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your ref. PJB-AEA/94L (ER098/94)

Dear Peter,

Here are the results on XXTRALUBE ZX1 tested neat. The testing was carried out at a temperature of 100°C as this is fairly typical of the temperatures seen in service.

The test was carried out with XXTRALUBE ZX1 undiluted to the Dobson shortened form of the IP239/85 method. This is the most cost effective way to provide the information you require. The friction and wear tests were carried out at 180Kg load for a period of sixty seconds again at 100°C.

The figures obtained:-

IP239/85 Dobson method

Weld load - the load where seizure occurs

Initial seizure load - The load where the first friction transient occurs but is not maintained

Mean Hertz Load - This parameter gives an indication of the "Load carrying" capacity of the oil

Weld load in excess of	800Kg (no detectable weld at machine limit)
Initial seizure load	70Kg
Mean Hertz Load	$Dobson_{10s}$ 62

Friction and wear test

Test temperature = 100°C
Test load 180Kg
Typical Friction coefficient, μ, = 0.09
Average ball wear scar diameter = 1.08 mm

Yours sincerely

N.A.Strong
14/10/94

AEA

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12th May 1993

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Dear Peter,

The comparative testing of Castrol RS oil with and without out XXTRALUBE ZX1 5% as requested your letter dated 16 April 1993 (ref PJB567-93l) has been carried out using the following standard tests:

- ASTM D3233-73 Standard Test Method for Measurement of Extreme Pressure Properties of Fluid Lubricants (Falex Method)

and

- IP 239/85 Extreme Pressure Properties: Friction and Wear Tests for Lubricants: Four Ball Machine.

The brief results summary for the two sets of tests are

Sample Identity	Falex Failure Load (lbf)	4 ball Initial Seizure Load (kg)	4 Ball Weld Load (kg)	Calculated Mean Hertz Load (kg)
Castrol RS	1250	126	450	50.28
Castrol RS + 5% XXTRALUBE ZX1	3600	140	620	58.64

The Falex tests were carried out to the standard procedure which is paraphrased below. This starts at 50°C then is elevated by the frictional work expended in the test. Obviously the longer the test goes on the higher the temperature becomes. So for the RS test the final temperature was ~85-90°C whilst the 5% XXTRALUBE ZX1 test temperature ended at ~150-175°C.

Falex Test ASTM D3233-73 Summary:
Run-in specimens at 300 lbf jaw load at 50°C for 5mins, then reset applied load to 500lbf for 1 min. Then increase jaw load by 250lbf per load increment for a duration of 1 min until failure. Failure is determined by shear pin breakage, inability to maintain load, or seizure load large increases in measured friction.

The 4-ball tests was carried out at 100°C and as the Shortened Method due to Dobson, which is included as an Appendix in the IP standard (I have included a photocopy of both the standards with this letter for your reference). This a more effective route to getting essentially the same answer as the full standard procedure, but is a lot less labour intensive.

Falex Test Results

Sample Identity	Failure Load (lbf)
Castrol RS	1250
Castrol RS + 5% XXTRALUBE ZX1	3600

Four Ball Test Results

Sample Identity	Initial Seizure Load (ISL) (kg)	Weld Load (WL) (kg)	Average Load (kg)	Nearest Standard Load (kg)	Mean Hertz Load Used (kg)	Mean Hertz Load Determined(kg)
Castrol RS	126	450	288	250	225*	50.28
Castrol RS + 5% XXTRALUBE ZX1	140	620	380	355	180**	58.64

* Failed test at 250kg; next standard load down 225kg.
** Failed test at 355kg (x2), 315Kg, 225kg; next but one standard load down 180kg.

I have produced graphs of the results of both of the tests, and these are attached to this letter. The details of the wear scar measurements for the Mean Hertz load determination are as follows:

		Ball Wear Scar Diameters (mm)							
Sample Identity	Comp Dia.at MHL (mm)	1	2	3	4	5	6	Ave	n
Castrol RS	0.61	3.45	3.2	2.69	2.73	2.60	3.59	3.04	0.2
Castrol RS + 5% XXTRALUBE ZX1	0.565	2.18	2.33	2.46	2.31	2.28	2.58	2.36	0.24

n = Compensation Diameter divided by the Average Wear Diameter

I hope this is comprehensible and I look forward to our meeting when we will be able to discuss these results and any future work that may be required.

Yours sincerely,

Paul Tweedale

Paul Tweedale.
Special Projects.

Comparative Tests on Castrol RS without and with 5% XXTRALUBE ZX1, Falex pin in jaw ASTM D 3233-73.