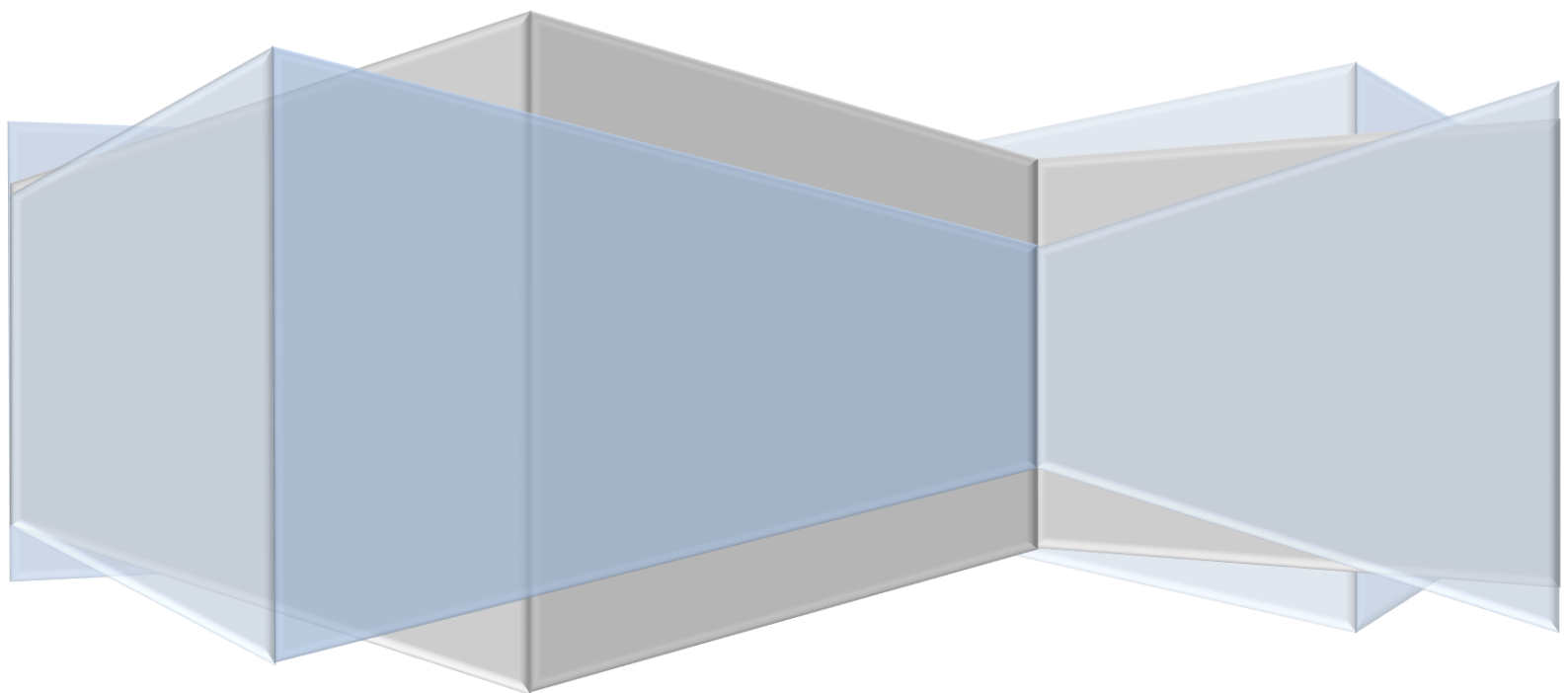


Revision A

Standard Diesel & FCC Additive Technical Analysis on Lubricity

ADDF-REP-TA-0002

Michelle Lam



Disclaimer: The content of this technical shall only summarise the information and results provided in the test certificate analysis (as provided). Any use of the terms stated in the technical report to an alternative purpose maybe unreliable. The writer/s of the technical reports and executive summary does/do not accept any liability in case of misuse of any information or results.

STANDARD DIESEL & FCC ADDITIVE TECHNICAL ANALYSIS ON LUBRICITY

ADDF-REP-TA-0002

Revision Number: A

Revision Date: 15/01/2017

PREPARED BY

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1 EXECUTIVE SUMMARY

Fuel Conditioner Concentrate (FCC) is added directly to fuel storage tanks to eliminate the problems associated with water contamination. FCC ensures that vehicle fuel systems remain clean and free from corrosion, gums, and varnishes. The main benefit of the FCC is derived from its regular use to maintain fuel systems free from liquid water. This prevents biological activity, reduces corrosion and inhibits reaction of the fuel with water. Regular use of FCC ensures that carburetors and fuel injectors work at peak performance eliminating poor running problems and expensive maintenance. The benefits of FCC extend throughout the fuel system.

FCC / FCC-V improves lubricity by 7% – 20% which is a significant improvement on durability of equipment which prevents premature wear of equipment and allowing equipment to operate to its intended design life. This increase in lubricity directly improves engine's performance and minimises maintenance requirement.

2 INTRODUCTION

FCC is an innovative and scientifically proven blend of surfactants (detergents), oxygenates and corrosion inhibitors developed to meet the challenge of today's engines. It's a non-hydrocarbon fuel conditioner that cleans fuel and improves performance whilst lowering emissions and increasing fuel efficiency. It is suitable for use for a large variety of fuel types.

With FCC, improvements in fuel efficiency and savings in maintenance costs are achieved through cleanliness and a better burn; as opposed to tampering with the combustion characteristics of the fuel.

2.1 DOCUMENT SCOPE

The intent of this document scope is to provide technical analysis on Standard Diesel's (Control Colas Tank DSL) lubricity after addition of fuel additive, herein referred to as FCC and FCC-V.

2.2 ABBREVIATIONS

| Abbreviations | Definition |
|---------------|-------------------------------|
| AddFuel | AddFuel Pty. Ltd. |
| ASTM | American Standard Test Method |
| FCC | Fuel Conditioner Concentrate |

2.3 REFERENCES

The references used in this document are:

1. Certificate of Analysis Submission No: 58649 (PO: 3806), 25-Oct-2015 (Att. 1).
2. Diesel Fuel Technical Review, Chevron.
3. Practical Lubrication for Industrial Facilities 2nd Edition, Heinz Bloch.
4. <http://www.environment.gov.au/topics/environment-protection/fuel-quality/standards/diesel>
5. https://www.dieselnet.com/tech/fuel_diesel_lubricity.php

2.4 ATTACHMENTS

1. Intertek Geotech, Report on Diesel Samples, Submission No: 53173b, 24-Feb-2015.
2. Australia Government Department of Environmental and Energy, Fuel Quality in Australia – Diesel Fuel Quality Standard.

3 LUBRICITY

3.1 DEFINITION

Lubricity: Ability of a lubricant (in this case diesel fuel) to minimize friction between and damage to surfaces in relative motion under load.

Some moving parts of diesel fuel pumps and injectors are protected from wear by the fuel. Lubricity is ability of a lubricant (in this case diesel fuel) to minimize friction between and damage to surfaces in relative motion under load. The lubrication mechanism is a combination of hydrodynamic lubrication and boundary lubrication. In hydrodynamic lubrication, a layer of liquid prevents contact between the opposing surfaces. For diesel fuel pumps and injectors, the liquid is the fuel itself and viscosity is the key fuel property. Fuels with higher viscosities will provide better hydrodynamic lubrication. Diesel fuels with viscosities within the ASTM D975 specification range provide adequate hydrodynamic lubrication. Boundary lubrication becomes important when high load and/or low speed have squeezed out much of the liquid that provides hydrodynamic lubrication, leaving small areas of the opposing surfaces in contact. Boundary lubricants are compounds that form a protective anti-wear layer by adhering to the solid surfaces.

3.2 OVERVIEW / SPECIFICATIONS

| Description | Definition |
|--|--|
| Lubricity | Ability of a lubricant (in this case diesel fuel) to minimize friction between and damage to surfaces in relative motion under load. |
| Test Method | IP 450 |
| Effect of Property on Performance / Significance of Property | Poor lubricity causes excessive wear and at the extreme, causes catastrophic failure. |
| Upper Limit / Specification | >600 μm might not prevent excessive wear. |
| Maximum Standard Lubricity | <450 μm should provide sufficient lubricity. |

3.3 ANALYSIS

The maximum standard lubricity is 450 μm (Ref. 4) to ensure sufficient lubricity for the engine's operation. Poor lubricity (>600 μm) could potentially causes excessive wear and at the extreme, causes catastrophic failure.

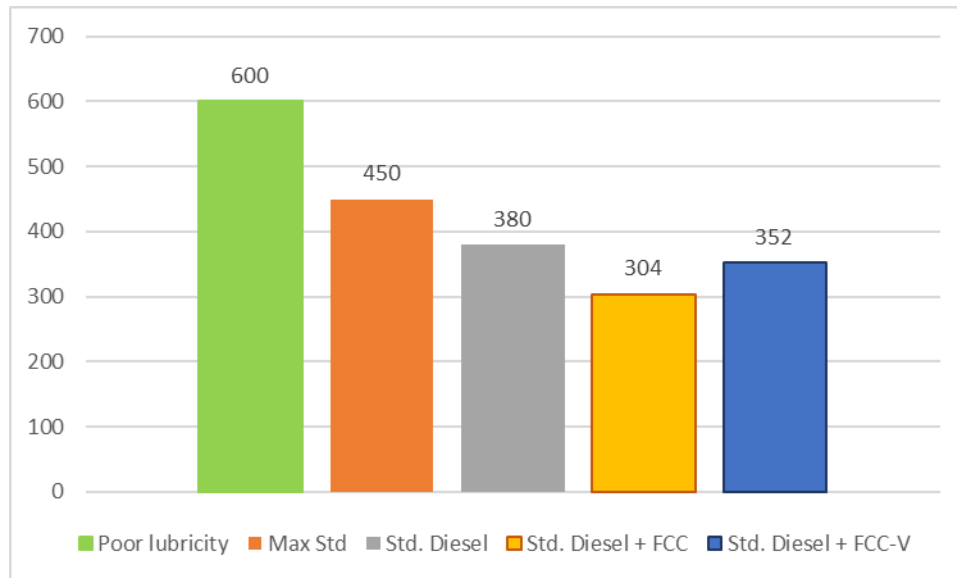
Based on the test results (Att. 1), the standard diesel (Control Colas Tank DSL) lubricity is 380 μm and when the standard diesel is added with:

- FCC: The lubricity improves from 380 μm (standard diesel) to 304 μm . This is a significant **20%** improvement of lubricity on the diesel fuel.
- FCC-V: The lubricity improves from 380 μm (standard diesel) to 352 μm . This is a high **7%** improvement of lubricity on the diesel fuel.

This increase in lubricity for both FCC and FCC-V, particularly FCC, will significantly improve durability of equipment and prevent premature wear of equipment by allowing equipment to operate to its intended design life. The improvement on lubricity is illustrated graphically in Figure 3.1.

The specifications of lubricity (upper limit, maximum standard and control sample) and improvement on lubricity of diesel (control sample) after addition of FCC and FCC-V are illustrated in Figure 3.1 below.

Figure 3.1: Lubricity Specifications (Std. Diesel and with FCC / FCC-V)





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24-February-2015

Attention: PETER SPRY
Purchase Order no. N/A
Your reference See sample details.
Our Ref No: Submission No: 53173b

REPORT ON DIESEL SAMPLES

Introduction:

Three diesel samples (see sample details) were received 10th February 2015 for testing as requested. The samples were tested as received.

Sample Details:

FCC Lab No: 59309-1
FCC-V Lab No: 59309-2
Control Colas Tank DSL Lab No: 59309-3

Results:

| Samples | Test | Unit | Result |
|------------------------|-----------------|------|--------|
| FCC | Lubricity IP450 | um | 304 |
| FCC-V | Lubricity IP450 | um | 352 |
| Control Colas Tank DSL | Lubricity IP450 | um | 380 |

INTERTEKGEOTECH

Noel Mellican
Division Manager

Max Offer
Technical Manager

Sample as received by Intertek. This report is for the exclusive use of Intertek's Client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this report. Only the Client is authorized to permit copying or distribution of this report and then only in its entirety. The observations and test results in this report are relevant only to the sample tested.

Report Reviewed



Diesel fuel quality standard

Management of Diesel Oil Burn Systems

The use of oil burn systems in diesel vehicles can potentially breach section 20 of the *Fuel Quality Standards Act 2000* if the addition of oil to the diesel within the engine results in the diesel not complying with the Fuel Standard (Automotive Diesel) Determination 2001.

As the Australian Government is committed to international best practice regulation of fuel quality, it has been decided not to amend the determination to allow the use of oil burn systems in any diesel vehicles operating in Australia.

It is considered that there is enough concern about the potential impacts on sulfur levels in diesel from the addition of used motor oil to warrant this decision.

[Management of Diesel Oil Burn Systems](#) - position paper

Environmental standards

The first suite of national fuel standards, which came into force on 1 January 2002, regulates petrol and diesel parameters that have a direct impact on the environment ('environmental standards').

The standards will have a major impact on the amount of toxic pollutants in vehicle emissions, such as benzene and particles, with studies estimating reductions of up to 50 per cent for some pollutants over 20 years. This is great news for our health, with cleaner air helping to reduce the number of serious respiratory illnesses and asthma cases, particularly in children.

Operability standards

A second suite of national fuel standards came into force on 16 October 2002. These standards ('operability standards') address those parameters of diesel that do not have a direct impact on emissions but, if not controlled, can have adverse impacts on the efficient operation of the engine.

Further operability standards are being developed that may include:

- for diesel - the parameters are appearance, acidity, cloud point and cold filter plugging point.

Summary table

The environmental and operability standards are consolidated in the following tables. The legal instrument implementing the standard is:

[Fuel Standard \(Automotive Diesel\) Determination 2001](#)

Diesel standards

| Parameter | National standard | Date of effect | Test Method |
|--|--|----------------|-------------|
| Biodiesel ¹ | 5.0% volume by volume (max) | 1-Mar-09 | EN 14078 |
| Sulfur | 500 ppm (max) | 31-Dec-02 | ASTM |
| | 50 ppm (max) | 1-Jan-06 | D5453 |
| | 10 ppm (max) | 1-Jan-09 | |
| Cetane Index | 46 (min) index | 1-Jan-02 | ASTM D4737 |
| Derived Cetane Number (of diesel containing biodiesel) | 51.0 (min) | 21-Feb-09 | ASTM D6890 |
| Density | 820 (min) to 860 (max) kg/m ³ | 1-Jan-02 | ASTM |
| | 820 (min) to 850 (max) kg/m ³ | 1-Jan-06 | D1298 |
| Distillation T95 | 370°C (max) | 1-Jan-02 | ASTM D86 |
| | 360°C (max) | 1-Jan-06 | |
| Polyaromatic hydrocarbons (PAHs) | 11% m/m (max) | 1-Jan-06 | IP391 |
| Ash | 100 ppm (max) | 1-Jan-02 | ASTM D482 |
| Viscosity | 2.0 to 4.5 cSt @ 40°C | 1-Jan-02 | ASTM D445 |
| Carbon Residue (10% distillation residue) | 0.2 mass % max | 16-Oct-02 | ASTM D4530 |
| Water and sediment | 0.05 vol % max | 16-Oct-02 | ASTM D2709 |
| Water (all diesel containing biodiesel) | 200 mg/kg (max) | 21-Feb-09 | ASTM 6304 |
| Conductivity @ ambient temp | 50 pS/m (Min) @ambient temp (all diesel held by a terminal or refinery for sale or distribution) | 16-Oct-02 | ASTM D2624 |
| Oxidation Stability | 25 mg/L max | 16-Oct-02 | ASTM D2274 |
| Colour | 2 max | 16-Oct-02 | ASTM D1500 |
| Copper Corrosion (3 hrs @ 50°C) | Class 1 max | 16-Oct-02 | ASTM D130 |

| | | | |
|--------------------------|---|--------------|----------|
| 12/11/2016 | Fuel Quality in Australia - Diesel fuel quality standard | Attachment 2 | |
| Flash point | 61.5°C min | 16-Oct-02 | ASTM D93 |
| Filter blocking tendency | 2.0 max | 16-Oct-02 | IP 387 |
| Lubricity | 0.460 mm (max) (all diesel containing less than 500 ppm sulfur) | 16-Oct-02 | IP 450 |

¹ The biodiesel component of diesel must meet the requirements of fuel quality standard for biodiesel set out in the Fuel Standard (Biodiesel) Determination 2003.

Disclaimer

The information contained on this page is of a general nature only and should be read in conjunction with the *Fuel Quality Standards Act 2000*, Fuel Quality Standards Regulations 2001 and the Fuel Standard (Automotive Diesel) Determination 2001. Fuel suppliers may wish to seek legal advice about their obligations under this legislation.