

IRTEENZ
Technology 2000

PETER REES
THE GREENHOUSE CHALLENGE

Mobil Synthetic Lubricants
meeting the Greenhouse Challenge

Mobil — Delvac V

Presentation Overview

- Environmental Trends
- Heavy-Duty Diesel Engine Trends
- Synthetic Technology
- Fuel Economy benefits
- Reduced Waste Oil
- Reduced Oil Consumption
- **Reduced emissions**

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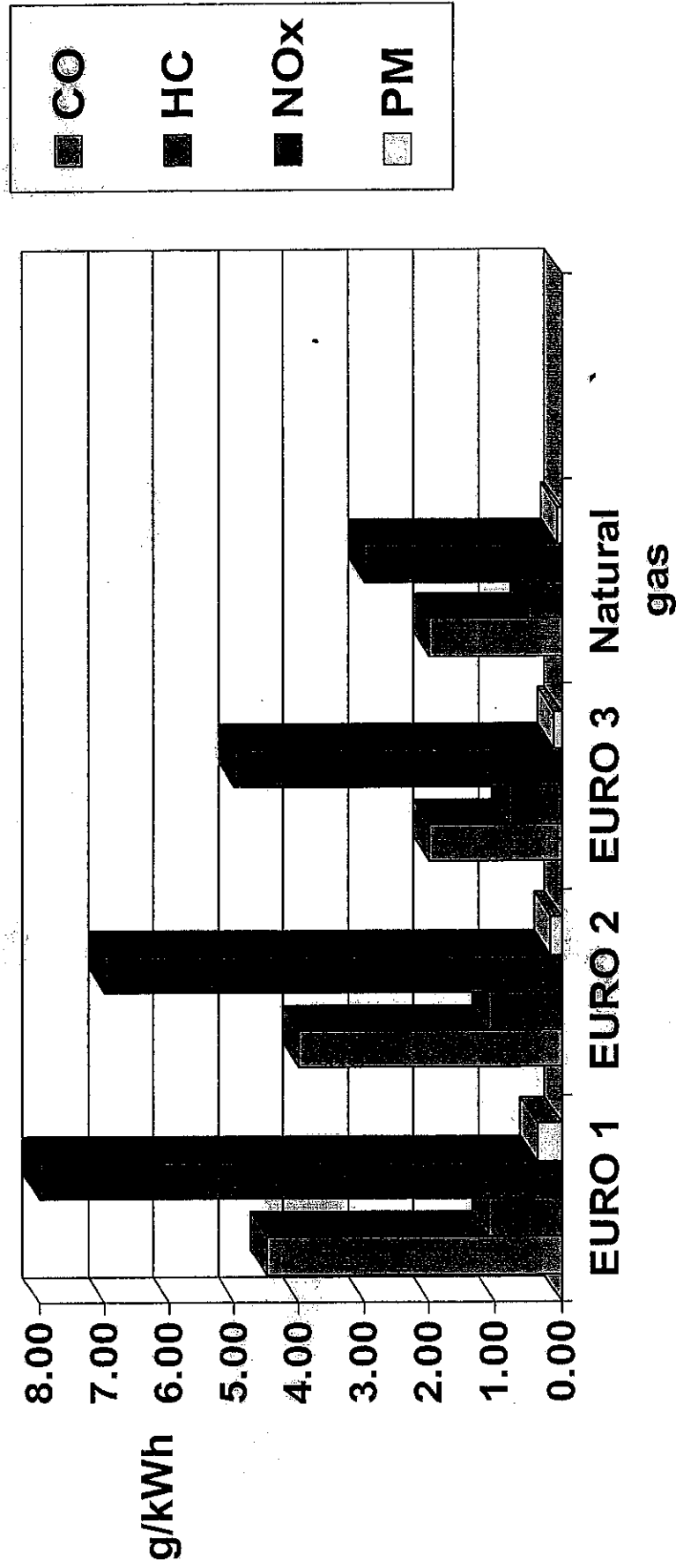
Environmental trends

- Euro I, II and III
- Restricted use of environmentally unfriendly products
- Energy economy

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Environmental trends

Emissions, heavy duty diesels

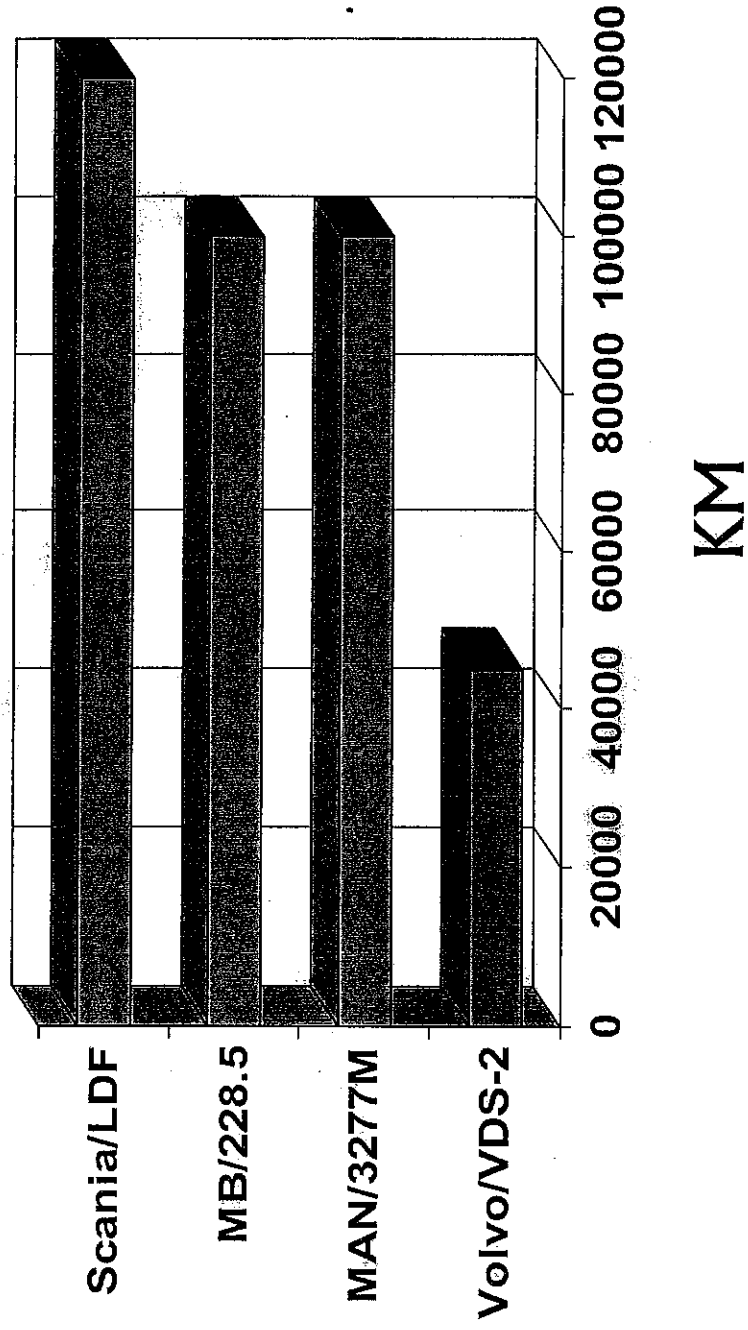


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Environmental trends

European Drain intervals - 4/1997



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Changing Engine Requirements

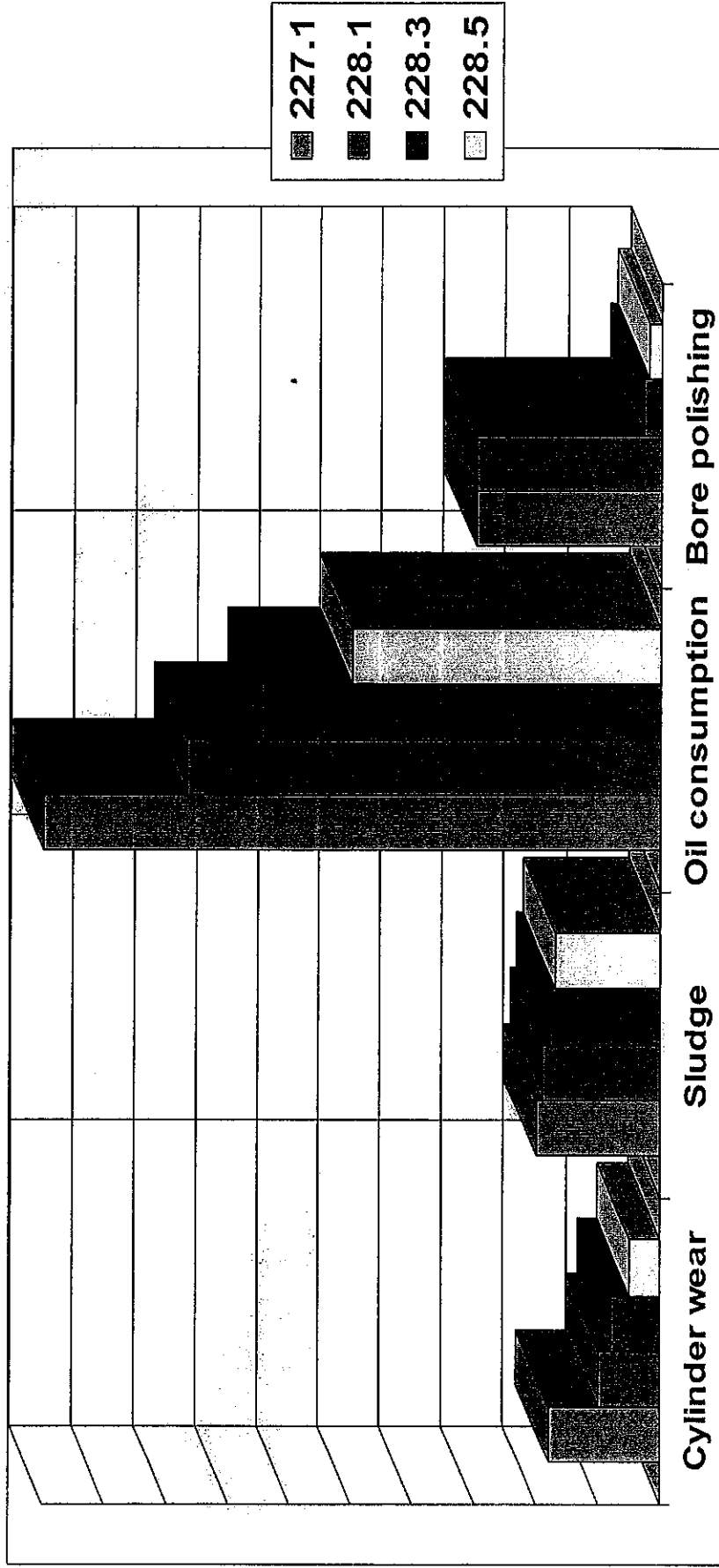
- Trend toward more demanding engine service:
 - Increased power density
 - Higher operating temperatures
 - Longer oil drain intervals
- Recent mandated reduction in NOx emissions results in:
 - Retarded engine timing & higher soot loading
 - Increased potential for viscosity increase, higher wear & filter plugging
 - Potential decrease in fuel economy
 - Possible limitations on oil drain extensions
- New Zealand heading towards Euro 3 (2002)

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Environmental trends

Development of heavy duty diesel oils:

Source: Mercedes-Benz



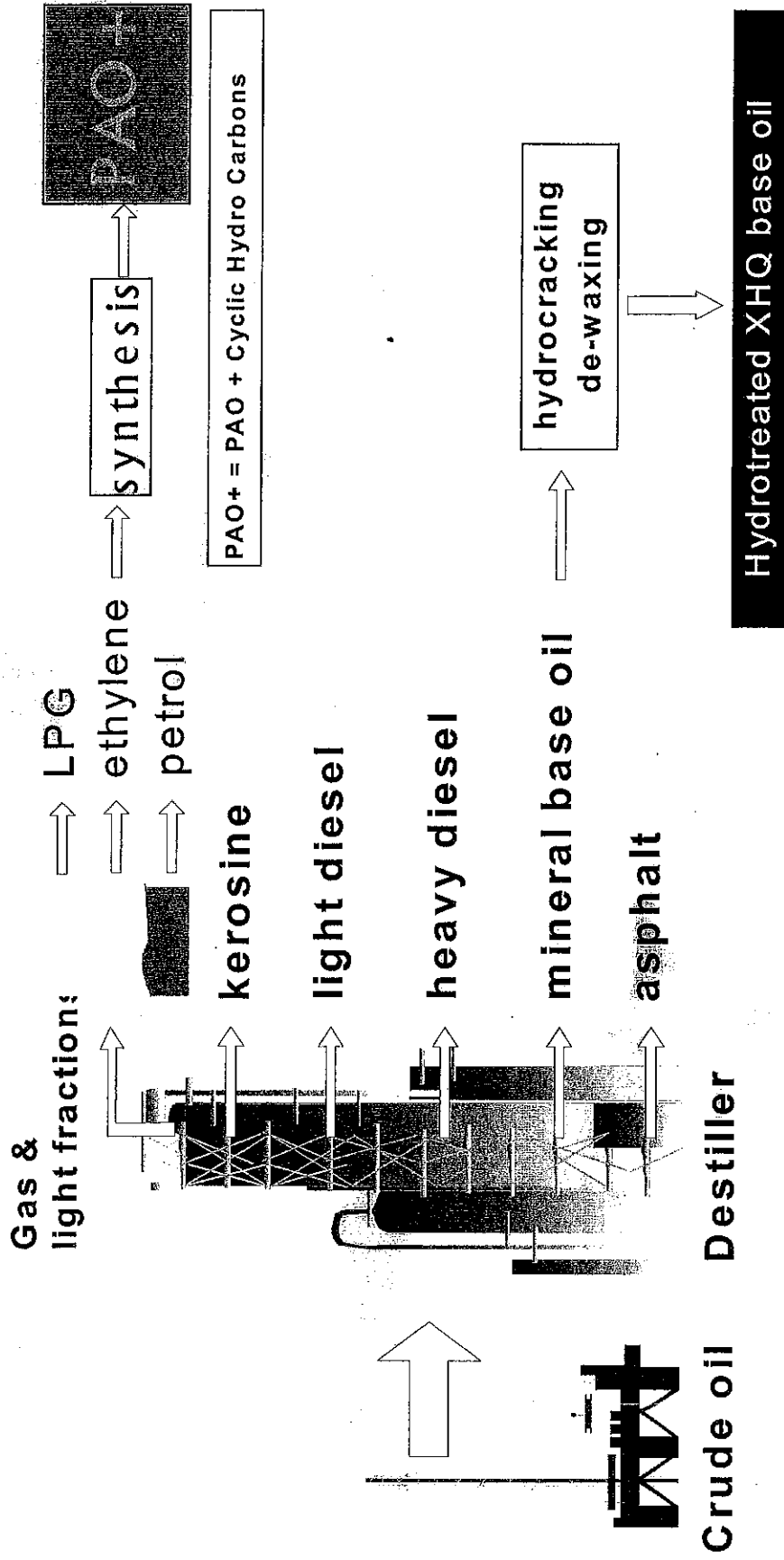
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Synthetics Background

- History dates back to World War Two
- Used extensively in the Space Shuttle Program
- Adapted for passenger vehicle lubricants over 25 years ago
- Mobil's Synthetic Heavy Duty Diesel Engine Oils have strong links with these highly successful synthetic lubricants
- Over 20 years of development in the HDD lubricants market
- Lubricants tailored to exceed the highest North American and European industry specifications

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What is a fully synthetic lubricant



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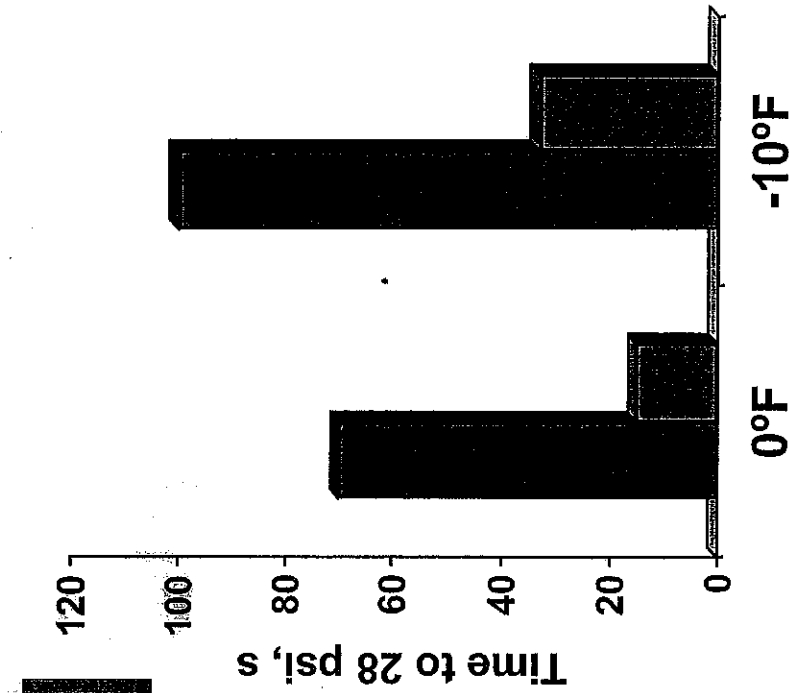
Benefits of Synthetic Lubricants

- Enhanced physical characteristics
 - Low oil volatility at high temperature
 - Excellent low temperature pumping & starting
- Extended service interval capability due to enhanced
 - Soot handling
 - Wear protection
 - Oxidation & deposit control
- Reduced oil consumption
- Improved fuel economy

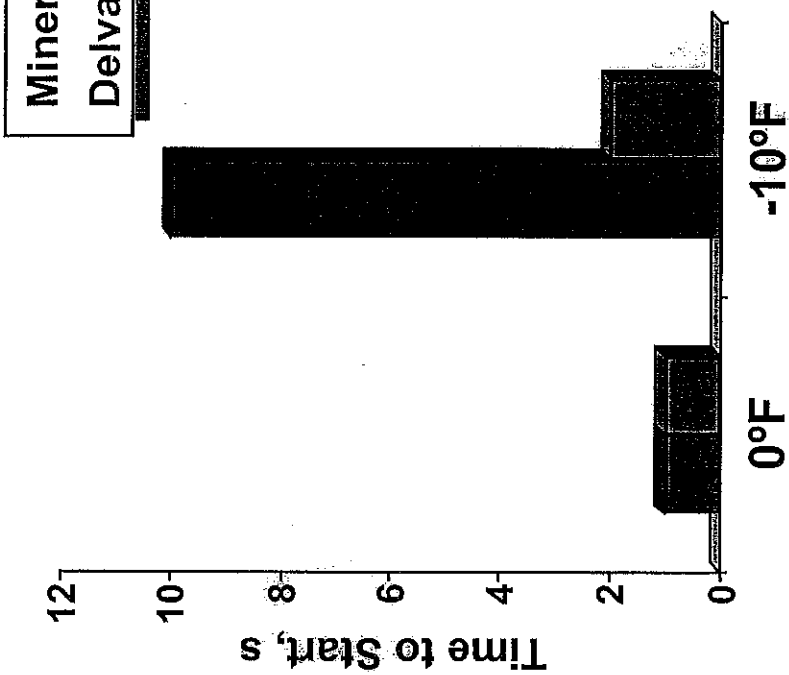
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Synthetic Lubricant-Cold Temp Performance

Pumpability



Startability

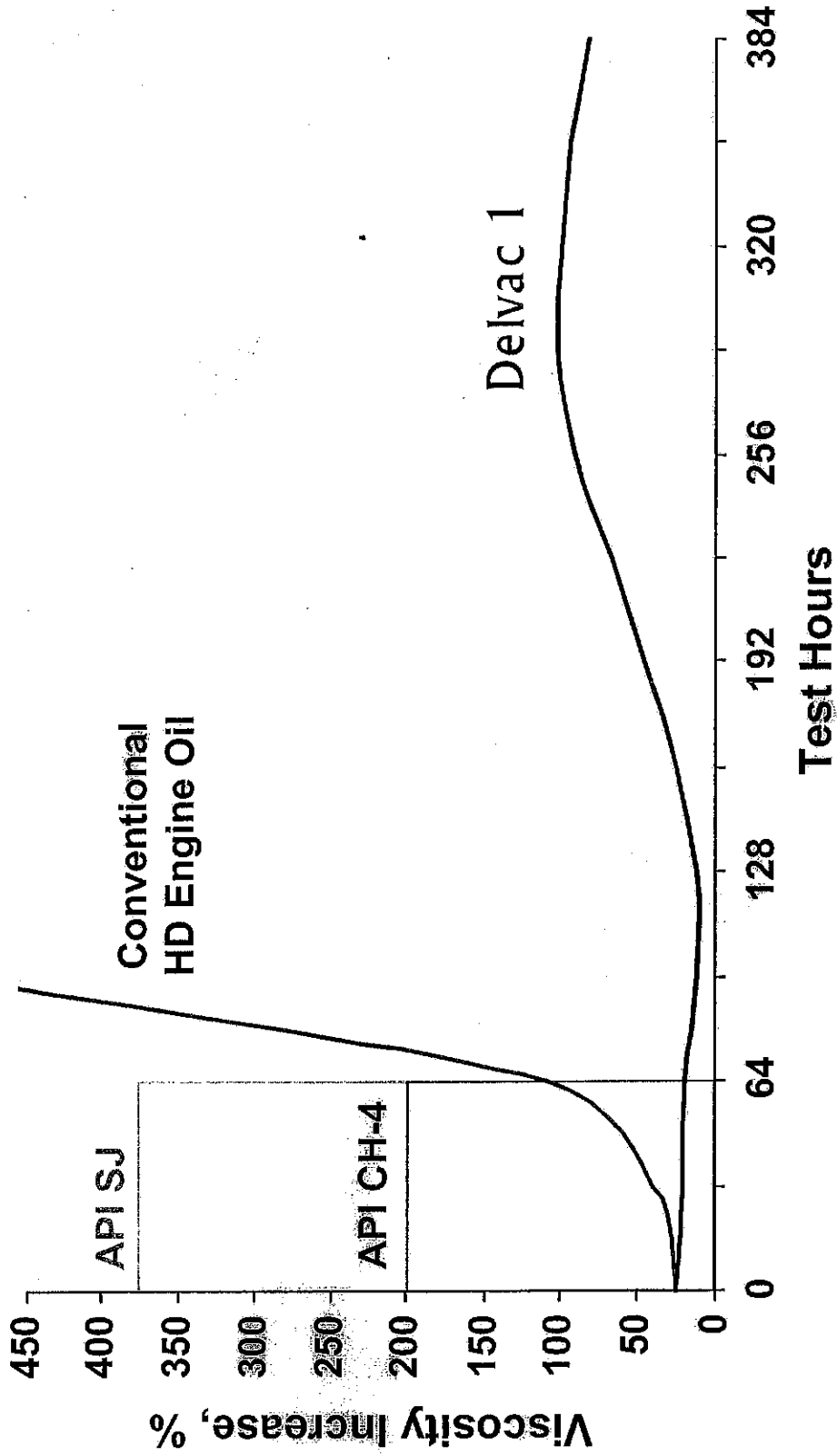


Details of performance described in:
W.H.Buck and J.R.Lohuis; SAE Paper No. 940097

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Synthetic Lubricant-Oxidation Control

Sequence III Engine Test

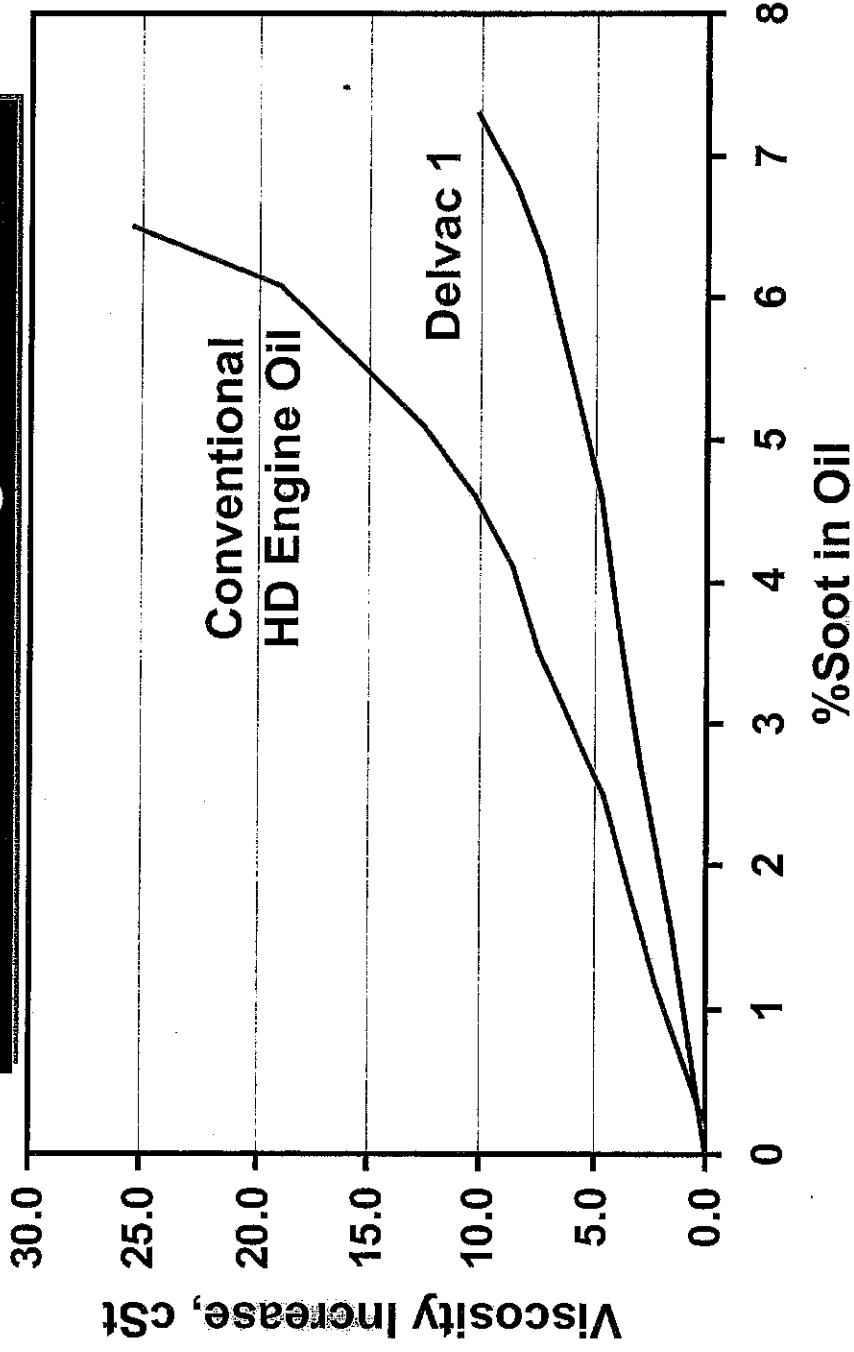


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Synthetic lubricant - Viscosity retention

Outstanding dispersancy of Delvac v minimizes soot agglomeration and viscosity increase even at very high used oil soot levels

Mack T-8E Engine Test

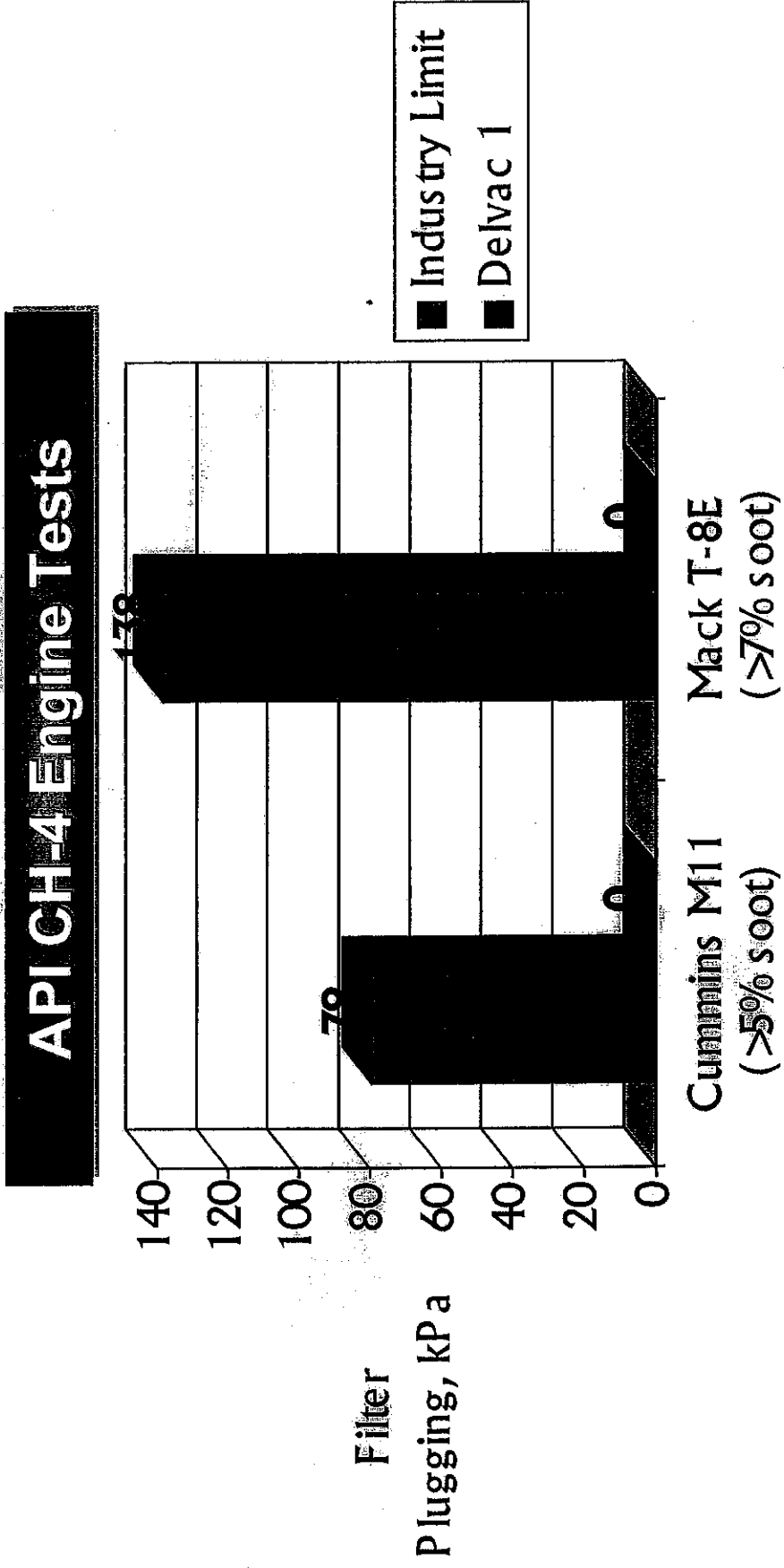


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Synthetic Lubricant - Filter Plugging

The enhanced soot control capability of Delvac v also minimizes filter plugging at high levels of used oil soot contamination



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Fuel Economy Tests

Delvac v has demonstrated fuel economy over a range of different test fleet tests; fuel savings improve with increasing stress to the lubricant

| | <u>Mineral Ref</u> | <u>Delvac 1</u> |
|--------------------------|--------------------|-----------------|
| <u>Caterpillar 3406E</u> | | |
| Total Miles Driven | 1,010,771 | 1,039,926 |
| Total Fuel Used, gal | 165,755 | 167,509 |
| Average MPG | 6.10 | 6.21 |
| Delvac 1 Benefit | | 1.81% |
| <u>Caterpillar 3176B</u> | | |
| Total Miles Driven | 634,076 | 669,023 |
| Total Fuel Used, gal | 90,681 | 90,491 |
| Average MPG | 6.99 | 7.39 |
| Delvac 1 Benefit | | 5.73% |
| <u>DDC Series 60</u> | | |
| Average MPG | 6.12 | 6.41 |
| Delvac 1 Benefit | | 4.68% |
| <u>Cummins N14E</u> | | |
| Average MPG | 5.72 | 6.06 |
| Delvac 1 Benefit | | 6.10% |

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Improved fuel economy

Mobil Delvac 1 SHC - engine oil

Fuel saving 2.5% due to:

- Reduced internal friction:
- Superior soot control
- Excellent cold start properties

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Improved fuel economy

Mobil Delvac 1 SHC - Engine oil field test results

| <u>Country</u> | <u>Company</u> | <u>Type</u> | <u>Make</u> | <u>% Fuel Saving</u> |
|----------------|----------------|-------------|-------------|----------------------|
| • Germany | HHA | City Bus | MB | 2.0 |
| • Sweden | Freiberg | City Bus | MB | 3.2 |
| • Sweden | Metab | Intern. tr. | Scania | 2.1 |
| • Sweden | Johansson | Intern. tr. | Scania | 2.5 |
| • U.K. | Henley | Intern. tr. | MAN | 3.2 |

Average fuel saving with Delvac 1 SHC 2.8%

Note: SAE J 1321 Test "Two Truck" Road Test gave 2.1% fuel saving

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Improved fuel economy

All Synthetic truck - Field tests

| <u>Country</u> | <u>Company</u> | <u>Type</u> | <u>Make</u> | <u>% Fuel Saving</u> |
|----------------|----------------|-------------|-------------|----------------------|
| • Austria | Spindler | Intern. Tr. | MAN | 3.7 |
| • France | Spamabus | City Bus | RVI | 3.9 |
| • Netherlands | Boot & Buteijn | Intern. Tr. | MB&Volvo | 3.0 |
| • Italy | Tigullio | City Bus | Iveco | 4.7 |

Average Fuel Saving All Synthetic Truck 3.8%

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Reduced quantity of waste oil:

Longer drain intervals:

| | <u>Current period.</u> | <u>Synthetics</u> |
|----------------------|------------------------|-------------------|
| ● Engine Oil (30L) : | 20.000 km | 100.000 km |
| ● Gear box (15L) : | 60.000 km | 1x per yr |
| ● Rear axle (12L) : | 60.000 km | 1x per yr |

Savings of litres of waste oil:

| | |
|--------------------------|-------------------------------|
| ● At 150.000 km/yr/truck | |
| ● Savings : | - Engine oil 120 ltr per yr |
| | - Gear box oil 15 ltr per yr |
| | - Rear axle oil 12 ltr per yr |

Savings waste oil: 150 ltr per year per truck

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Reduced quantity of waste oil:

Mercedes Benz Field Test A

(Euro II, low sulphur fuel)

Mobil Delvac 1 SHC

- Test 600.000 km
- Drain interval 100.000 km
- EM/P A -used oil analyses every 50.000 km
 - Little soot in the oil (0,5%)
 - no significant viscosity increase

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Reduced engine oil consumption:

Average lube oil consumption:

- Conventional engine oil : av. 2 ltr at 10.000 km
- With Synthetics : av. 1 ltr at 10.000 km

Quantity of lube oil saved:

- At 150.000 km per truck per year

Savings: 15 ltr engine oil per truck per year

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Reduced emissions

Typical emission details of heavy duty diesels

| | | |
|------|-----------|------|
| NOx: | 5...15 | g/km |
| HC: | 0,6...2 | g/km |
| CO: | 1...6 | g/km |
| PM: | 0,5...1,5 | g/km |

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Reduced emissions

Improved fuel economy 2.5%

Excellent cold start at low temperatures:

- Increased start revs with 70%
- Reduced start time with 80%

Less lube oil consumption:

- Clean engine
- 30% less consumption
- Improved combustion

Result:

- Less emission NO_x, CO and HC

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Reduced emissions

Calculation (Based on 1 truck 150 000km/yr):

Avg. engine power 100 kW , (max 350 kW)

Avg. speed 80 km/h,

Avg. fuel consumption 30 liter / 100 km

Fuel savings, (4%) result of

Mobil Delvac 1 SHC.

Euro 2 -standards:

CO=4 g/kwh, HC=1.1 g/kWh, NOx=7 g/kWh, PM=0.15 g/kWh

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Reduced emissions

Result:

1800 L / (30 L / 100 km) = 6000 km

6000 km / (80 km/h) = 75h

75h x 100 kW = 7 500 kWh

Reduction of emissions:

| NOx | CO | HC | PM |
|--------------|--------------|-------------|-------------|
| 50 kg | 30 kg | 8 kg | 1 kg |

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Environmental Benefits, Truck owner

1 truck /year
150 000 km/year

- Improved fuel economy:

1.800 ltr

- Less waste oil:

150 ltr

- Less Oil consumption:

15 ltr

- Less emissions:

| | |
|-----|---------|
| NOx | (50 kg) |
| HC | (8 kg) |
| CO | (30 kg) |
| PM | (1 kg) |

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Economic Benefits, Fleet owner

300 truck
150 000 km/year/truck

- Improved fuel economy: 540 000 ltr
- Less waste oil: 45 000 ltr
- Less Oil consumption: 4 500 ltr
- Less emissions:

| | |
|-----|-----------|
| NOx | 15 000 kg |
| HC | 2 400 kg |
| CO | 9 000 kg |
| PM | 300 kg |

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Synthetics in Greenhouse Challenge

- Improved fuel economy
- Reduced quantity of waste oil by longer drain intervals
- Reduced engine oil consumption
- Reduced emissions

Environmental savings
and
reduction in operating costs

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