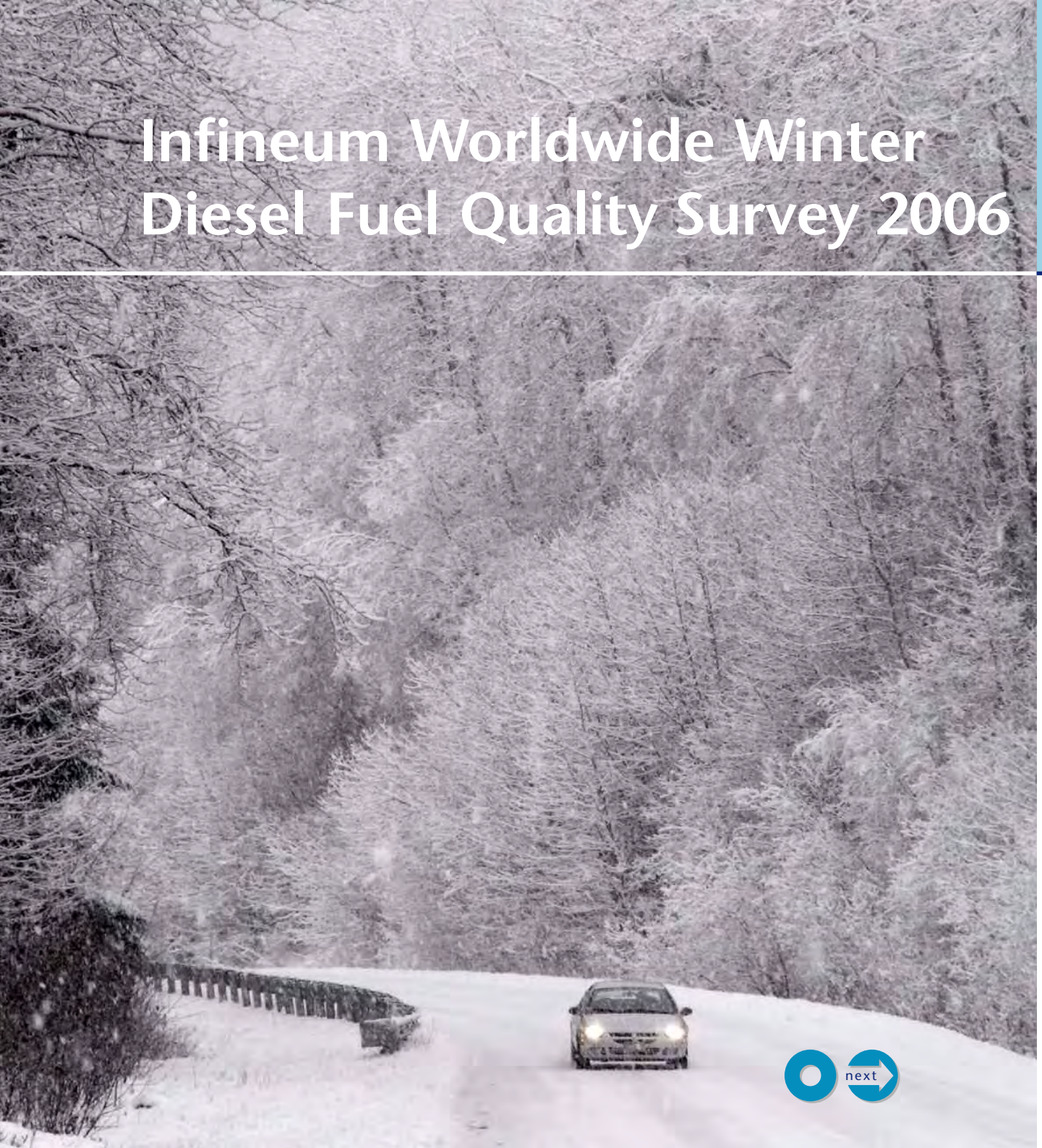
Infineum Worldwide Winter Diesel Fuel Quality Survey 2006



2006

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Introduction

The Infineum Worldwide Winter Diesel Fuel Quality Survey aims to provide the petroleum refining and distribution industry with an overview of the quality of automotive diesel in the marketplace, allowing tracking of international trends. To achieve this purpose, the Survey needs to cover as much of the globe as possible. For the winter 2006 survey, some 336 samples were collected in 41 countries around the world. The majority of samples were collected during January and February, deep winter months in the northern hemisphere. In southern hemisphere countries, sampling was delayed until later in the year when true winter grade samples could be obtained.

Samples need to be representative of the diesel purchased by the average consumer so they are gathered from service stations by Infineum colleagues at local area offices. As a general principle, Infineum tries to get one sample that represents the production from each refinery or region in a given country.

To minimise the possibility of taking multiple samples from a single refinery, knowledge of local exchange agreements and distribution systems is used to select where each sample is collected. For the larger diesel consuming countries, this procedure results in samples that represent a reasonable average of the overall quality. However, for smaller countries or specific producers, spot sampling over a short period of time will effectively only provide a snapshot of production quality, with data derived from only one or two samples. This can make it more difficult to evaluate trends with any accuracy.

Analysis

The analyses applied to each sample are those we consider to be of most interest to the diesel producers, marketers, distributors and consumers. They cover areas of national specification, exchange specification and performance parameters. A degree of standardisation has been applied to enable diesel from all countries to be compared and the data analysed as a single set. Standardisation, however, means that not all national specifications are reported.

This year, for the first time, we are reporting the presence of FAME (fatty acid methyl ester) in samples collected within Europe. Although the data reported are qualitative, given the current drive to increase use of fuel derived from renewable sources, we expect this to be an interesting parameter to follow in this and future surveys.

Wherever possible, industry standard test methods have been applied and in-house test methods avoided. This has been done so that the data published here most accurately reflect the results which could or would be generated by organisations within the petroleum industry.

When considering our data, in particular when comparing the various test results with the national specifications, it should be noted that a number of the tests have quite wide reproducibility bands, and very little repeat testing has been conducted to determine compliance or otherwise with specifications.

Test Methods

The majority of testing was carried out at quality accredited laboratories in the USA, Japan and the UK using the following test methods:

Density	ASTM D4052
Kinematic Viscosity	ASTM D445
Sulphur Content	ASTM D2622 / ASTM D4294
Cetane Number	ASTM D613
Cetane Index	ASTM D4737 / ASTM D976
Pour Point	ASTM D97 / ASTM D5950
Distillation	ASTM D86
Cloud Point	ASTM D2500 / ASTM D5772 / ASTM D5771
CFPP	IP309 / ASTM D6371
HFRR	ISO 12156-1 / ASTM D6079
Wax Content	Differential Scanning Calorimetry
LTFT	ASTM D4539
FAME	NF M 07-084 (modified)

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The Trends

Over the past 10 years, the principal changes that have taken place in worldwide diesel production have been sulphur reduction and the associated requirement for lubricity enhancement. These have, of course, been driven by environmental concerns and legislation aimed at reducing atmospheric pollution. Sulphur reduction in diesel fuels has both the direct effect of reducing the pollutants associated with atmospheric sulphur, and the indirect effect of enabling reductions of regulated vehicle emissions via use of sulphur intolerant after-treatment devices.

It has not been possible for all countries to move at the same speed, but diesel surveys in recent years suggest that at least everyone is moving in the same direction. For many the journey is now almost complete; 5ppm sulphur has already become a specification in Swedish MK1 diesel; 10ppm is required in Germany and Austria, 15ppm has recently been introduced in the United States and the remaining European countries need to produce 10ppm sulphur in 2009. Additionally, the current survey indicates that fuel producers in many countries have moved ahead of the specifications. In Denmark, Finland, Japan, Norway, Poland, Switzerland and Hungary, average production surveyed is below 10ppm sulphur, and in Benelux, the Czech Republic and Korea, average production surveyed is below 15ppm.

However, continuing change is inevitable, and new forces unrelated to sulphur content are emerging that are driving further changes in diesel production:

- The need to reduce CO_2 emissions via the use of 'renewable energy' to combat global warming has gained much wider acceptance by the general public.
- Since the 2004 survey crude prices have risen by 100%, reaching an all-time high in excess of $70 per barrel, focusing the attention of many of the world's economies on security of supply and alternative energy sources.
- Alternatives to crude derived diesel such as GTL (gas to liquids), CTL (coal to liquids) and FAME (fatty acid methyl ester) are becoming commercially viable without the need for tax incentives.

The mix of these factors with ongoing government legislation in many areas is steadily opening the path to wider use of biofuels to extend the diesel pool. In real terms today this means FAME from a wide variety of sources being introduced, but this may be just the beginning. For example, a mandate issued to CEN (Conseil Européen de Normalisation) by the European Commission requires CEN to consider the use of FAEE (fatty acid ethyl ester) in European fuel. This could allow bio-derived alcohol to replace the crude derived alcohol that is currently used in FAME production; a step being pioneered in Brazil, though there are technical difficulties to be overcome.

Given appropriate vehicle design, FAME can be used directly as bio-diesel, but use of FAME in this way is currently either limited geographically or restricted to fleet operators so these fuels have not been included in this survey. Alternatively, FAME can be used in blends with crude-derived diesel. These blends are now commonly identified by the acronyms B5, B10 or B30 etc., where 5, 10 or 30 denotes the percentage of FAME contained within the blend. Fuel quality considerations, vehicle compatibility concerns and more recently specifications, have so far tended to restrict use of blends in general distribution to those containing a maximum 5% FAME.

Infineum has been monitoring FAME B5 penetration in Europe since the 2002 diesel survey but both in 2002 and 2004 the number of samples collected that contained FAME was small. However, for the first time this year, analysis indicates that B5 penetration is beginning to take-off. A new phase of change is upon us.

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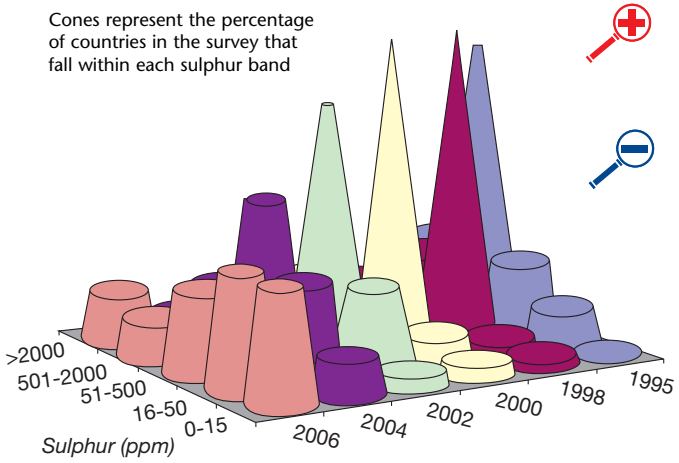
The Trends

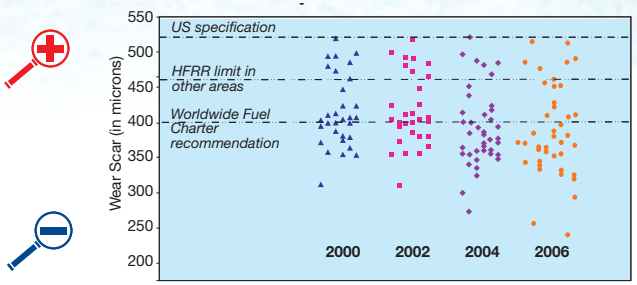
Sulphur, Lubricity and FAME

Sulphur content, lubricity and the inclusion of FAME in diesel blending can increasingly be considered in close relationship. As sulphur is removed via hydrotreatment, lubricity falls, often requiring the use of additives to maintain acceptable performance. However, the addition of FAME to desulphurised diesel will have a strong positive effect on lubricity and can negate the need for additive if used at greater than 1 - 2%.

This year's survey confirms that sulphur content continues to fall. The largest peaks on the graph now sit firmly at the 0 to 50ppm levels and represent by far the majority of countries surveyed.



Worldwide Lubricity Performance



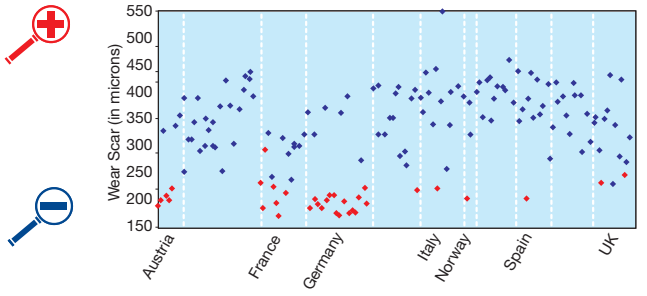
Despite the sulphur reductions, lubricity appears to be well maintained. On average all of the countries surveyed demonstrate lubricity performance that is within HFRR (high frequency reciprocating rig) specifications, 520µm maximum for the U.S. and 460µm maximum for the rest of the world.

This three-way relationship gets more interesting when we start to consider inclusion of FAME in diesel blending. Widespread use of FAME in this way is currently limited to Europe, where it has gradually been introduced as tax incentives designed to encourage use of renewable fuels have taken hold.

The following chart represents HFRR wear scar values for the European samples collected for the 2006 survey. Additionally, samples marked in red have been identified by FTIR analysis as blends containing FAME. The strong positive effect of FAME on fuel lubricity is very clear. Very few lubricity additive treated fuels have HFRR wear scars below 250µm while very few FAME-containing blends have wear scars above 250µm.

FAME is used outside of Europe, in Brazil, Indonesia, Malaysia and the U.S. for example, but use in B5 blends is not yet sufficiently widespread in the countries sampled for this survey to detect trends.

2006 B5 FAME Penetration in Europe



Data points in red represent survey samples that contain FAME

Looking to the Future

Use of FAME is set to increase and other alternative forms of fuel are certain to attract the attention of policy makers, environmentalists and increasingly the general public. Probably the best indication of future intent is European policy. A 2003 directive required that 2% of automotive fuel be obtained from renewable sources by 2005, rising to 5.75% by 2010, and a recent report from the Biofuels Research Advisory Council is focusing on 25% by 2030. Given that the current estimate for biofuel penetration is <2% of the market, there is clearly still a long way to go, but as this survey indicates, progress is being made.

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