2-Stroke Oil In Diesel – A Technical Study

— Adrian Velaers - Sasol Energy Technology

ABSTRACT

The practice of adding 2-stroke oil to diesel is a topic that is enthusiastically discussed and debated by diesel vehicle owners around the world. The consensus of opinion on the ideal blending ratio as per some internet forums is reported to be a 200:1 volume mixture of JASO-FC grade 2-stroke oil in low sulphur diesel. The benefits of this are claimed to be better lubrication of injectors and fuel pumps, improved cetane number resulting in better combustion, and no detrimental effects. As these claims are based on anecdotal evidence, this study aimed to quantify any such effects under scientific laboratory conditions.

The motorist's motivation for following this self-medication advice stems from a perception that low sulphur diesel has inadequate lubrication capabilities in the high-tech fuel pump and fuel injection hardware found in modern diesel engines. The basis for this is not that sulphur itself acts as a lubricant, but rather that trace amounts of polar molecules present in crude-oil give diesel good lubricity properties. It is true that the refinery process used to remove sulphur from diesel also tends to remove these polar molecules. However, it is quite simple to replace the lost polar molecules by adding a lubricity improver additive which is the universal norm for low sulphur diesel practiced by the oil industry throughout the world.

This study reviews the industry standard test method for diesel lubricity which is part of SANS 342:2014, the standard governing the sale of diesel in South Africa. A diesel fuel passing this test demonstrates a high level of lubricity and adequate protection of modern diesel injection equipment. A number of test fuels were blended with and without 2-stroke oil and tested according to this method. An additional diesel lubricity test method known to be representative of diesel fuel pump wear was also used to confirm the results. The study also tested the cetane number of the same fuels to quantify any cetane benefit derived from 2-stroke oil in diesel. The 2-stroke oils used in the study were also analysed for metal content and high levels of zinc and other metals were found in the oils tested.

The study also included engine dynamometer testing using a modern common rail passenger car diesel engine. Engine performance and emissions were compared under laboratory conditions. Common rail injector fouling tests were also run to compare low sulphur diesel to the same fuel dosed with 2-stroke oil.

The results of the study support a view that the practice of dosing diesel with 2-stroke oil is surprisingly ineffective in terms of lubricity and cetane improvements. Engine performance, fuel consumption and emissions were also unchanged; however the use of 2-stroke oil in diesel is potentially harmful to modern diesel injection equipment. Trace amounts of zinc, an element which is found in most 2-stroke oils, are well known to cause injector nozzle fouling and the study measured high levels of injector fouling when the test engine was running on diesel dosed with 2-stroke oil. While the oil industry may not mind the additional revenue from the sale of 2-stroke oil with each tank of diesel, this study demonstrated that it is not in the best interest of the user to do so.

Keywords: 2-stroke oil, 2SO, lubricity, diesel, injector fouling

NONMENCLATURE LIST

Abbreviation	
2SO	2-Stroke Oil
DPF	Diesel Particulate Filter
EMA	Engine Manufacturers Association
EN590	Specification of European Diesel
HFRR	High Frequency Reciprocating Rig
IQT™	Ignition Quality Tester
IP	Illuminating Paraffin
LIA	Lubricity Improver Additive
Micron	Micrometer(µm) or 0.001mm
NEDC	New European Drive Cycle
ppm	Parts per million
ppb	Parts per billion
SAIT	South African Institute of Tribology
SANS	South African National Standard
SLBOCLE	Scuffing Load Ball on Cylinder Lubricity Evaluator

1. INTRODUCTION

It is well known that some diesel vehicle owners add 2-stroke oil to their diesel tank when they fill up. This topic is frequently discussed and debated, most notably on internet forums. The consensus is reported to be a 200:1 volume mixture of JASO-FC grade 2-stroke oil in low sulphur diesel. The benefits of this are claimed to be better lubrication of injectors and fuel pumps, improved cetane number resulting in better combustion, and no detrimental effects - based on anecdotal evidence.

The motivation for following this self-medication advice stems from a lingering urban legend that modern, low sulphur diesel has inadequate lubrication capabilities in the high-tech fuel pump and fuel injection hardware. There is also a concern that some suppliers of discount diesel (and others) may stretch their profits by blending illuminating paraffin in to the diesel and it is argued that a small dose of 2-stroke oil will help to compensate for the impaired lubricity caused by any illuminating paraffin dosing.

Superficially, it seems like a reasonable, belt-and-braces approach that is well aligned with the South African tradition of making a plan to get through difficulties. However, if one considers that the competitive automotive and fuel industry has conducted extensive research and agreed on carefully formulated fuel specifications to ensure reliable performance and long engine life, it is a fairly cavalier move on the part of the motorist to just add some extra “stuff” to the fuel in the belief that it will make it even better. This is especially true if one considers that 2-stroke oil is a very light oil that works to lubricate the internals of a 2-stroke engine because it is designed to form a residue that accumulates after the petrol evaporates. This is fundamentally different to the situation inside the diesel injection equipment where the diesel does not evaporate and a 200:1 trace of 2-stroke oil would remain dissolved in the fuel.

Notwithstanding the repeated assurances by the fuel industry that the fuel specifications for low sulphur diesel contain stringent provisions to ensure adequate lubrication for the engine components, the advocates for blending 2-stroke oil in diesel remain unconvinced due to lack of any published technical literature on the topic. Low sulphur diesel is a sensitive topic because there is also a very strong sector demand for even lower levels of sulphur in diesel to enable the introduction of more efficient and cleaner diesel technologies. (Perversely, such technologies would very likely be harmed by the addition of 2-stroke oil, as shown later in this paper).

Sasol has expressed the view that the practice of dosing diesel with 0.5% 2-stroke oil (equivalent to 200:1) is, at best, ineffective in terms of the problems described above, and at worst, it is potentially harmful to modern diesel injection and exhaust after treatment equipment (ie. catalytic converters). This view has elicited the reasonable public request that Sasol should indicate what tests were conducted to provide the basis for their view and this technical publication is intended to address that request.

2. TECHNICAL BACKGROUND

This section is included in an attempt to provide a brief and simple outline of the underlying technical principles of lubrication and diesel lubricity measurement. This forms the context of the fuel testing that was carried out and provides the basis for conclusions that were inferred.

The lubricity of a liquid can be loosely defined as its ability to prevent wear between moving parts. The manner in which it achieves this ability has two facets. Liquids generally tend to wet a metal surface which means that the liquid is actually adhering to the material surface. The liquid also coheres to itself, so any movement between the moving metal parts causes the liquid to be dragged into the contact area and to get between the two interacting surfaces. In this way, the fluid acts as a lubricant by squeezing itself into the rubbing interface and keeping the two rubbing surfaces apart. This is termed full hydrodynamic lubrication (*Stachowiak, 2005*) and it relies on there being adequate rubbing speed between the parts to drag in enough liquid. Increasing the load by pressing the rubbing surfaces together has a negative effect – the load tends to squeeze the liquid out. The inter-liquid “cohesion” is a liquid property called viscosity and an increase in viscosity will help to promote full hydrodynamic lubrication, however if the fluid is too viscous to be pulled into the gap, it may hinder lubrication. Mechanical equipment is therefore designed to use a lubricant within a specific viscosity range to ensure adequate lubrication.

When it comes to the diesel injection equipment of modern vehicles, the diesel pump and injectors are internally lubricated by the diesel fuel itself and full hydrodynamic lubrication is the design target. However, at slow engine speeds (like when starting the engine), the fuel lubrication can get a bit marginal. This is where another liquid property becomes critical, the surface-wetting characteristic, which is termed the boundary lubrication condition (*Stachowiak, 2005*). There are certain types of molecules (polar molecules) (*Stachowiak, 2005*) that adhere really well to a metal surface and they can be very effective at preventing wear under boundary lubrication conditions. Such molecules are found in trace amounts in crude-oil, but unfortunately, the process of removing sulphur from the diesel also tends to remove the polar molecules. This is how the rumour of low-sulphur diesel having poor lubricity got started, however, it is quite simple to just replace the lost polar molecules by adding a lubricity improver additive (LIA) which is the universal norm for low-sulphur diesel practiced by the oil industry.

3. LUBRICITY MEASUREMENT

The measurement of diesel fuel lubricity was a requisite step in the process of defining a fuel specification that was agreeable to all the industry stakeholders. For this purpose, it was necessary to develop representative test methods and there were two top methods to choose from. The industry was initially divided in opinion as to which methods were most representative and this section will delve a little bit deeper here to understand which method is best for the current topic (*Nikanjam, 1999*).

The one method was the Scuffing Load Ball-on-Cylinder Lubricity Evaluator (SLBOCLE) (ASTM D6078, 1999). The SLBOCLE test device presses a steel ball bearing against a rotating steel ring that is partially immersed in the lubricating fluid. A load is applied to the ball and it is increased until a specific friction force is exceeded which corresponds to the appearance of a “scuff” mark on the rotating cylinder. The load in grams at which this happens is recorded as the test result. In the United States, the Engine Manufacturer’s Association (EMA) guideline recommends a SLBOCLE test result in excess of 3100g as a minimum requirement for an acceptable fuel. Other sources are more conservative at recommending 3500g as an acceptable benchmark. As this test method has never formed part of a formal specification, these indicators can be used as a guideline.

The competing method was the High Frequency Reciprocating Rig (HFRR) (ASTM D6079,1999) which comprises of a steel ball that is pressed against a flat surface with a fixed load of 200g. The ball is then rapidly vibrated back and forth using a 1 mm stroke. After 75 minutes, the flat spot (wear scar) that has been worn on the steel ball is measured with a microscope. The size of the wear scar (in microns) is directly associated with the lubrication qualities of the fuel being tested. There is general agreement based on pump wear testing that if the HFRR wear scar diameter is less than 460 microns, the fuel will perform satisfactorily in an engine. European engine manufacturers and fuel injection pump manufacturers developed a round robin program in an effort to evaluate these two test procedures and they concluded that the HFRR may be a better predictor of fuel lubricity in an engine environment.

In terms of this simplified description of lubrication principles, one can appreciate that the SLBOCLE and HFRR methods do not actually measure the same thing. The SLBOCLE method, starting with a light load applied to the ball, will initially enjoy full hydrodynamic lubrication which will become challenged as the load is increased. The process will transition into boundary lubrication conditions as the load continues to rise and the test will finally end when the limits of boundary lubrication are reached and the ball scuffs the cylinder surface. In the HFRR test, on the other hand, the initial conditions are clearly beyond the boundary lubrication zone because wear always takes place. However, as the flat spot on the ball grows in size, the point is reached where the applied load is spread over a sufficiently large contact rubbing area for boundary lubrication to start to take effect. However, the motion is reciprocating (stop – start - stop), so the worn flat spot will continue to grow until full hydrodynamic lubrication can keep the metal surfaces apart. In simplistic terms, one could say that the SLBOCLE test measures the point at which boundary lubrication fails whereas the HFRR test measures the degree to which full hydrodynamic lubrication is achieved. In effect, therefore, the SLBOCLE test is mostly indicative of the fuel's wall-wetting characteristics and is a relevant test procedure for seizure protection and the presence of polar molecules, while the HFRR test is more indicative of the fuel viscosity and is a relevant test procedure for wear. As the methods measure different lubricating regimes, it is not surprising that there is poor correlation between the methods (*Nikanjam, 1999*. In general most fuels that meet the HFRR specification would also provide sufficient seizure protection, although this is not guaranteed and in order to ensure adequate lubricity it is important to consider both.

For the 2-stroke oil investigation, it was clear that results from both SLBOCLE and the HFRR tests would be required. The first step was to assess whether the trace amount of 2-stroke oil would improve the boundary lubrication situation (i.e. the hypothetical low-sulphur issues) and the second to assess whether it would improve the full hydrodynamic lubrication situation (i.e. low-viscosity IP dosing issues).

4. EXPERIMENTAL PROCEDURE

The following fuels were blended and used in the test methods listed:

Table 1: Test fuels

Sample Name	Fuel Description	2-stroke oil	LIA (Lubricity Improver Additive)*
EN590	European grade low sulphur diesel	No	Yes
EN590 + 2SO	European grade low sulphur diesel + 2-stroke oil	200:1	Yes
Market Diesel	South African low sulphur diesel from Johannesburg forecourt	No	Yes
Market Diesel + 2SO	South African low sulphur diesel + 2-stroke oil	200:1	Yes
Refinery Diesel	Low sulphur unadditised refinery diesel	No	No
Refinery Diesel + 2SO	Low sulphur unadditised refinery diesel + 2-stroke oil	200:1	No
2SO	2-stroke oil complying to JASO FC/API TC/ISO GD	-	-

* LIA : Lubricity Improver Additive

In this investigation the following test methods have been used:

1. **Lubricity:**
    - HFRR (High Frequency Reciprocating Rig) - ASTM D6079
    - SLBOCLE (Scuffing Load Ball-on-Cylinder Evaluator) – ASTM D6078
2. **Cetane number:**
    - Derived cetane number using the IQT™ (Ignition Quality Tester) - ASTM 6890
3. **Zinc content:**
    - Traces of zinc analysed by ICP-AES. Detection limit of 15ppb
4. **Exhaust emissions:**
    - Engine test measured over the New European Drive Cycle (NEDC) on an engine bench dynamometer
5. **Injector fouling:**
    - Engine test measured using the Sasol Common Rail Injector Fouling test on an engine bench dynamometer:
      Engine tests were conducted at the Sasol Automotive Lab in Cape Town, using accepted industry standard test procedures. The engine used in this case was a 1.6 litre, 4-cylinder turbo-diesel engine with piezo-electric common rail fuel injection from a popular passenger car sold in South Africa.

5. RESULTS

The results of the various test procedures are given in the sections below with brief descriptions.

5.1 Lubricity

HFRR test results:

The HFRR (High Frequency Reciprocating Rig) was used to measure diesel lubricity by rubbing a steel ball on a plate in a bath of fuel. The ball develops a flat spot over the course of the test which is called the wear scar, the diameter of which is the measure of diesel lubricity. All diesel sold in South Africa must pass this test with a maximum wear scar of 460 microns, which does ensure adequate lubricity for all diesel fuel systems. This is the same specification as applied in Europe and many other parts of the world. The results in Figure 1 represent the fuels tested as per Table 1.

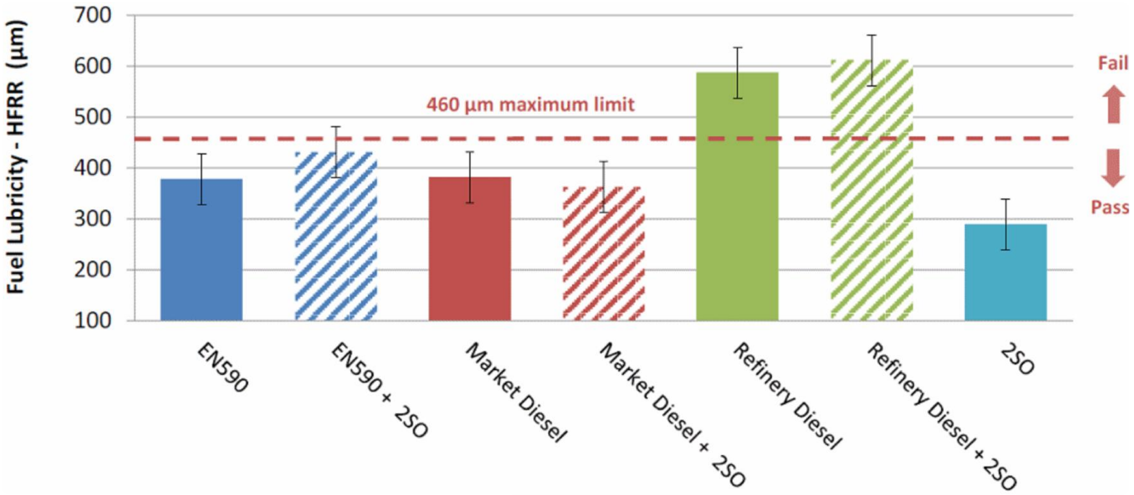

Figure 1: HFRR Lubricity results

The test method has an uncertainty band indicated by the error bars on the graph. Only differences that exceed these repeatability limits can be considered significant. Results that fall within the repeatability band of the method are considered to be the same. The neat 2-stroke oil itself was also tested and it is interesting to note that the lubricity of the oil is not vastly better than a final market diesel, hence it is not surprising to see no significant difference between the various fuels and those dosed at 200:1 with 2-stroke oil. Liquid fuel properties such as viscosity were identical at a 2-stroke oil dose of 200:1 in the diesels.

Note that by law in South Africa, diesel has to meet SANS 342:2014 lubricity specifications before being sold into to the market. In cases where lubricity does not meet the HFRR specification, a lubricity improver additive will be dosed at the refinery or depot and the bulk fuel tank will be tested for compliance. The refinery diesel results from Figure 1 are not unusual for desulphured diesel which does not contain a lubricity improver additive. The difference between the refinery and market diesel in Figure 1 is indicative of the efficiency of the lubricity improver additive itself and puts the minimal effect of 2-stroke oil into perspective.

SLBOCLE test results:

The other test method for diesel lubricity used in this study was the SLBOCLE (Scuffing Load Ball-on-Cylinder Lubricity Evaluator). This method measures seizure load. Although it is not written into any legislated specification for diesel, it was used to gain a better understanding on the lubricity effect of 2-stroke oil in diesel. The results are presented in Figure 2 using the same test fuels.

Similar to the HFRR, the method has some degree of uncertainty indicated by the error bars. Neat 2-stroke oil was also tested here and the results are very similar to the HFRR in terms of the negligible lubricity benefit of 2-stroke oil in a diesel fuel system application.

Note that the practise of diluting diesel with illuminating paraffin (IP) is illegal and has a detrimental effect on lubricity. As seen in the results in Figure 1 and Figure 2, 2-stroke oil will not help to bring this into specification; whereas additional lubricity improver additive might be able to. In South African law, IP has to contain a tracer additive which enables easy detection of diesel that contains IP. Results of diesel-IP blends are not published here as this practice should in no way be endorsed by a technical publication, however it can be revealed that the effect of 2-stroke oil was similarly negligible.

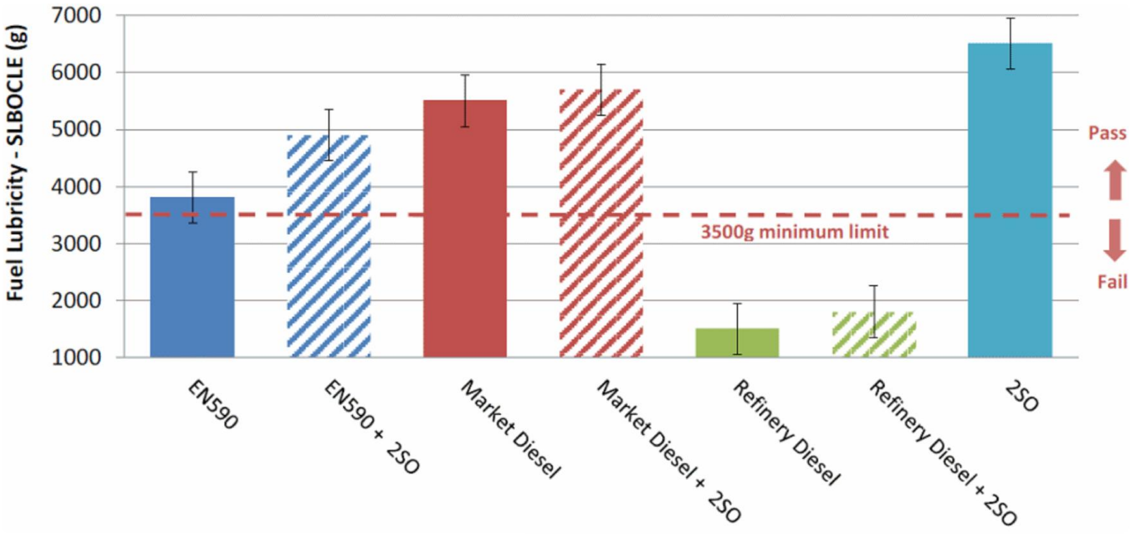

Figure 2: SLBOCLE Lubricity results

5.2 Cetane Number

According to the Derived Cetane number test method ASTM 6890, fuel samples are ignited in a combustion chamber at elevated temperature and pressure. The ignition delay is measured and correlated to the cetane number scale. The results in Figure 3 represent the relevant fuels tested.

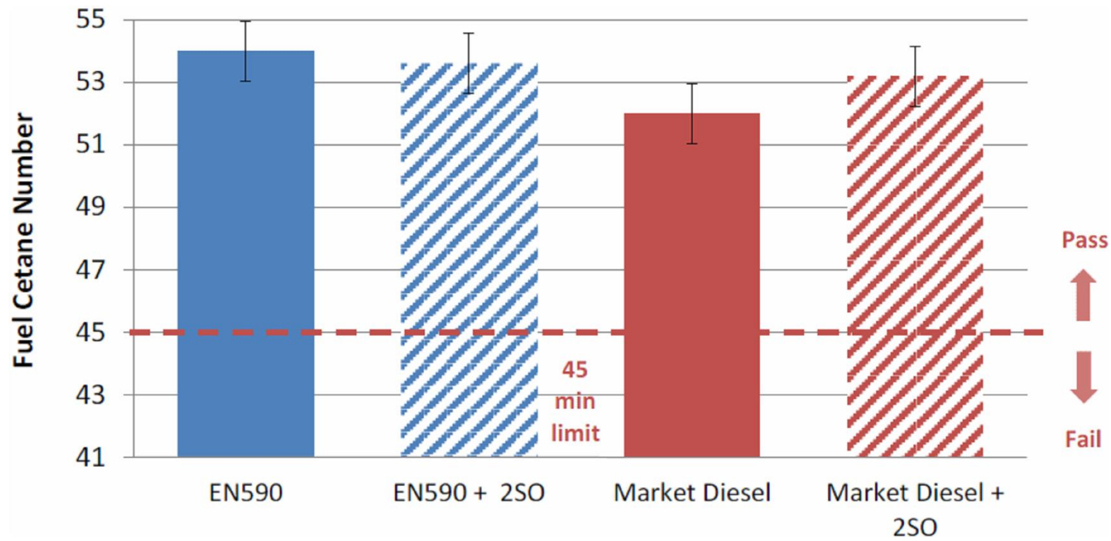

Figure 3: Cetane number test results

There is no technical reason for trace amounts of a light lubricating oil to materially change the ignition characteristics of diesel. The results follow by indicating negligible differences in cetane number when 2-stroke oil is added to diesel at 200:1. The repeatability of the test method is indicated by the error bars, and results within this repeatability are considered to be the same.

5.3 Zinc Content

Modern diesel engines require clean diesel, which refers to diesel free of harmful contaminants such as sulphur and metals. It is well known that sulphur can poison the platinum coated catalysts and oxygen sensors, and also cause a build-up of sulphuric acid in the oil. It is of course beneficial to use the lowest sulphur that can be sourced, and any diesel engine is compatible with sulphur free diesel. It is less well known that traces of soft metals such as zinc and copper can be dissolved into diesel fuel and are known to cause stubborn injector nozzle deposits. These deposits narrow the nozzle holes of diesel fuel injectors which result in less fuel delivery and engine power loss over time. 2-stroke oil, like most engine oils, does contain zinc. In this study two different brands of 2-stroke oil, referred to here as 2SO A and 2SO B, were analysed and found to contain high levels of zinc:

- **2SO A:** 15.8ppm Zn
- **2SO B:** 16.9ppm Zn

Zinc levels as low as 1pmm in diesel can cause severe injector fouling and such fuels are used for injector fouling engine tests to accelerate fouling for research purposes. Low levels of zinc were measured using the ICP-AES method specifically calibrated for diesel measurements and accurate to 15ppb. Figure 4 indicates the various fuels and 2-stroke oil blends that were tested. Included in this figure is the injector fouling test fuel which is discussed in further detail in Section 5.5.

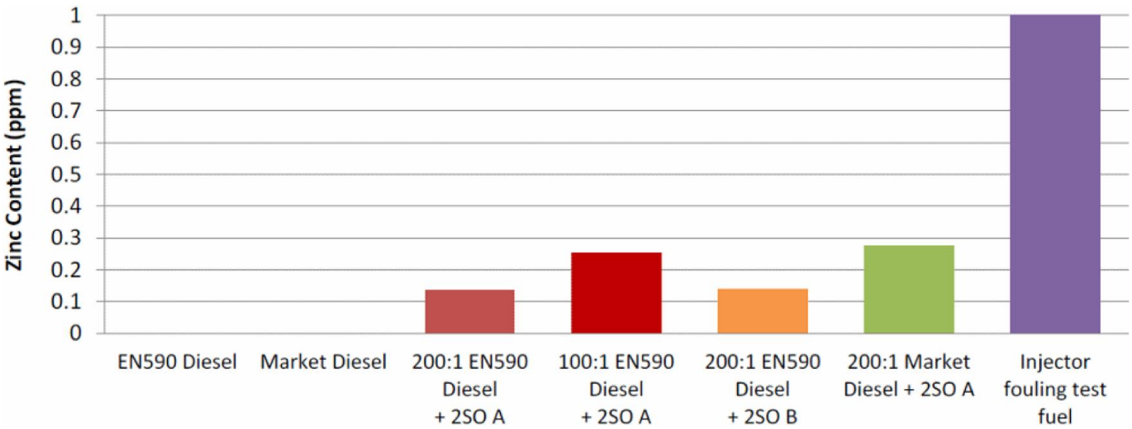

Figure 4: Zinc analysis of test fuels

Zinc content held in solution is strongly dependant on the solvency power of the specific fuel, which is why different fuels can show different zinc contents for the same level of zinc added (*Velaers, 2013*).

5.4 Exhaust Emissions

2-stroke petrol engines are associated with excessive exhaust gas emissions and visible blue smoke. In order to quantify the effect of 2-stroke oil on exhaust emissions in a diesel engine, exhaust emission tests were conducted according to the NEDC (New European Drive Cycle) at the Sasol Automotive Lab on a transient engine dynamometer. The engine used was the same 4 Cylinder common rail turbo-diesel as described in Section 4.

Exhaust emissions of the Market Diesel were compared to a 200:1 blend of Market diesel and 2-stroke oil. The test was repeated three times for each fuel and the average results were compared. The results showed that the 2-stroke oil had a negligible effect on all legislated emissions (Carbon Monoxide, Hydrocarbons, Nitrogen Oxides and Particulate Matter (black smoke)). There was also no evidence of any visible smoke. The fuel consumption over the test cycle was also unchanged. This is in-line with expectations as 2-stroke oil is a light oil such as diesel, so small amounts should have no marked effect on emissions from a diesel engine. Any resultant damage to exhaust after treatment systems can however increase emissions.

5.5 Injector fouling

The Sasol Common Rail Injector Fouling test method is based on a worldwide industry standard test for injector fouling. The development of this test procedure and subsequent results have featured in a number of peer reviewed international publications (*Velaers, 2012/2013*). In this study fuels were tested without detergency additives or any artificial zinc addition. The same 4 Cylinder common rail turbo-diesel as described in Section 4 was used in this test procedure on a bench dynamometer at the Sasol Automotive Lab.

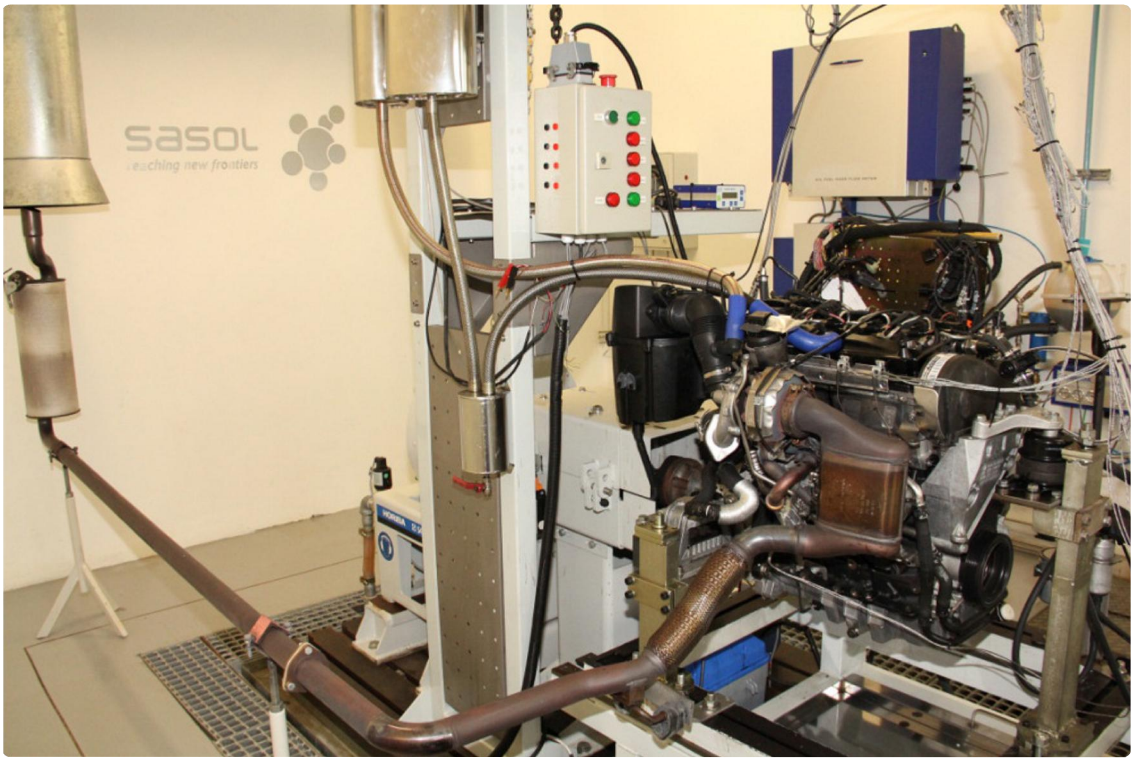

Figure 5: The engine test apparatus used at the Sasol Automotive Lab

The engine test was started with new injectors and was run over a very high load test cycle for 16 hours. Every 30 minutes the engine's full power and associated fuel flow was measured at 4400rpm (rated power and maximum rail pressure point of the engine). Any drop in power and fuel flow over the running time of the test indicates that injector fouling is taking place, restricting fuel flow though the injector nozzle holes into the engine.

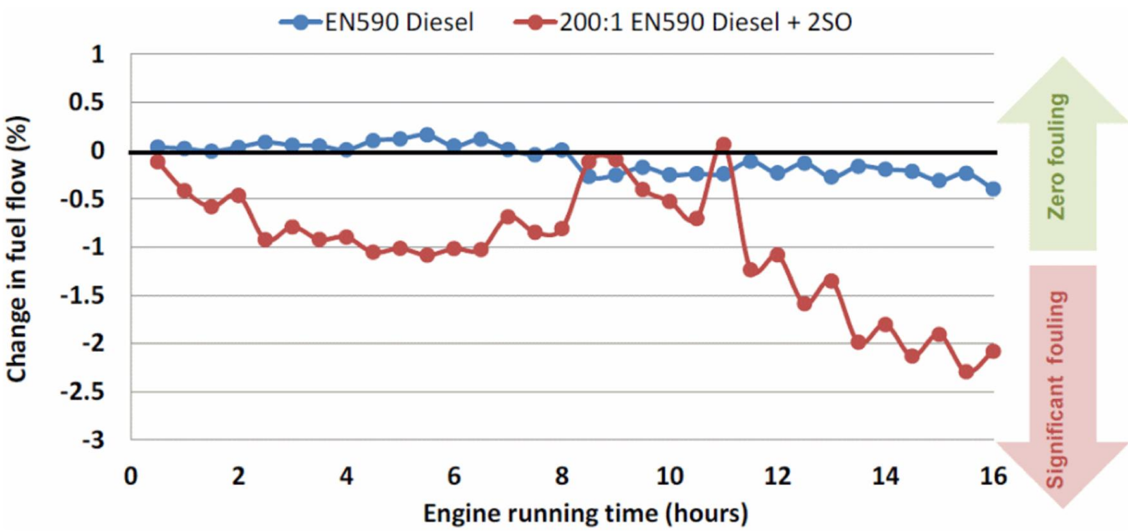

Figure : Results of the Sasol Common Rail Injector Fouling Test

The EN590 diesel used is the standard reference fuel for this test. This was compared to the same EN590 diesel dosed at 200:1 with 2-stroke oil. Figure 4 shows that the zinc content for this fuel was 0.135ppm, and EN590 diesel contains no zinc. Figure 6 shows the results of the injector fouling test. Regular diesel contains no zinc and causes almost zero flow loss in the test. Injector fouling test fuel, which is artificially dosed to 1ppm zinc as depicted in Figure 4, typically results in around 6% flow loss in the same test. The results show that fuel flow is reduced by 2% over the 16 hour engine test when 2-stroke oil is mixed with diesel.

This also results in an engine power loss of 2%. This result is therefore not surprising as even trace amounts of zinc can cause injector fouling in modern engines (*Leedham, 2004*).

Injector deposits form gradually over time. If they don't strongly bond to the injector they can break off under the forces of the fuel flow and thermal contraction of the injector. This is why in this test procedure, the engine is stopped and allowed to cool after 8 hours before being restarted. This explains the increase in fuel flow at the 8 hour midpoint in the test. Metal based deposits, such as those caused by zinc, bond very strongly to the injector nozzle and build up continuously. These are permanent and not removed by cold starting. It follows that regular use of 2-stroke oil in diesel could result in substantial injector fouling over the lifetime of a diesel engine. Furthermore, in modern vehicles with exhaust gas after treatment systems, zinc and other metal contaminants collect in the diesel particulate filter (DPF) and do not burn off when re-generated, thus blocking it over time.

6. DISCUSSION

2-stroke oil is a product designed very specifically to dissolve homogeneously in petrol and lubricate parts of a 2-stroke engine once the petrol has evaporated off the metal surface. 2-stroke engines are designed to require minimal lubrication though the use of roller bearings on all rotating parts as well as having only one piston ring. The efficacy of this product as a lubricity improver for diesel fuel is extremely limited, and this study proves that it has no measurable effect in terms of improving diesel lubricity. It is however shown that the lubricity of low sulphur refinery diesel can be substantially improved by Lubricity Improver Additives which are specially formulated for use in diesel and on diesel engines. These additives are routinely used by oil companies throughout the world to ensure that diesel complies with the stringent lubricity specifications in each country.

The dilution of diesel with IP, petrol or contamination by water, are risks that all diesel engine operators face. Each one of these aspects can result in the ultimate failure of diesel injectors and fuel pumps. Unfortunately no amount of 2-stroke oil will mitigate the problem if these substances make their way into the diesel tank, and even a lubricity improver additive will be ineffective in the case of petrol and water contamination. The best way to guard against such contamination is to use a reputable brand of fuel from a reputable outlet. In the unlikely case of a fuel related failure, consistent use of the same filling station or brand makes a liability claim against the respective retailer that much easier to prove. Suspected fuel contamination should always be followed up by a fuel sample analysis of a fuel sample taken from the vehicle tank, and not the fuel filter. In the case where expeditions into remote areas are undertaken, it would be more beneficial to fit a higher capacity water trap to the vehicle and to replace the fuel filter more regularly than to invest in 2-stroke oil as a diesel additive.

While this study does show that no detrimental effects on lubricity or exhaust emissions are caused by the addition of 2-stroke oil to diesel, fuel injector fouling is a possible risk. The trace amounts of metals such as zinc found in most lubricating oils, including 2-stroke oil, can cause rapid injector fouling. While some high quality diesel fuels on the market, such as Sasol turbodiesel™ ULS, contain detergency additives that can clean up these sort of deposits, metal contaminants can still be harmful. The diesel particulate filter (DPF) fitted to most modern diesel vehicles is very effective in capturing soot (carbon) which can be readily burnt off (regenerated) when blocked. Other contaminants found in oils, such as zinc, result in ash formation in the DPF which eventually results in a permanent blockage and premature failure of this costly component.

It would therefore be irresponsible to advise or condone the use of 2-stroke oil in diesel and this practice is not recommended.

7. CONCLUSIONS

Based on the results of this study, the following conclusions are drawn:

- At a 200:1 volumetric blending ratio, 2-stroke oil has a negligible effect on diesel lubricity.
- All diesel fuel sold in South Africa has to meet the SANS 342:2014 lubricity specification to ensure the proper protection of diesel fuel pumps and injector systems.
- The low sulphur diesel products sold by Sasol contain lubricity improver additives which are far more effective than 2-stroke oil.
- At a 200:1 volumetric blending ratio, 2-stroke oil has a negligible effect on diesel cetane number.
- No measurable effect on all other regulated diesel properties was measured at a 200:1 dose of 2-stroke oil in diesel.
- 2-stroke oil can contain around 16ppm zinc, or higher depending on the formulation and batch.
- Trace amounts of zinc in diesel are known to rapidly accelerate injector nozzle deposits.
- Engine test results show that a 200:1 blend of 2-stroke oil in diesel results in a 2% loss of engine power in a 16 hour test due to injector fouling, a risk that would apply to any common rail diesel engine, but could also worsen fouling in older engines.
- Vehicles fitted with a diesel particulate filter (DPF) in the exhaust system could experience reduced DPF life due to the collection of ash and metal based contaminants in the filter over time with the continued use of 2-stroke oil.

The abovementioned results should hopefully clear up many of the public misconceptions around the use of 2-stroke oil in diesel and highlight why both oil companies & engine manufacturers do not recommend the addition of any after-market additives, ie. 2-stroke oil, to the fuel tank. It is also good advice to use fuels from reputable outlets backed up by the technical support of a competent fuel company to enable the best engine performance and durability.

ACKNOWLEDGEMENT

Sasol Southern Africa Energy is acknowledged for funding this work and for providing the necessary technical research facilities. The author would also like to acknowledge colleagues Andy Yates, Renier Nel and Belinda Harker for their valuable input.

REFERENCES

ASTM D6079-11, Standard Test Method for Evaluating Lubricity of Diesel Fuels by the High-Frequency Reciprocating Rig (HFRR), ASTM International, West Conshohocken, PA, 2011 (first version 1999), www.astm.org (http://www.astm.org).

ASTM D6078-04, Standard Test Method for Evaluating Lubricity of Diesel Fuels by the Scuffing Load Ball-on-Cylinder Lubricity Evaluator (SLBOCLE), ASTM International, West Conshohocken, PA, 2010 (first version 1999), www.astm.org (http://www.astm.org).

ASTM D6890-13, Standard Test Method for Determination of Ignition Delay and Derived Cetane Number (DCN) of Diesel Fuel Oils by Combustion in a Constant Volume Chamber, ASTM International, West Conshohocken, PA, 2013 (first version 2003), www.astm.org (http://www.astm.org).

EN590-2010, Automotive fuels - Diesel - Requirements and test methods, European Committee for Standardization, Brussels, 2010.

Leedham A, Caprotti R, Graupner O, Klaua T, Impact on Additives on Diesel Injector Deposits, 2004, SAE Technical Paper 2004-01-2935.

Nikanjam M, Diesel Fuel Lubricity: On the Path to Specifications, 1999, SAE Technical Paper 1999-01-1479.

Stachowiak GW, Batchelor AW, Engineering Tribology 3rd Edition, 2005, Elsevier Butterworth Heinemann.

Velaers A, de Goede S, The Properties and Injector Fouling Performance of Neat GTL and EN590 Diesel Blends in Various Diesel Engines, 2012, SAE Technical Paper 2012-01-1692.

Velaers A, Woolard C, de Goede S, Injector fouling performance and solubility of GTL diesel dosed with zinc, 2013, SAE Technical Paper 2013-01-1697.

Paper ID: SAIT2015-011

Presented at the 11th International Tribology Conference

SAIT TRIBOLOGY 2015

10-12 March 2015, Pretoria, South Africa

Do Octane Boosters Work? (/dooctaneboosterswork.php)
Octane Booster Shootout (/Octane-Booster-Shootout.php)
What is Octane? (/whatisoctane.php)
How Octane is Tested (/octanetesting.php)
Can I Use AvGas? (/canirunavgas.php)
2 Stroke Oil in Diesel (/2strokeoilindiesel.php)
2 Stroke Oil in Diesel Technical Study (/2-stroke-oil-in-diesel-technical-study.php)
Unleaded or LRP? (/unleadedorlrp.php)
Fuel Saving Devices (/fuelsavingdevices.php)
Home (/)
Contact Us (/contact-us.php)
Privacy Policy (/privacy-policy.php)