

BASE OIL CHEMISTRY FOR DIESEL ENGINE LUBRICANTS

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EQUILON ENTERPRISES
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API BASE OIL GRADES

- **GROUP I BASE STOCK**
 - CONTAINS <90% SATURATES
 - CONTAINS >0.03% SULFUR
 - HAS A VISCOSITY INDEX >80 AND <120
- **GROUP II BASE STOCK**
 - CONTAINS > 90% SATURATES
 - CONTAINS <0.03% SULFUR
 - HAS A VISCOSITY INDEX >80 AND <120
- **GROUP III BASE STOCK**
 - CONTAINS >90% SATURATES AND <0.03% SULFUR
 - HAS A VISCOSITY INDEX >120



LUBRICANT BASE OILS

- BASE OILS MAKE UP APPROX. 80 TO 86% OF FINISHED DIESEL LUBRICANT
- MINERAL BASE OILS - PROCESSED PETROLEUM FRACTIONS, GENERALLY IN THE C20 TO C40 CARBON NUMBER RANGE
- TYPICAL 10W-40 BASE OIL WILL HAVE AN AVERAGE CARBON NUMBER OF ~31-32
- SYNTHETIC BASE OILS - POLYALPHAOLEFINS - MADE BY POLYMERIZATION OF DECENE UNITS



POSSIBLE ALKANE ISOMERS

CARBON NUMBER	NO. OF ISOMERS
C10	75
C20	366,319
C30	4,111,846,763
C40	62,491,178,805,831



BASE OIL COMPOSITION

- TASK MADE DIFFICULT BY LARGE NUMBER OF POSSIBLE ISOMERS
- AT THE LEAST, ONE IS REDUCED TO THE ANALYSIS OF COMPOUNDS BY CLASS, E.G.
 - % SATURATES, % AROMATICS, % POLARS
- AT THE BEST, ONE CAN ANALYZE BY COMPOUND TYPE
 - % PARAFFINS, % MONOCYCLOPARAFFINS, % DICYCLOPARAFFINS, % TRI.....
 - % MONOAROMATICS, % DIAROMATICS, % TRI.....
- CAN DO ELEMENTAL ANALYSIS, E.G., S AND N



BASE OIL COMPOSITION

- API BASE OIL CATEGORIES ARE DEFINED USING ASTM D2007 - NOT RELIABLE METHOD
- TYPICAL BASE OIL ANALYSIS WOULD INVOLVE SEPARATION OF COMPOUND CLASSES BY D2549 OR RELATED METHOD TO GIVE SATURATES, AROMATICS, AND POLAR FRACTIONS
- FRACTIONS ANALYZED BY SOME TYPE OF MASS SPECTROMETRY METHOD TO GIVE % OF VARIOUS COMPOUND TYPES, e.g., % paraffins, % mononaphthenes, % dinaphthenes, ...



COMPOSITIONAL PROPERTIES FOR FUEL ECONOMY

PROPERTIES NEEDED FOR BETTER FUEL ECONOMY (LOWER PVC)

- REDUCED POLYAROMATICS
- REDUCED POLYNAPHTHENES
- LONG ALKYL CHAINS



BASE OIL IMPACTS ON DIESEL PARTICULATES

- COMPOSITIONAL FACTORS NOT KNOWN AT THIS POINT
- KNOWN LUBRICANT FACTORS THAT IMPACT PARTICULATES
 - VISCOSITY
 - DEPOSIT FORMING TENDENCIES
- MORE STUDIES NEEDED



COMPOSITION IMPACTS IN OTHER TESTS

- MACK T-8 / T-8E - BEST PERFORMANCE WITH HIGH SATURATES BASE OILS AND BOOSTED ASHLESS DISPERSANTS PACKAGES WITH MODERATE DETERGENT LEVELS
- CAT 1K, 1N, AND 1P - BEST PERFORMANCE WITH HIGH DETERGENCY, HIGH AROMATICS, AND MODERTE SULFATED ASH

R. A. Cherillo and A. Huang, "The Increasing Significance of Base Oils in the Evolution of Heavy-Duty Diesel Engine Oils", NPRA Paper, 1999



AROMATICS DO CONTRIBUTE TO SOLVENCY

	GROUP I	GROUP II
% POLARS AT 10K MILES	26.1	18.7
% POLARS IN CLEAR TOP	12.6	6.4
DIFFERENCE	13.5	12.3



COMPOSITIONAL FACTORS AFFECTING OXIDATION

- HETEROAROMATIC COMPOUNDS - N AND S
- POLYAROMATICS
- POLYNAPTHENES
- MONOAROMATICS
- MONONAPTHENES
- PARAFFINS

DECREASING
POTENTIAL FOR
OXIDATION



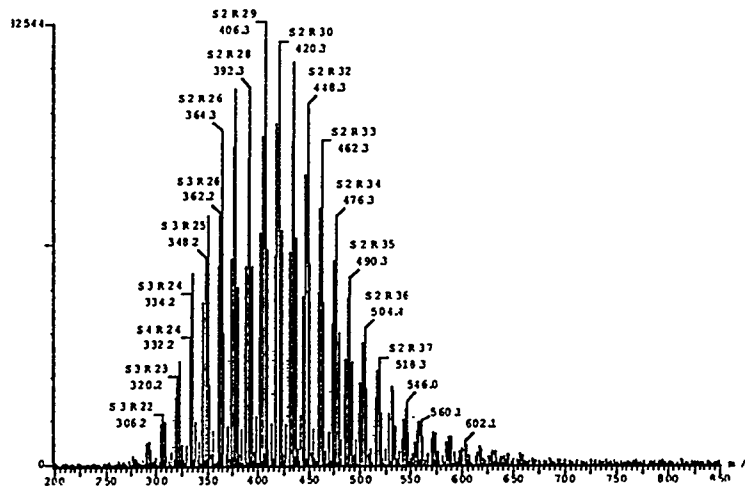
OXIDATION IN SEQUENCE IIIE (FIXED ADDITIVE PACKAGE)

GROUP I > GROUP II > GROUP III \geq GROUP IV

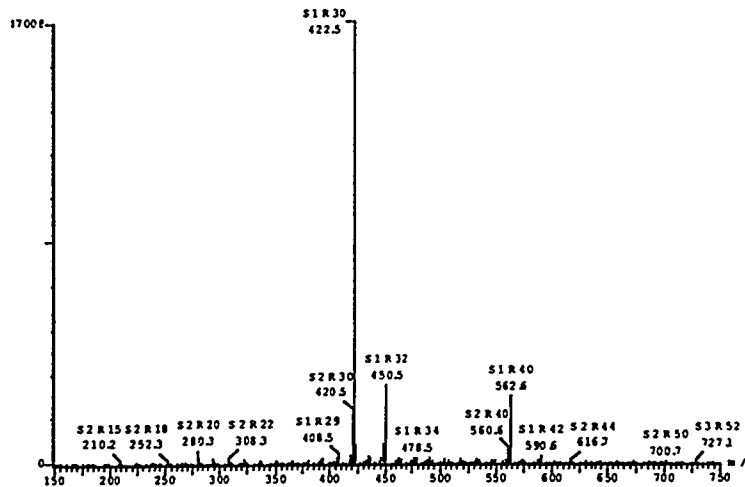
NOTE: THIS IS A GENERALIZATION. DEPENDING ON COMPOSITION, SOME GROUP II'S MIGHT OUT PERFORM SOME GROUP III'S. SOME GROUP III'S CAN PERFORM AS WELL AS GROUP IV'S.



FI-MS OF SATURATE FRACTION OF 10W-40 BASE OIL BLEND



FI-MS OF PAO



COMPOSITION OF SOME TYPICAL BASE OILS

	GROUP I	GROUP II	GROUP III
% PARAFFINS	15.52	21.39	41.63
% MONONAP	26.28	35.59	38.11
% POLYNAP	36.2	39.4	20.12
% MONOARO	14.79	1.39	na
% POLYAROM	3.86	1.4	na
% THIO	1.4	0.21	na



IMPACT OF COMPOSITION ON PROPERTIES

- PERFORMANCE PROPERTIES OF DIESEL LUBRICANT DEPEND ON BOTH BASE OIL AND ADDITIVE CHEMISTRY
- HOLDING THE ADDITIVE PACKAGE CONSTANT, ONE CAN MAKE CERTAIN GENERALIZATIONS ABOUT BASE OIL CHEMISTRY FOR
 - OXIDATION
 - FUEL ECONOMY
 - SOLVENCY

