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PROJECT PROPOSAL

EVALUATION OF THE INFLUENCE OF ADDITIZED DIESEL ON THE PERFORMANCE AND EMISSIONS OF A DIESEL ENGINE

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1. INTRODUCTION

The department of Mechanical Engineering, Tshwane University of Technology has been requested by a client to evaluate the effect of the diesel fuel additive on the operation of a diesel engine. Therefore, the department prepares a short project proposal to evaluate the performance and emissions of the diesel fuel additive utilising a typical South African engine.

The department proposed to conduct a series of tests on a locally widely used diesel engine. These tests should be conducted under cycle representative of local driving conditions. The tests will generate the results which will illustrate the extent to which fuel efficiency, power and several other engine parameters are affected by the diesel fuel additive. These results will then enable the department to assess the benefits of using the product tested.

This document serves as a preliminary project proposal and quotation. Much of the detail of the tests and evaluation procedures to be used are discussed below. A cost breakdown is provided, and the issues surrounding the time scheduling of the project are discussed. The results of test will be presented to the client in comprehensive documentation.

2. OBJECTIVES

The main goal of the project is to determine the effectiveness of a new fuel additive to be introduced into diesel fuel. The additive will be tested in a local, representative engine operated on a test cycle representative of local driving conditions.

The objectives of the proposed project are as follows:

- To quantify the effect of the diesel fuel additive on the power output, specific fuel consumption and several other parameters that could be influenced by using the additive under steady state testing conditions.
- To determine the emissions parameters of the diesel engine running on diesel with fuel additive under steady state testing conditions.
- To demonstrate the ability of the additive to cleanup fuel injection equipment and combustion chamber cleanliness under the proposed driving conditions.

3. TEST PROCEDURES

3.1 ADDITIVE MIXING PROCEDURE

Blends will be prepared on a volume basis at 25 ^{o}C. Although blend preparation on the basis of weight has the advantage that the weight fraction does not vary with temperature, the

common practice in the fuel industry is to carry out the mixing process on a volume basis at the ambient temperature of the blending location. For this reason, the option selected in this work will be to use blending rules as a function of volumetric fractions. The diesel fuel additive will be mixed based on the instructions of the additive supplier. The additive will be volumetrically measured to obtain required ratios. First, it will be mixed in a small container with diesel fuel according to the additive/fuel ratio required (may be 1:5000, 1:10000, depends on the client's request). The solutions will be kept stationary at room temperature for two days in this small glass container to observe if any phase separation will occur between the diesel fuel and additive. The aditised diesel fuel will be then poured in fuel tank and then mixed again to make sure that the mixture will be properly blended.

3.2 EXPERIMENTAL EQUIPMENT AND TEST PROCEDURES

3.2.1 Short Term Performance Test

A number of engine tests will be conducted at the Thermodynamics Laboratory engine test bench of the department of Mechanical Engineering, TUT. Engine tests will be performed on an Isuzu KB 250D four cylinder, four-stroke, water cooled naturally aspirated DI engine or any engine depends on the client's request. The Isuzu engine is selected on this project because it is commonly used in South African light-duty diesel vehicles.

Before embarking on the engine tests, the fuel tank, engine oil level, coolant and other engine conditions of the engine will be checked. The engine will be tested at the maximum fuelling mode, the volume of the fuel injected per stroke will be kept constant by the injection pump fuel rack to obtain a base line curve. This mode will be performed at an increasing speed, starting at 1200 rpm, and incrementing in steps of 200 to 2800 rpm. The preliminary tests will be undertaken to determine the engine's performance characteristics and exhaust emission levels, constituting the 'baseline' that will be compared with the corresponding cases when using the diesel fuel with additive. The engine will first be operated on the test fuel with additive for about 30 min without any load at the required engine speed. After reaching stable operating conditions, the engine load will be adjusted progressively until it reached the required level. In order to stabilize the engine operation at the required load, the engine will be then operated again for another 30 minutes. Measurements of fuel and air consumption rates, exhaust temperatures, brake load and exhaust regulated (NOx, CO, HC) and unregulated emissions (CO_2) will be taken. For any change in the engine loading and speed, the engine will be allowed to run for about 15 minutes to stabilize at the new load/speed point and the new data will be captured. Before testing a new fuel blend, the fuel lines will be purged and the fuel filter will be changed. The fuel tank will be drained and then filled with a few litres of diesel fuel. The engine will be again operated for about 1 hour in order to ensure that the last amount of the previously used fuel sample which could possibly still be remaining in the system will be fully consumed. The fuel tank will be emptied and manually cleaned again. The same procedures will be repeated for any fuel with new additive ratio to be tested.

Engine power will be measured from the dynamometer torque and speed. Fuel flow will be accurately measured and fuel efficiency reported as Specific Fuel Consumption (SFC) will be calculated.

3.2.2 Long Term Performance Test

The purpose of the long term testing, using 200 h preliminary durability screening test, is to assess the potential of additive on diesel engine durability. By using this test, candidate additive can be uniformly evaluated over longer periods of time for the effect on engine wear, injector cooking, carbon deposits and effects on lubrication oil. Performance parameters for this test will be compared with diesel fuel. The same engine used in the short term performance test (Isuzu KB 250D) will be operated for 200 h under cycled conditions that approximated city-suburban driving conditions. The engine will be operated in 12 h shifts, 3 h per cycles, allowing for 4 cycles per day. This will be followed by a 12 h heat soak period. This heat soak period led to a rapid build-up of deposits. This procedure will be repeated until 200 h on the test cycle will be completed. During the execution of any test, only the engine speed and engine load will be cycled. It is expected that after this engine test duration, sufficient deposit build up will be achieved. At the end of each cycle of the test, the engine will be dismantled, visually inspected and rated according to the Coordinating Research Conical (CRC) test procedures (November 15-17: 1993). After the rating process, the deposits from each of the four combustion chamber regions, the cylinder head region and the piston top region will be scraped using a gasket scraper and a fine wire brush. The sample material from the respective regions of the four cylinders will be then mixed together to form a large average sample for the respective region. When scraping, great care will be taken to avoid metal being collected along with the deposit. Usually, the last thin layer of the deposit will be ignored because it is too close to the metal surface. After scraping, the cylinder head will be washed using an organic solvent (acetone); this process will be assisted with sand paper and a wire brush for removing the remaining deposits. Subsequently, the cylinder head will be brushed again until all the deposits will be removed and only varnish remained. The piston crown and piston top will be cleaned in a similar manner. This will be carried out carefully so that the piston crowns and piston tops are not damaged during cleaning. Compressed air will be used to remove the loose carbon from the cleaning areas. Thereafter, the cylinder head will be assembled to the engine; the used lubrication oil will be discharged and refilled with new oil before performing a new test.

4. PROJECT OUTLINE

A breakdown of the project plan is given below in Table 1. This details the individual steps required for the engine preparation, measurements and report compilation.

Table 1 Project Plan Breakdown.

Step	Description	Task Number	Task description	Time Allocation (days)
0	**Engine Preparation**			5
		1	Acquire Engine	
		2	Engine Installation on Test Bed	
		3	Engine Break In	
		4	Performance and Emissions Test	

		5	Engine Strip Down	
1	**Keep Clean - Unadditised Fuel**	6	Weigh New Inlet Valves	15
		7	Measure Injector Flow Rate	
		8	Engine Preparation and Rebuild	
		9	Performance and Emissions Test	
		10	Keep Clean Test - 200 hrs Unadditised Fuel	
		11	Performance and Emissions Test	
		12	Engine Strip Down	
		13	Measure Injector Flow Rate	
		14	CCD Measure, Rate and Photograph	
		15	Weigh New Inlet Valves	
2	**Keep Clean - additised Fuel**	16	Engine Preparation and Rebuild	15
		17	Keep Clean Test - 200 hrs additised Fuel	
		18	Performance and Emissions Test	
		19	Engine Strip Down	
		20	Measure Injector Flow Rate	
		21	CCD Measure, Rate and Photograph	
		22	Weigh New Inlet Valves	

5. COST BREAKDOWN

The cost breakdown of the project is given below in 2.

Table 2 Project Cost Breakdown

Task	Cost
Engine Acquisition and Preparation	R 15 000
Special Measurement Apparatus Preparation	R 10 000
Engine Break in (10 hrs)	R 4 000
Performance and Emission test	R 15 000
CDD Thickness, Scrape and Weigh Rate	R 8 000
Long Duration Testing (400 hrs)	R 50 000
Combustion deposit/Oil Analysis	R8 000
Data Analysis and Report Compilation	R 6 000
TOTAL PRICE	**R116 000.00**

6. CONCLUSION

The client is planning to introduce a new fuel additive into the local diesel fuel and requires that the effectiveness of the use of the additive in diesel fuel to be evaluated. The department of Mechanical Engineering has been asked to prepare a project plan and costing to perform the necessary evaluation. This document serves as a preliminary project proposal and all aspects detailed above are open to discussion.