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## **EFFECTS ON LUBRICITY OF WATER CONTAMINATION OF DIESEL FUEL WHEN TREATED WITH CHORNCO 2082 DIESEL FUEL TREATMENT**

**TESTED ON 20 MARCH 2003**

### **INTRODUCTION**

1. From time to time there are instances where water contaminates diesel fuel held in storage. Chornco claim that their product, "Chornco 2082" will encapsulate a percentage of water held in suspension and carry it harmlessly through the fuel system and their components. This claim relates to a maximum of 1% water by volume held in suspension. A lubricity test would demonstrate if there were any increase/decrease in wear scars produced where water was present. This would provide a clear indication of the potential to protect engine components under these circumstances.
2. As part of a series of testing done by the Army to evaluate the effectiveness of Chornco 2082, the Army Engineering Authority (AEA) request the NZ Defence Technology Agency (DTA) to carry out a lubricity assessment of this product mixed with diesel in the ration of Chornco to diesel of 1:1280. A number of straight diesel and Chorncoised diesel was supplied to DTA for testing. DTA performed an assessment of fuel lubricity using the Falex Ball-On Three Disks (BOTD) test machine. Test report (C960-File ref. 3739/9404 dated 26 March 03) from DTA was subsequently given to AEA. The test showed that the mean wear scar diameter was reduced by 11% with the addition of Chornco 2082. This therefore clearly represents an improvement in lubricity.
3. As part of these tests, DTA conducted a Water Reaction Test that gives an indication of the water-shedding capability of the fuel. This test showed that straight diesel demonstrated good seperability whilst Chorncoised diesel produced an amount of emulsion visible after 10 minutes of shaking. This would indicate that there may be a problem in using this product and further investigation was to be carried out as a result. It should be noted that the Water Reaction Test derived from Def Stan (UK) on Naval Fuel Distillates was not compatible with the equivalent Ground Fuels Standard

4. It is considered by AEA that this Water Reaction Test was inappropriate for the consideration of ground fuel for the following reasons:
  - a. water is not pumped in and out of ground fuel storage fuel tanks or vehicle fuel tanks,
  - b. current fuel contracts limit allowable water percentage to 0.02% by volume, and
  - c. settling times are generally much greater than 10 minutes
  
5. For these reasons it was decided to repeat the Water Reaction Test in Trentham using 5% by volume water content using the 10 minute settling period and to measure the lubricity immediately after shaking in order to determine the effect of a 5% water/95% fuel emulsion on engine components should this highly unlikely situation arise.

## **OBJECTIVES**

6. The purpose of these tests was to:
  - a. repeat the Water Reaction Test using a 5% water/95% fuel mixture;
  - b. identify the effects on the diesel fuel used by the New Zealand Army, in terms of lubricity, when water is present at 5%: and
  - c. identify the effects on the diesel fuel used by the New Zealand Army, in terms of lubricity, when water is present at 5% as well as Chorncoco 2082 at 1:1280

## **TESTING METHOD**

### **Water Reaction Test**

7. 5mls of water was added to a measuring tube with 95 mls of water. This mixture was shaken for 60 seconds by tilting the measuring tube to 45 degrees and then inverting it through 90 degrees at a rate of 1 cycle in 2 seconds. Following the shaking the tube was left to stand and was repeated with another tube and another mixture 10 minutes later. This was repeated another 4 times so that a total of six measuring tubes were able to be observed. 10 minutes after the last tube was left to stand and a photograph was taken to show effects of separation after 10 minutes and up to 1 hour.

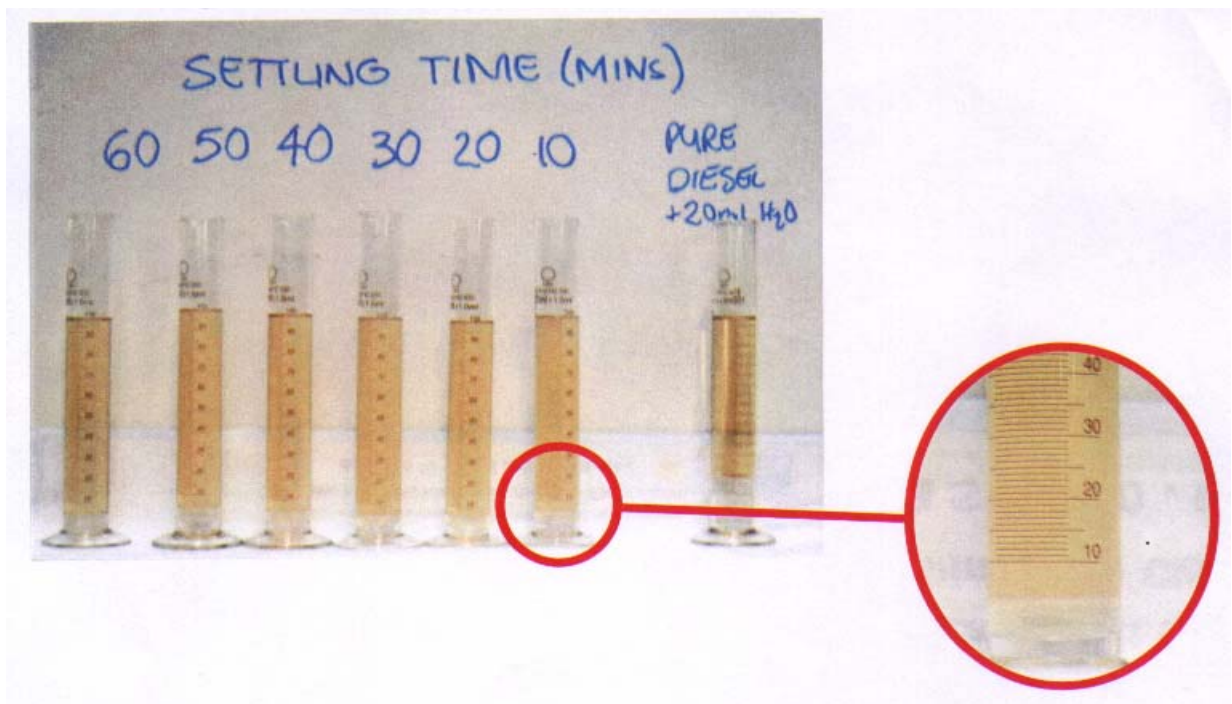
## Lubricity Tests

8. A Timken "OK" Wear test was conducted in order to determine the wear scar for each sample and this test would meet the requirements of ASTM D 2782. The use of constant weights and a torque gauge provides the load, which was set at 10 ft lbs. Measuring down to 1/10<sup>th</sup> of a millimetre. An amp meter indicated the electrical load. The machine was run for 30 seconds. Following each test the roller was removed and the wear scars were examined under a magnifier with a scale down to one tenth of a millimetre. Following each sample test the machine assembly, track, bath and screws were stripped down, degreased and cleaned thoroughly. The loads on the machine and the volumes of fuel in the bath were kept constant. For clarification the mixing process was repeated for each test, which used 10 millimetres of each sample tipped into the test tray and compromised of the following:
- a. Test 1. 10mls of straight diesel.
  - b. Test 2. 10mls of diesel mixed with 5%, by volume, of water.
  - c. Test 3. 10mls of diesel mixed with 1:1280 of Chornco 2082 Diesel Fuel Treatment.
  - d. Test 4. 10mls of diesel mixed with 5%, by volume, of water and 1:1280 of Chornco 2082 Diesel Fuel Treatment.

## RESULTS OBTAINED

### Water Reaction Test

9. The following photograph shows the water separation characteristics:



10. It was observed that complete separation of water and fuel did occur prior to the 10 minute period. This separation did not show any signs of change in subsequent time intervals of 10 minutes.

### Lubricity Tests

11. The results obtained for these tests are detailed as follows:

#### DIESEL ONLY – Comparing all results

Test Sample	Wear Scar Length	Wear Scar Width	Reduction/Increase in Length (%)	Reduction/Increase in width (%)	Ammeter reading	Increase/Decrease
<b>Baseline readings - 1</b>						
Test 1	9.1	4.5	n/a	n/a	1.3A	n/a
<b>Comparison readings</b>						
Test 2	9.2	4.7	+10%	+4.4%	1.5A	+20%
Test 3	8.6	4.3	-5.5%	-4.4%	1.1A	-15.3%
Test 4	8.6	4.3	-5.5%	-4.4%	1.2A	-7.7%

#### DIESEL WITH 5% WATER BY VOLUME – Comparing water addition only.

Test Sample	Wear Scar Length	Wear Scar Width	Reduction/Increase in Length (%)	Reduction/Increase in width (%)	Ammeter reading	Increase/Decrease
<b>Baseline readings - 2</b>						
Test 2	9.2	4.7	n/a	n/a	1.5A	n/a
<b>Comparison readings</b>						
Test 4	8.6	4.3	-6.2%	-8.5%	1.2A	-20%

12. It was noted that the lubricity of the fuel was poor, the Torque Meter needle vibrated considerably. This was due to Stick Slip\* as the Asperities\*\* welded and were torn apart. When Chornco 2082 was applied there was no such vibration. The only reason for this, given the strict regime of the trial was that additional lubrication provided by Chornco 2082 reduced the asperity contact.

13. When testing the Chorncoised fuel samples there was a reduction in the current consumption of the test instrument. This indicates lower friction in the current consumption of the test instrument. This indicates lower friction and subsequently a smaller wear scar resulting.

### SUMMARY

14. Complete separation of water and fuel occurred within 10 minute periods.

15. In all cases, the addition of Chornco 2082 resulted in an immediate and noticeable decrease in vibration of the instrument, wear scar length and width when added to both the standard diesel and the diesel containing 5%, by volume, of water.

## CONCLUSION

17. The tests have proved conclusive in that water mixed with diesel fuel has an adverse effect on its lubrication properties. Separation of the water and fuel mixture did occur within 10 minutes when the water is 5% of total volume. The use of Chornco 2082 supports the manufacturers claims and gives a positive set of results that would provide a solution to the potential wear effects brought about by water ingress in diesel fuel. In addition the improved lubricity demonstrated where water was not present further supports the use of the product when added to the fuel. Other proven benefits are provided in terms of fuel economy and improved engine performance. It is therefore concluded that the use of Chornco 2082 as a fuel additive provides only positive benefits in all circumstances tested.



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**\*STICK-SLIP:** is the jerky movement, which can result when an object moves across another. The asperities microscopically weld together for nanoseconds causing them to stick together, forming oscillations and inducing vibration. The mass moves rapidly and then tends to re-stick and break away, time and time again as the velocity increases. This is at a microscopic level.

**\*\*ASPERITIES:** Microscopic peaks and troughs derived from the machining process.