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The Effect of PTFE Surface Coating on Engine Fuel Consumption

S. Mahmoodul Haq[1], M. Asadullah Khan[1], S. Shahab Anwar[1] and S.N. Sarwar[1]

ABSTRACT

A number of poly tetra fluoro ethylene (PTFE) colloidal suspensions are being marketed in the country which claim to form teflon layer on engine cylinders when applied with crankcase lubricants, thus reducing engine wear and improving fuel efficiency. This paper gives laboratory test results of a commercial additive with PTFE. According to the test results, no practical advantage has been achieved through the use PTFE additive on fuel consumption; in fact, it increased the wear rate of engine.

INTRODUCTION

It has been reported by Brawdon and Tabor (1954) that friction accounts for the consumption of 5 - 10% of the energy yielded from the combustion in a typical automotive engine and this may increase to about 50% under part load operation.

Makinson and Tabor (1964) have reported that 60-80% of the friction energy is expended at the piston/cylinder wall interface. Thus, a great deal of attention has been focused on the improvement in engine lubrication to minimise friction and consequently reduce fuel consumption.

Many workers like Stewart and Selby (1977), have recently directed their research towards the viscosity index improvers as too low a viscosity causes high oil consumption, excessive wear rates and increased energy losses. The use of friction modifiers has also been suggested. These additives under conditions such as starting lubricant dilution by fuel, excessive lubricant temperature and engine overload or overspeed may prove to be beneficial. They may also reduce piston scuffing under normal conditions.

A number of colloidal additives have been reported in literature (Braithwaite, 1966) which generally consist of molybdenum disulphide and graphite but recently the use of PTFE has been suggested to reduce friction and improve fuel economy to a considerable extent although its use still remains to be somewhat controversial. Typical properties of PTFE based lubricant are mentioned in Table 1. PTFE along with special additives has been reported (Eiss et al., 1976) to form a micro thin coating on the internal surface of the engine. This coating is said to be approximately 1-2 micron thick and is reported to last almost life of the engine.

We have reported in this paper a number of experiments on the effects of mixing an imported PTFE oil based additive obtained from market to the lubricating oil and our main concern was to observe changes relative to fuel consumption, friction modification and wear characteristics of the engine.

These may be regarded as preliminary experiments and further long term testing is suggested on the wear rates, friction modification and improved fuel consumption.

RESULT

Steady state results of fuel consumption and temperatures relative to the speed, the n-Heptane test for the insoluble, clogging formation and metal content test by the Atomic Absorption are shown in Tables 2, 3, 4, 5 and 6, respectively. The sharp appearance of the scratch lining on the piston are shown in photograph (Figures 1a, 1b and 1c).

In Table 6 the word "treated" means the engine after draining the oil plus PTFE. It is supposed that PTFE forms a layer on the intenal surface of the engine. The word "during treatment" means when the engine is being run on a mixure of oil and PTFE for several hours. For the test (Tables 2 and 4) oil used was SAE-40 grade API SC/CC motor oil. Specifications for PTFE and analysis of motor oil are given in Tables 7 and 8, respectively.

DISCUSSION

It appeared from the series of test performed in the laboratory that PTFE based oil commercially available in market has failed to produce a coating on the internal

[1] Hydrocarbon Development Institute of Pakistan, Karachi.

Table 1. Properties of PTFE based lubricant.		
Kinematic Viscosity @100°F (cSt)		104.88
Kinematic Viscosity @210°F (cSt)		12.16
Viscosity Index		122-123
Solid Content	Wt.%	1.23
Flash Point PMCC	°C	119

Table 2. Base line test - without PTFE (untreated).

TEST	R.P.M.	Fuel Consumption ml/hr	Oil Temperature °C
1.1	2050	351	163
1.2	2100	400	164
1.3	2200	437	165
1.4	2300	459	167
1.5	2500	493	168

Table 3. Test with PTFE and oil (1:4) (during treatment).

TEST	R.P.M.	Fuel Consumption ml/hr	Oil Temperature °C
1.1	2050	384	145
1.2	2100	425	149
1.3	2200	467	152
1.4	2300	464	155
1.5	2500	493	158

Table 4. Test with motor oil (treated).

TEST	R.P.M.	Fuel Consumption ml/hr	Oil Temperature °C
1.1	2050	380	157
1.2	2100	410	170
1.3	2200	427	172
1.4	2300	460	172
1.5	2500	493	175

Table 5. n-Heptane insoluble test.

Lubricating Used Oil (50 hrs)	Untreated	During Treatment	Treated
Motor Oil	0.18	n.a.	0.56
PTFE+Oil (1:4)	n.a.	0.85	n.a.

Table 6. Spectrometric analysis of used oil.

Sample Used Oil (50 hrs)	Fe	Al	Cu
Motor Oil (Commercial oil in untreated engine)	52	Nil	Nil
Oil + PTFE. (Oil plus PTFE solution)	197.36	15.08	2.84
Motor Oil (Oil in PTFE treated engine)	110.52	10.77	2.35

surface of the engine. Therefore no reduction in wear was recorded and it did not produce any noticeable reduction in fuel consumption. It is obvious from the Tables 2 and 4 that the test before and after treatment shows no reduction in fuel consumption at a particular speed. The results are further supported by the spectrometric studies of the used oil which reveal that the amount of iron content has been increased during and after the treatment. It may be emphasized that particular PTFE based oil did not actually burnished into the pores of the engine instead it has formed sharp lines on the surface of the piston of test engine (Figure 1).

This may be attributed to some particles of PTFE formed during the experiment. The particles of PTFE may have been dragged out of the groove by the sliding motion and because of this action wear may have been

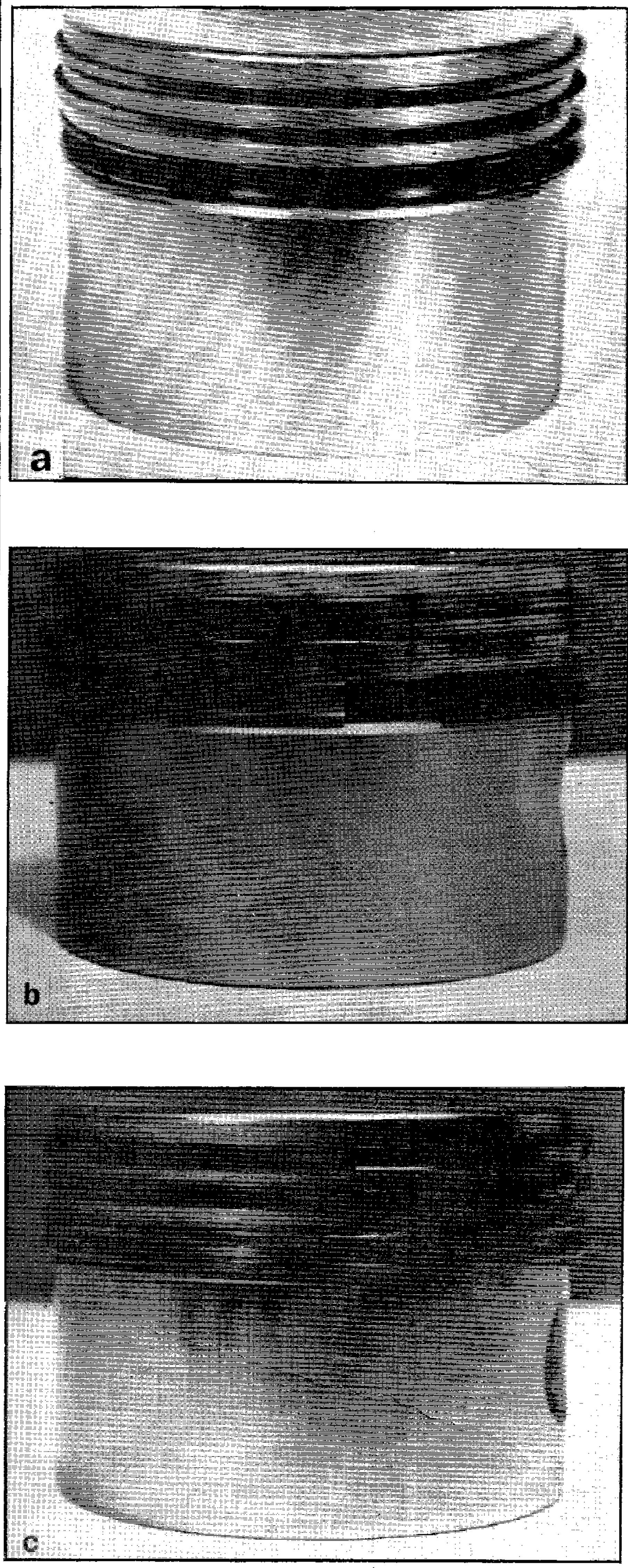

Figure 1– Piston surface: (a) before treatment, (b) during treatment, and (c) after treatment.

Table 7. Specifications for poly tetra fluoro ethylene.

Appearance

Viscosity opaque liquid with fine dispersion of white powder and fine sediment.

Color

Darkish brown with sometimes a clear dark liquid surface layer.

Typical Analysis

API Gravity at 60°F (ASTM D-1298)	27.6
Viscosity Index (ASTM D-2270)	155
Pour Point (ASTM D-97)	-30°F
Maximum Sedimentation Rate	30% of solids in 21 days
Solid Content	1.09%
Particle Size	Not less than 90%: below 5 microns Not less than 95%: below 10 microns Not less than 99%: below 60 microns.

Viscosity

Kinematic Viscosity	@ 100°F	139.8 cSt
	@ 212°F	16.9 cSt
Saybolt Universal Viscosity	@ 100°F	647.6 SUS
	@ 212°F	85.6 SUS
Flash Point PMCC		315°C
Colour Index (ASTM D-1500)		6.5
Particle Size Distribution	5-14 micron	70%
	15-24 Micron	15%
	25-49 micron	12%
	50-99 micron	
	100 micron	3%

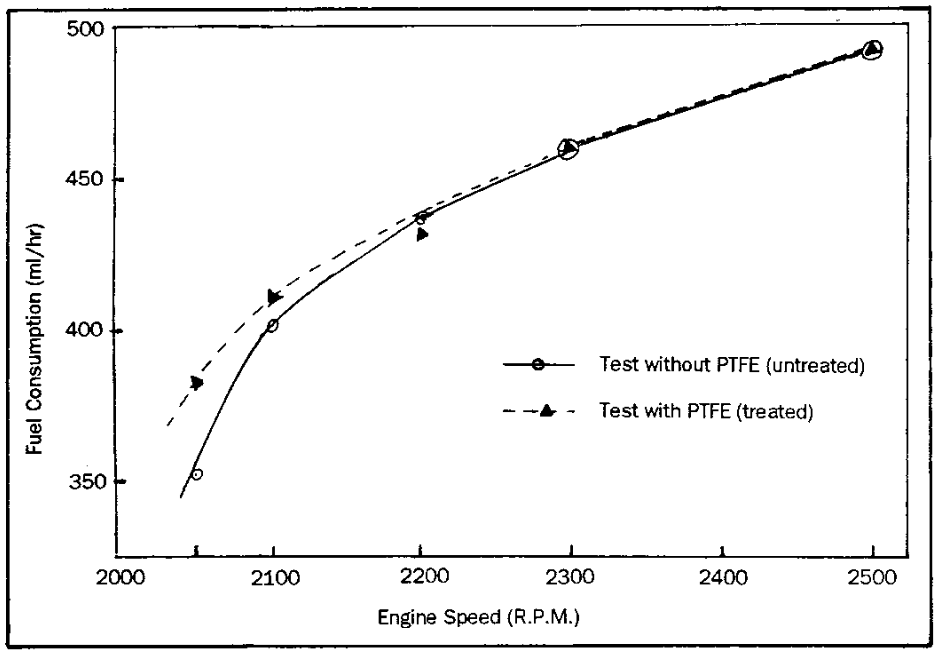

Figure 2– Fuel consumption vs. speed of the engine.

Table 8. Analysis of motor oil.	
Kinematic Viscosity @ 100°C (cSt)	12.0 - 15.0
Viscosity Index	85
Sulphated Ash (Wt.%)	0.38

occurred. When considering the particles formation during the treatment, the friction comes into the scene which also expectedly increases and hence becomes a part of the increasing load to the engine and consequently the engine consumes a greater proportion of fuels at medium RPM (Figure 2). During the treatment it has shown slight reduction in oil temperatures but after the treatment a steady increase in the temperatures has been noted (Figure 3).

Wear of the Engine

The analyses of the oil plus PTFE and oil alone indicate that the PTFE does not stop the wear of the engine but on the other hand it increases the wear of the engine (Table 6).

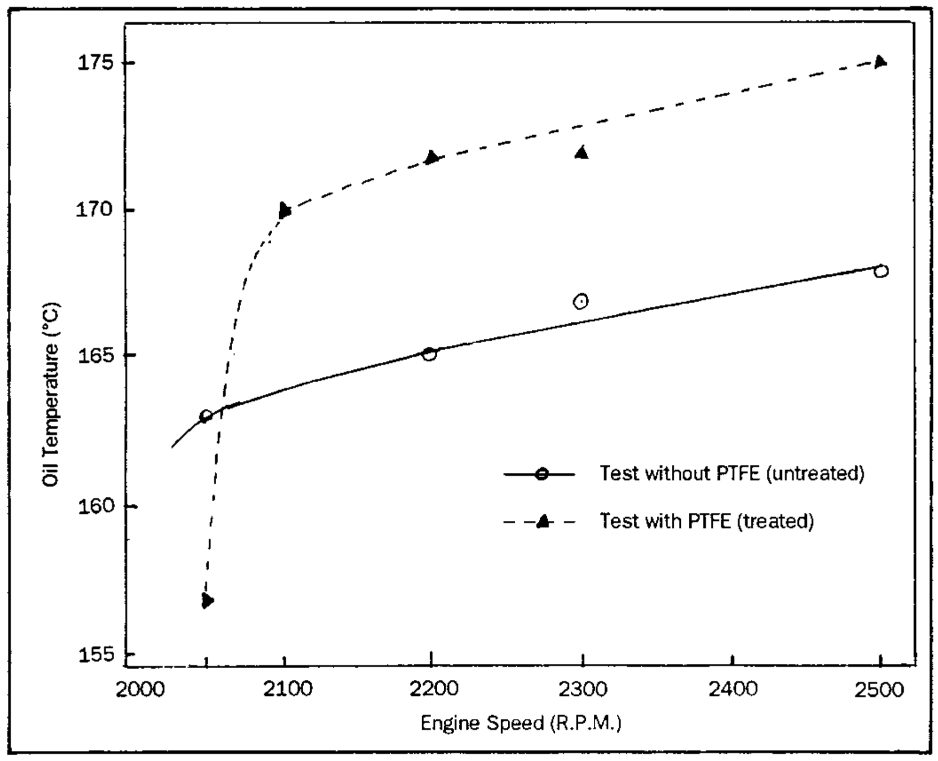

Figure 3– Temperature vs. speed of the engine.

CONCLUSION

The selected PTFE used in the study has failed to indicate any fuel consumption advantage contrary to its claims. The use of this particular PTFE, on the other hand, produced adverse effects on the engine by increasing its wear.

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