-4
Mobil Clean 5000	5W-20, 5W-30, 10W-30	GF-4
Mobil Clean 7500	5W-20, 5W-30, 10W-30	GF-4
Mobil Clean High Mileage	5W-30, 10W-30	GF-4
Mobil DriveClean	5W-20, 5W-30, 10W-30	GF-4
Northland MW Select	5W-30	GF-4
Pennzoil Motor Oil	5W-30, 10W-30	GF-4
Pennzoil Platinum Full Synthetic	5W-30, 10W-30	GF-4
Pennzoil SUV, Truck and Minivan	5W-30, 10W-30	GF-4
PepBoys Proline	5W-30, 10W-30	GF-4
Petro-Canada Arctic Synthetic	0W-30	GF-4
Petro-Canada Maximum	5W-30, 10W-30	GF-4
Petro-Canada Supreme	5W-20, 5W-30, 10W-30	GF-4
Petro-Canada Synthetic	5W-30, 10W-30	GF-4
Phillips 66 TropArtic Full Synthetic	5W-30, 10W-30	GF-4
Phillips 66 TropArtic Synthetic Blend	5W-30, 10W-30	GF-4
Quaker State 4x4 & SUV Synthetic Blend	5W-30, 10W-30	GF-4
Quaker State Advanced Engine Full Synthetic	5W-30, 10W-30	GF-4
Quaker State High-RPM Synthetic Blend	5W-30, 10W-30	GF-4
Quaker State Peak Performance Motor Oil	5W-30, 10W-30	GF-4
Texaco Havoline	5W-30, 10W-30	GF-4
Texaco Havoline Synthetic	5W-30, 10W-30	GF-4
Walmart Supertech	5W-30, 10W-30	GF-4
XR4	5W-30, 10W-30	GF-4
XR4 Synthetic	0W-30, 5W-30	GF-4

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 GM4718M

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”

GM4718M Registered Products

Revision Date: 4-Feb-2005

Current ILSAC GF-4 Products

Product Name	Viscosity Grades	ILSAC Grade
Chevron Supreme Synthetic	5W-30, 10W-30	GF-4
Mobil 1	0W-30, 5W-30, 10W-30	GF-4
Texaco Havoline Synthetic	5W-30, 10W-30	GF-4

SAE J300

TABLE 1—SAE VISCOSITY GRADES FOR ENGINE OILS

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

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-1and GF-2 are obsolete, GF-3 will be soon

  API SH can only be licensed if preceded by a C category