



## **Executive Summaries of Two Trials of Emulsified Fuels**

### **Trial 1: At wharf**

#### **Emulsified Fuel Tests on Arahura Generator Engine**

**Andrew Campbell Fuel Technology Limited**

**10 August 2013**

#### **1. Executive Summary**

The use of an emulsified fuel comprising M80 as the base fuel, 8% water plus an emulsifying agent has been trialled in a Wartsila 6R22HF generator engine on board the Arahura.

A 5.5% decrease in specific fuel consumption was realised with the use of the emulsified fuel under high load operation, compared with use of straight M8. Considering the potential experimental errors involved, this improvement is significant. The apparent improvement in fuel consumption was also supported by other data including that indicating a lower loss of energy to the exhaust gases.

However, operation at low load was compromised, as indicated by increased smoke and increased specific fuel consumption (although the increase in indicated fuel consumption was within experimental error and is therefore not significant).

Although the improvement in fuel economy realised under high load operation is significant, it is reliant upon a single test (although data taken during each test did indicate that the metering involved was consistent, adding to the robustness of this final "single" result). Methods to provide more robust verification of improvements and compromises have been provided.

## **Trial 2: At Sea**

### **Trial of Emulsified Fuel Fuelling of Arahura Generator Engine “AE2”**

**Andrew Campbell Fuel Technology Limited**

**September 2015**

#### **1. Executive Summary**

Engine trials were carried out on one of the Arahura's generator engines to test the use of a water in M80 emulsified fuel (M80, without the water, is the standard fuel used by the Interislander for its vessels). This followed successful tests of this fuel in a one-day trial in 2013. The aim of this trial was to evaluate the performance of the engine over a longer timeframe. This necessitated on-board production of the emulsified fuel – which effectively amounted to a trial of the logistics of the fuel's use as well as the fuel's performance.

This report concerns the engine performance testing component of the trial.

The generator engine was instrumented so that its specific fuel consumption could be determined (requiring the metering of fuel consumed and electrical energy generated) and the data from this and the standard engine instrumentation were used to assess the performance of the engine over various series of one-hour tests on M80 (the standard fuel) and on emulsified fuel. The end-to-end trial comprised a total of 1250 hours of engine operation over which 36 such one-hour tests were conducted, around 80 tonne of emulsified fuel was consumed<sup>1</sup>, and a similar order of standard M80 fuel was consumed.

Comparison of test results from testing the generator engine on M80 and on emulsified fuel found that:

1. Use of emulsified fuel brought about an improvement in specific fuel consumption of around 3%. It is possible that a greater improvement in specific fuel consumption could have been found had the comparison been made in like-for-like engine conditions and arrangements. For example the temperature of the emulsified fuel was consistently around 15°C cooler than for the M80 which may have changed the characteristics of the first atomisation of the fuel.
2. When the engine was returned to standard M80 operation at the end of the trial an approximately 2% improvement in specific fuel consumption remained. This improvement was real as it was supported by other evidence including reduced exhaust temperature (indicating lower energy loss to the exhaust). No specific cause for this improvement was identified. However, internal inspection of the combustion chamber and part of the exhaust did find a reduction in the amount of soot after operation on emulsified fuel and this cleaner state of the engine may be the reason.
3. There were no significant differences in the cylinder pressure diagrams at same engine loads indicating that there were no

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<sup>1</sup> Based on production of 82,979 litres, less around 2 tonnes reprocessed.

concerning changes to the combustion profile. Note that pressure diagrams are normally a good source of information when looking for reasons for changed performance. However, on this occasion the taking of pressure diagrams for the different fuels was separated by a turbocharger change and a change in the visual cleanliness of the engine making it difficult to attribute small variations in pressure diagrams to differences in how the fuels combusted.

3. There were no significant differences in exhaust emissions. Similar to the taking of pressure diagrams, exhaust emissions testing of the two fuels was separated by changes in the engine arrangement and a more detailed assessment could not be made because of this.