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INFINEUM WORLDWIDE WINTER DIESEL FUEL QUALITY SURVEY 2012

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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 2012 survey, some 381 samples were collected in 42 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 undertaken in mid-2011, when true winter grade samples could be obtained, enabling the Survey to be released earlier than usual.

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. 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 test methods below. Samples collected in Saudi Arabia and China were tested at local laboratories, using the same or similar test methods.

Density	ASTM D4052
Kinematic Viscosity	ASTM D445
Sulphur Content	ASTM D2622 / ASTM D4294
Cetane Number	ASTM D613 / IP365
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 Content	EN14078
Rancimat	EN 15751 (mod)

The Trends

Infineum last published the Worldwide Diesel Fuel Quality Survey in 2010, at a time when world financial markets were experiencing extremely tough times. Today we see a continuation of the economic recession in many regions, while others, particularly Brazil, Russia, India and China (the so called BRIC countries), are still experiencing growth.

The oil industry certainly felt the effects of the economic situation within the Organisation for Economic Co-operation and Development (OECD) in terms of lower fuel demand, increased costs and falling refinery margins. Outside of the OECD, recessionary effects were significantly more limited but still played a role as weak OECD demand knocked-on to non-OECD producers. When changing demand patterns and revisions to emissions and biofuels legislation are added it is no surprise that refineries throughout the world are increasingly looking for smart ways to help them respond quickly to change so that they can make the right products while maintaining sufficient margins.

The global demand for diesel is expected to grow at a much faster pace than gasoline. This imbalance in demand growth, along with refinery rationalisations within the OECD, will bring challenges for the remaining refineries and the trend for international trade of fuel will continue to grow. However, these opportunities are creating challenges and refineries need to work hard to meet the varied specifications of their global customers.

It is hardly surprising in this uncertain and complex market that some industry initiatives have been less of a priority. The data from this year's Worldwide Diesel Fuel Quality Survey indicates that the majority of diesel fuels remain in line with the fuel quality standards that are in place. However, progress towards meeting renewable fuel targets and efforts to further reduce sulphur levels have in many cases stalled.

Renewable fuels

Concerns relating to energy security and the environment have driven up the production and use of biofuels. Renewable fuels targets are being introduced across the globe and over 40 countries have some form of mandate in place. However, the real step change is that some governments, in addition to biofuel targets, are also introducing regulations to ensure that biofuels meet certain sustainability requirements and CO_2 savings.

In Europe, the Biofuels Directive introduced an indicative target of 5.75% biofuel content in fuel by volume by 2010. This has been superseded by the wider-ranging Renewable Energy Directive (RED), which has now been adopted to promote the use of renewable and sustainable energy across all sectors in Europe. All Member States are required to meet the RED target, which states that 10% of transportation energy must come from renewable sources by 2020. In the same timeframe, an amendment to the Fuel Quality Directive requires greenhouse gas emissions per unit of energy from fuel and energy supplied to be reduced by at least 6%. These directives provide a framework to promote the use of biofuels whilst ensuring greenhouse gas emissions from transport fuels are reduced.

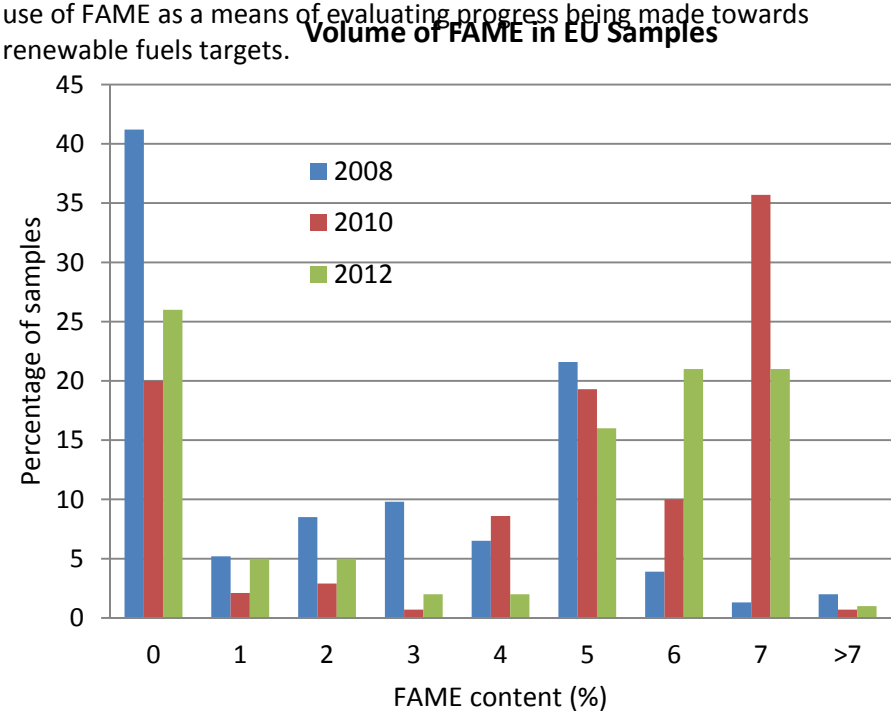
In North America, the National Renewable Fuels Standard Program (RFS2) states that the total amount of biofuel blended into transport fuels must steadily increase to reach 36 billion gallons in 2022. The US Environmental Protection Agency (EPA) reviews the targets each year, and has set the 2012 fuel volume targets to 15.5 billion gallons. Of this, the specific RFS2 requirement for biodiesel usage is 1 billion gallons and is expected to increase to 1.28 billion gallons in 2013. We anticipate more Bx (where x denotes the percentage of biodiesel) blending to occur in the US as some obligated parties are increasing biodiesel blending rather than purchasing *Renewable* Identification Numbers (RINs) to make up any shortfall. Several US states, including Minnesota, Illinois and Missouri, already have their own renewable fuel mandates. For biodiesel blending, current state mandates tend to require B2 to B5 blending and some only come into effect once local production targets or local feedstock targets are met.

In Latin America there is a very mixed picture of biofuels mandates and progress towards their implementation. For biodiesel, Brazil and Argentina are keen to increase blending levels above the respective B5 and B7 levels. Argentina may decide to use more biodiesel locally after changes in oil company ownership. These changes, which could have reduced some outlets for Argentina's biodiesel abroad, may mean the material will be used in Argentina - inducing higher Bx blending sooner. In Colombia there have been delays in implementing B10 and in Peru B5 requirements are being met by imports of B100.

In Asia Pacific there is again a very mixed picture. Renewable fuel blending mandates have been introduced in some countries with targets ranging from B2 to B5. In some cases these targets are only implemented in certain regions or cities, while in others they apply nationwide. However, other countries in the region, including New Zealand, Pakistan and Vietnam, have no mandates in place.

Focus on FAME

The addition of fatty acid methyl ester (FAME) to diesel fuel is one way to produce renewable diesel fuel. Because FAME is in wider use than alternatives, such as hydrogenated vegetable oil (HVO) and biomass-to-liquids (BTL), the analysis of the Survey samples has concentrated on the use of FAME as a means of evaluating progress being made towards renewable fuels targets.



Europe

To gain an insight into the FAME penetration in blends with fossil diesel (Bx), the percentage of FAME contained in each sample collected was evaluated. The results were then compared with data generated for the 2008 and 2010 Surveys.

In 2008 FAME was detected in < 60% of the samples collected, with a peak concentration of 5% - in line with the EN590 limit applicable at that time. In 2010 FAME was detected in 80% of samples collected, with the concentration again peaking at the then EN590 limit of 7% and with over 65% of samples containing 5% or more. In the current Worldwide Diesel Fuel Quality Survey, FAME was detected in fewer than 75% of the samples, while almost 60% contained 5% or more. When compared to the previous Survey a higher percentage of samples contained no FAME and fewer samples contained 7% or more, indicating a slowdown in FAME use.

Further revisions to the EN590 specification are in the pipeline. These should allow the use of up to 10% biofuel blends by the end of 2013. In the current Survey only one sample contained more than 7% and it will be interesting to monitor industry progress towards these targets in our next Survey in 2014.

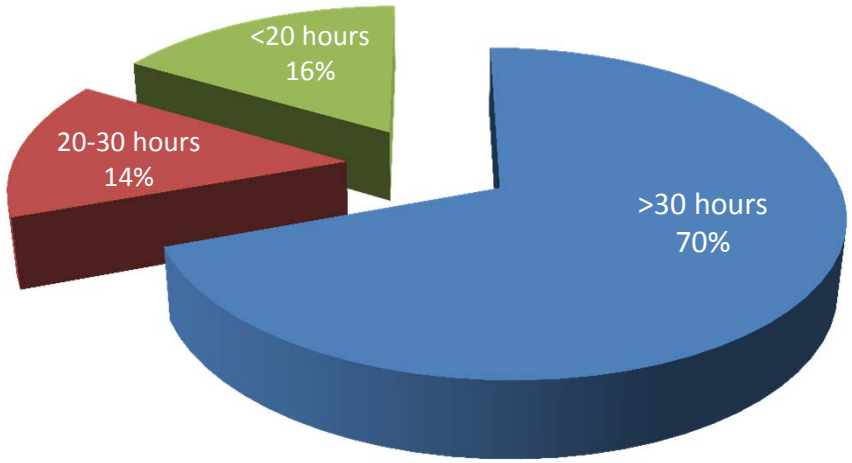
The Survey sample points in Europe are selected to try and match the demographics of EU crude oil consumption. This allows us to estimate the total percentage of FAME being used in Bx blends in the diesel pool.

Year	Estimated FAME penetration as Bx
2008	2.2%
2010	4.5%
2012	4.5%

As FAME concentrations have increased, the EN590 diesel fuel quality standard has been modified to ensure fuel quality is maintained. A Modified Rancimat Test (EN15751) for oxidation stability, requiring an induction period of greater than 20 hours for any diesel blend containing more than 2% FAME (on a volume basis), has been included. In 2010 the Worldwide Diesel Fuel Quality Survey began to monitor this parameter; reporting that 10% of fuels failed to meet the minimum Rancimat requirements at the time of testing.

In 2012 an increase has been observed in the number of samples from Europe with induction periods of less than 20 hours and even some B0 samples with 'failing' Rancimat test levels. In total 16% of European samples failed to meet the 20 hour limit. Given the length of time that typically exists between fuel production and sample testing for the Survey it is difficult to be certain about the root cause of this finding. However, it could be indicative of a fuel stability issue and may be worthy of some further investigation by the industry.

EU Rancimat results



Rest of the world

United States: Samples were only collected from states corresponding to the locations of the major distribution terminals, which means it is not possible to comment fully on biodiesel penetration in the region. Biodiesel was detected in samples from Minnesota, Illinois, California, New Jersey and Massachusetts. Most of the other samples collected in the region were FAME free, but many states with biodiesel regulatory mandates (e.g. Oregon and Missouri) were not sampled. We expect to find more FAME containing samples in the 2014 Survey as other states introduce local mandates.

Canada: A renewable fuel standard was published in 2010 with an annualised 2 vol% biodiesel target for diesel fuel, including heating oil. Here, just as in the US, several provinces and regions have introduced their own renewable mandates and targets. However, biodiesel is not blended during the deep winter months so, as expected, none of the samples collected in 2012 contained FAME.

Latin America: Biodiesel regulatory mandates that are in force in Columbia (B10), Brazil (B5), Argentina (B7) and Peru (B5) are clearly visible within the Survey fuels. The reported push to increase biodiesel blending ratios still higher is not yet evident.

Asia Pacific: Samples from three Asia Pacific countries (Thailand, South Korea and Malaysia) contained FAME at or above the government mandated levels. While Indonesia has a biodiesel mandate of B2.5 on Government Public Service vehicles and in Australia New South Wales State has a biodiesel mandate of B5, which had been recently reversed to B2, none of these samples contained FAME in this year's Survey.

In summary

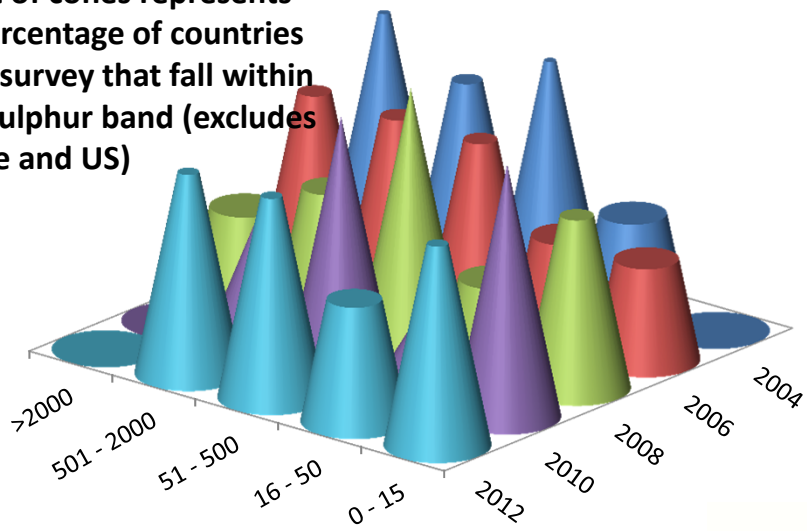
Data from the 2012 samples indicates that the use of FAME is backing off, probably because it was very expensive in 2012. Additional cost in a tight market could be encouraging some producers to use bioethanol rather than FAME to meet renewable targets.

Sulphur content and lubricity

In many parts of the world diesel fuels have been produced for some years which meet minimum sulphur levels and therefore do not exhibit discernible trends. However, the reduction of sulphur in diesel fuel and the associated natural lubricity performance debit that accompanies it continues in some regions of the world. The Survey analysis presented here excludes the European Union and the US data in order to focus on data collected from the countries that are still working towards the 'ultra low sulphur' benchmark.

The general trend is going in the right direction - downwards - but slower progress is being made. In some of the world's less mature markets, for example China, Indonesia and Argentina, there are still very high (>1,000 ppm) sulphur levels, especially in rural areas. As consumers in these countries increasingly look to buy more advanced vehicles it will be important to ensure fuel quality is improved and legislation enforced so that vehicle performance is not adversely affected. Emerging economies are still developing emissions specifications and fuels in these countries will need to continue to improve in order to meet them.

Height of cones represents the percentage of countries in the survey that fall within each sulphur band (excludes Europe and US)



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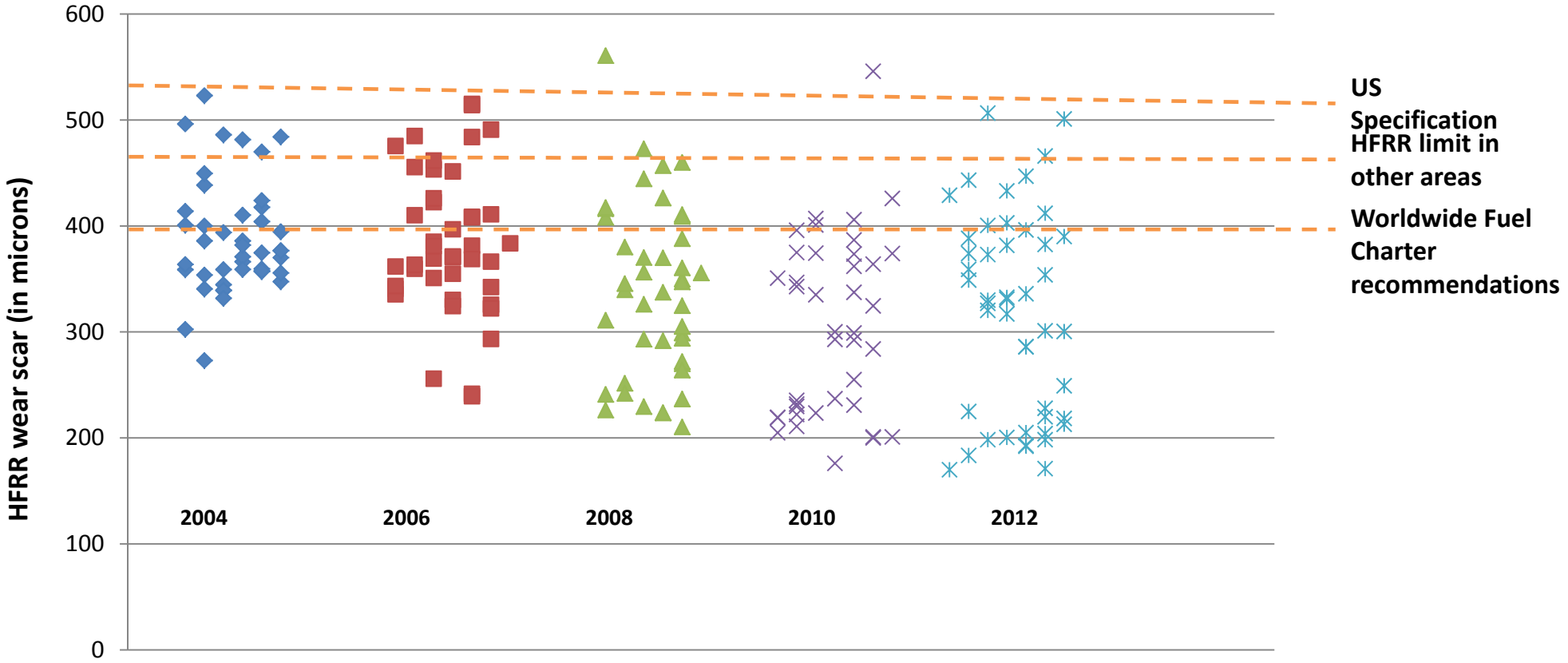
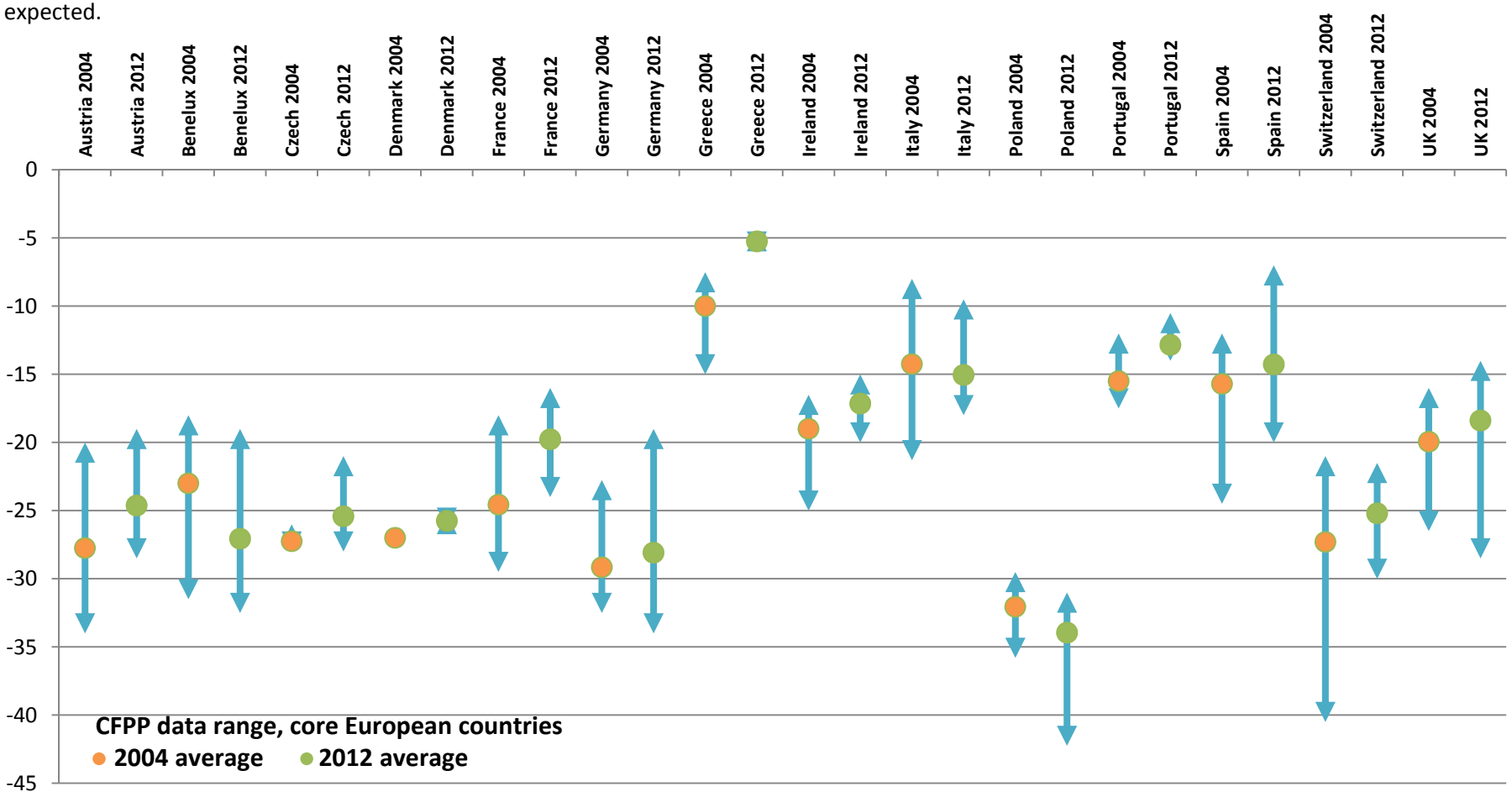
In 2010 we reported an improving picture for lubricity, associated with additive treatment and increasing FAME use. At that time, the majority of countries surveyed had an average HFRR wear scar diameter below the Worldwide Fuel Charter recommendation of 400µm. In 2012 we have observed a stalling in this downward trend, which is attributable to a combination of the backing off of FAME use, the tough economic climate and variations in sampling (e.g. inclusion of an increased number of Middle Eastern countries compared to 2010).



Cold flow performance

Cloud point and cold filter plugging point (CFPP) test parameters indicate that cold flow performance of diesel fuels worldwide has not changed significantly since 2004. The table compares the CFPP average and range for samples collected in the core European countries in 2004 with those collected in 2012. While some differences can be noted in both the average and range values, these are considered to be within the variability expected.

Field issues have led some European OEMs to question the value of the CFPP test in protecting vehicle operability with both Bx and B0 fuels. Infineum continues to support the use of the CFPP test, in conjunction with operability, rig and field testing, as a reliable indicator of how wax will impact the low temperature performance of fuels.



However, vehicle hardware changes and/or severe weather conditions may contribute to increased field issues in certain circumstances. Additionally, biodiesel-containing fuels can also affect vehicle operability by filter waxing below the fuel's cloud point and through precipitation and filter blocking above the cloud point by minor components in the FAME.

Infineum will continue to actively participate in industry initiatives to help to better understand and resolve these issues.

Looking forward

As mentioned earlier, demand patterns are changing. Considered globally, the demand for gasoline and heavy products is plateauing and the demand for middle distillate fuels is growing. This requires refineries to increase processing of the heavier fuel fractions. Unfortunately, this results in increased refinery CO_2 emissions, an unwelcome by product - particularly in Europe where refineries must meet Emission Trading System requirements.

In Europe and parts of North America, the change in demand and falling refinery margins mean refinery sales, closures or conversions are necessary to reduce overcapacity. However, these refinery rationalisations mean that those remaining will have to work even harder to meet demand. North American refineries located near major ports are eager to take advantage of diesel fuel balances and exports where possible.

As countries recover from the recession it will be interesting to see if their progress towards meeting renewable fuel regulatory mandates picks up. Whether that occurs or not, it is evident that the introduction of new mandates and the trend for established mandates to increase the biodiesel blending ratio (Bx) will secure their future production and use. This potential increased use of biofuels adds yet another layer of complexity on the top of this already precarious balancing act.

As the level of Bx increases it will be even more important to minimise the impact of minor components in saturated FAME through careful FAME selection and processing. And, as diesel exports grow to maintain regional supply/demand balances, it will become increasingly important for refineries and fuel marketers to ensure the quality of the diesel fuel they supply meets the requirements of the fuel's final destination.