NOVEL ESTER BASED LUBRICITY IMPROVER

New Developments in Fuel Management – Industry Briefing

6th March 2018
Lubricity – “The intrinsic ability of a fluid to prevent wear on contacting metal surfaces”

Cause of lubricity problems in diesel fuel
- Hydroprocessing to reduce sulphur levels also removes
  - N species
  - O species
  - Polyaromatic
  - Others
LOW LUBRICITY – CONSEQUENCES AND SOLUTIONS

- Diesel lubricity problems manifested by:
  - excessive wear of rotary fuel injection pumps
  - very occasional problems with in-line pumps using ultra low sulphur fuel

- Potential solutions:
  - Increase sulphur levels
  - Less hydroprocessing - not possible for high sulphur crudes
  - improved pump metallurgy - increased cost to FIE manufacturers and many old pumps already in the field
  - **use of lubricity additives - preferred choice**

- Requirements for additive use:
  - acceptable method for measurement of lubricity
  - lack of interaction with fuels, lubricants or other additives
Lubricity Specifications exist worldwide for automotive diesel:
- 460 µm – EN590 European Automotive Diesel, 1996
- 460 µm – AS3570, Australian Automotive Diesel, 2002
- 460 µm – DB 11/239, China Automotive Diesel, 2003
- 460 µm – South Korea, Petroleum Business Act, 2002
- 520 µm – USA, ASTM D975 Automotive Diesel, 2006
- 460 µm – USA, EMA Standard
- 520 µm – ISO 8217 Marine Gas Oil Specification, 2010
RATING COMPONENTS

HFRR:
WS1.4 = 332 µm
Pump-Rating 3,5

HFRR:
WS1.4 = 632 µm
Pump-Rating 7
INTRODUCTION

Source: Robert Bosch GmbH Stuttgart
LUBRICITY IMPROVER – REQUIREMENTS

- Non-Depletive
- Constant & Predictable Composition
- Compatible with all other diesel additives
- Non-Disarming of SDA
- Non-depositing in HPCR internal diesel injectors
- Easy to Handle
- No-harm to Filters
- Non-depositing in HPCR internal diesel injectors
- No-harm to Filters
COMPARISON OF LI TECHNOLOGIES

- Two Approaches:
  - Brand Protection Approach
    - Low tolerance for risk
    - Continuous Improvement
    - Ester
    - **No interactions**
  - “Minimum Compliance” Approach
    - Higher tolerance for risk
    - Traditionally Most Cost Effective Solution
    - Mono Acid
    - Potential for interactions
NEW ADDITIVE DEVELOPMENT

- Innospec have supplied both lubricity additive chemistries for many years.
- Manufactured and patented ester lubricity additive chemistries originally in the 1990's.
- Have continued to optimise ester lubricity additive technology.
- Developed new ester additive technology, OLI 9980.
Different additive chemistries respond differently in HFRR test
LUBRICITY – MARKET ISSUES – FIE’S / OEM’S

- Vehicle and fuel injection equipment (FIE) manufacturers appear to be re-visiting lubricity

- SAE Paper, Bosch – Diesel Lubricity Requirements of Future Fuel Injection Equipment
  - Focussed on diesel fuel system lubrication for highly loaded contacts found in high pressure pumps
  - Severity likely to increase in future applications due to requirement for increased fuel pressure
  - Propose that extra lubricity protection may be required in future vehicles.
  - Conclude that ester based additives provide better protection to modern FIE than acid and amide based additives
MARKET ISSUES – FIE / OEM’S

- All acids have been implicated in the formation of internal diesel injector deposits, and mentioned by a number of OEM’s e.g. Daimler, Peugeot
- TOFA’s are listed as source of acids and potential concern, particularly in the presence of sodium
- Major market issue reported in France due to use of sodium nitrite corrosion inhibitor
- Other market issue reported linked to sodium / acid presence in Denmark
LI INTERACTION WITH SODIUM – TESTING

- Acid type concentration and sodium level has negative effect on FBT
- Ester type lubricity additive does not show this negative effect on FBT

<table>
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<th>LI content, mg/kg</th>
<th>Filter blocking tendency (FBT)</th>
<th>Sodium content, mg/kg</th>
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Development of alternative fuels has resulted in new specification introduction in Europe.

Highly paraffinic diesels produced using synthesis gas (GTL) or hydrotreated bio-oils or fats (BTL) are being introduced.

European specification EN 15940 introduced in 2016: ‘Automotive Fuels – Paraffinic diesel fuel from synthesis or hydrotreatment’

Included comment on seizure protection – ‘Indication that diesel fuel high in paraffin content does not always protect fuel system components sufficiently against pump seizure’
Further comments within EN 15940 specification include;

- Some paraffinic fuels poor in ‘natural’ seizure protection do not protect against seizure even if wear scar in HFRR test <460um

- All lubricity additives reduce risk of wear. However, depending on nature of fuel and the type of concentration of additive used for adjusting lack of lubricity, adequate seizure protection is not necessarily ensured by low values in the HFRR test alone

- It is recommended to only use fuels that pass a limit value of >3500g in the SLBOCLE test

- Ester lubricity additives reported to show better response in the SLBOCLE test than mono acid additive chemistry
SUMMARY

- Lubricity Improvers widely used around the world to meet diesel fuel specification requirements

- Dominant additive chemistries are mono acid and ester based

- Additive selection often based on individual customer preference

- Concerns over performance of mono acid chemistry have been raised recently however in relation to;
  - Ability to provide robust protection in high pressure fuel pumps
  - Injector fouling in modern diesel engines
  - Seizure protection when used with highly paraffinic diesel fuels