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SOME EXPERIMENTAL RESULTS CONCERNING THE INFLUENCE OF SURFACE COATINGS ON THE WEAR OF POLY-ETHER-ETHER-KETONE (PEEK) POLYMERIC GEARS

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ABSTRACT

Gears made of general purpose Poly-Ether-Ether-Ketone (PEEK) polymeric material and coated on their flanks with a thin layer of different solid lubricants MoS_2*, graphite (C), BN and PTFE are tested in relation to wear and mesh point temperature in conditions of prolonged running. The derived experimental results are graphically shown. Some conclusions are given (the order of wear increasing according to the type of coating (PTFE – the least wear, uncoated, graphite,* MoS_2*, BN); proportional correlations between the wear and the mesh temperature etc.)*

Keywords: wear, polymer gears, solid (dry) lubricant coatings

1. INTRODUCTION

The applications of polymeric gears increase because of their most beneficial properties: low cost (when injected /moulded), light weight and low inertia, capability to absorb shock and vibration as a result of their elastic compliance, noiselessness

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2. POLYMER GEAR WHEY(H)16(L,)9 HEI [(FR[(2.)]TJ En Q Q q 0.120067 w 0 g q 0 -23.169403 5

2h59>([(-)]TJ ET Q 0 g q 0 -23.169403 595.651243 842.382001 reJ ET Q 0 g q 0 -23.169403 595.651243 842.382001 re W n 99.984982 Tz B2 /

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PEEK gears could be added or subtracted from the test gear measurements. Wear is shown by the percentage relative weight loss *R%* calculated by means of the formula:

$$R\%_i=\{[(Q_i/Q_0).P_0-P_i]/P_0\}.100\% \qquad (1)$$

Where: P_0 – the original gear weight; P_i – the current gear weight; Q_0 – the original control gear weight; Q_i – the current control gear weight; $R\%_i$ – the current relative weight loss.

All the tested gears were loaded to a torque of 7 N.m, running at 1500 revs/min. Note that 1500 revs/min is a relatively high speed for unlubricated polymer gears, but this speed has been chosen for achieving 2.5 million cycles in 2 days of continuous running.

3. EXPERIMENTAL RESULTS

Figure 3 shows the wear for an uncoated PEEK 450G gear pair together with such gears (both pinion and wheel) coated with MoS_2, graphite, BN and PTFE against the number of running cycles. Note that each point on the graph represents the average of the pinion and wheel weight losses. Figure 4 shows the temperatures of these gears, where the temperatures were measured at the mesh point.

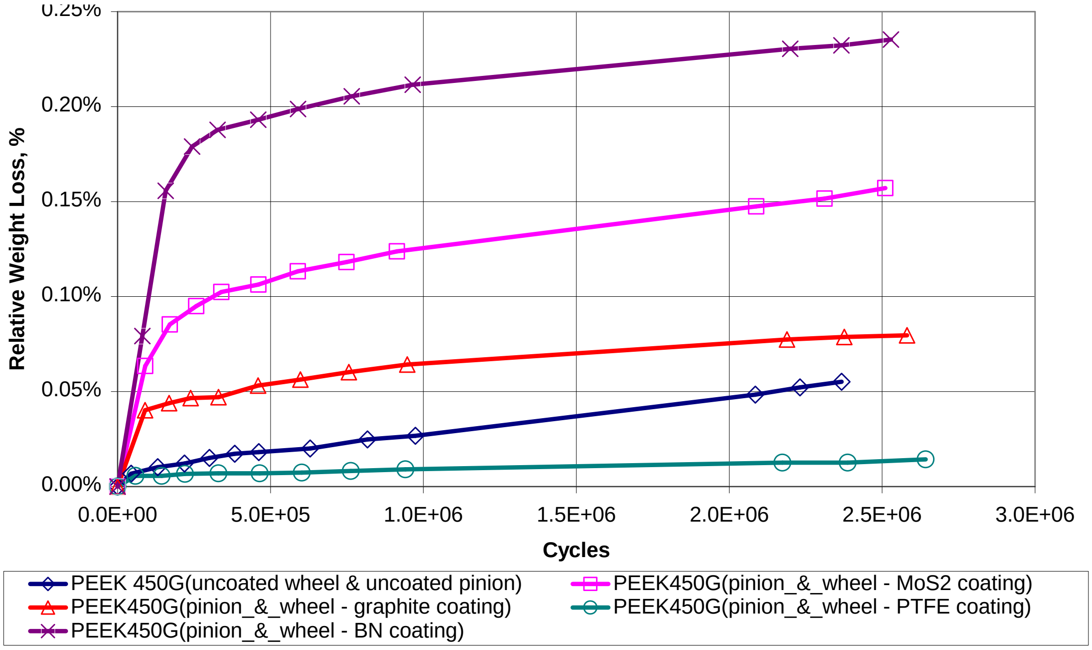

Fig. 3. The relative wear in the cases of meshing two identical gears - coated or uncoated

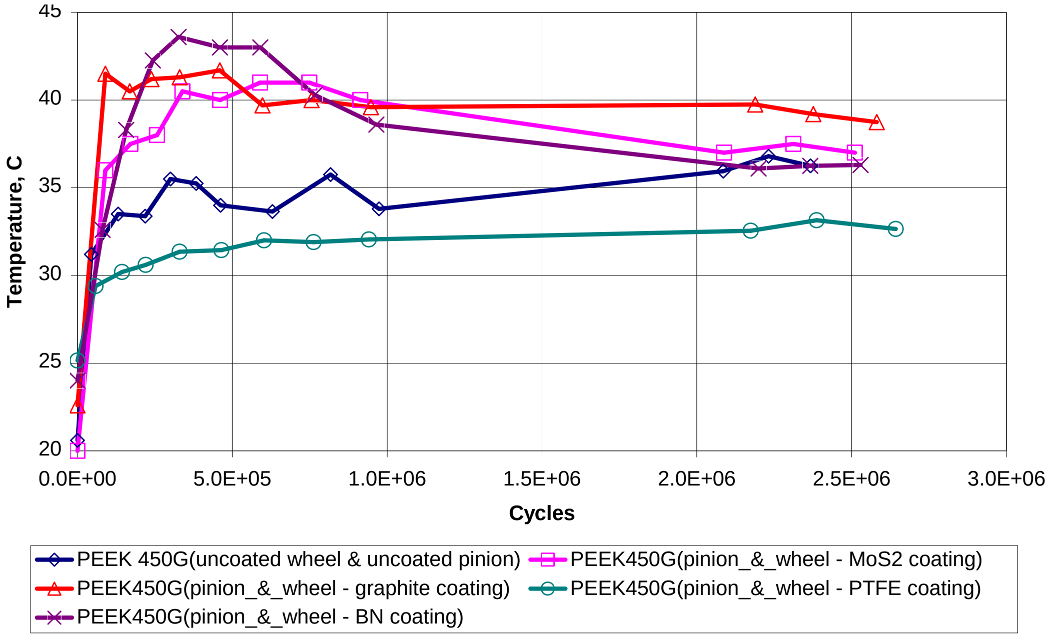

Fig. 4. The mesh temperature in the cases of meshing two identical gears

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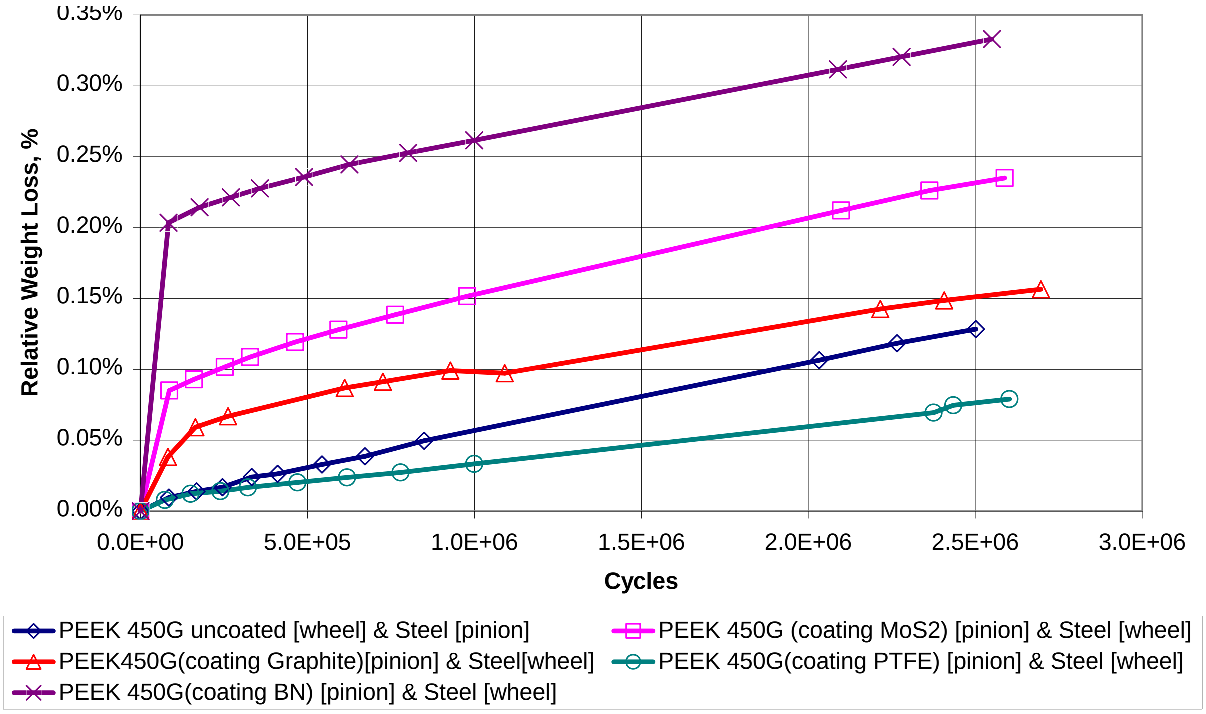

Fig. 5. The relative wear for polymeric gears (coated and uncoated) running against a steel gear

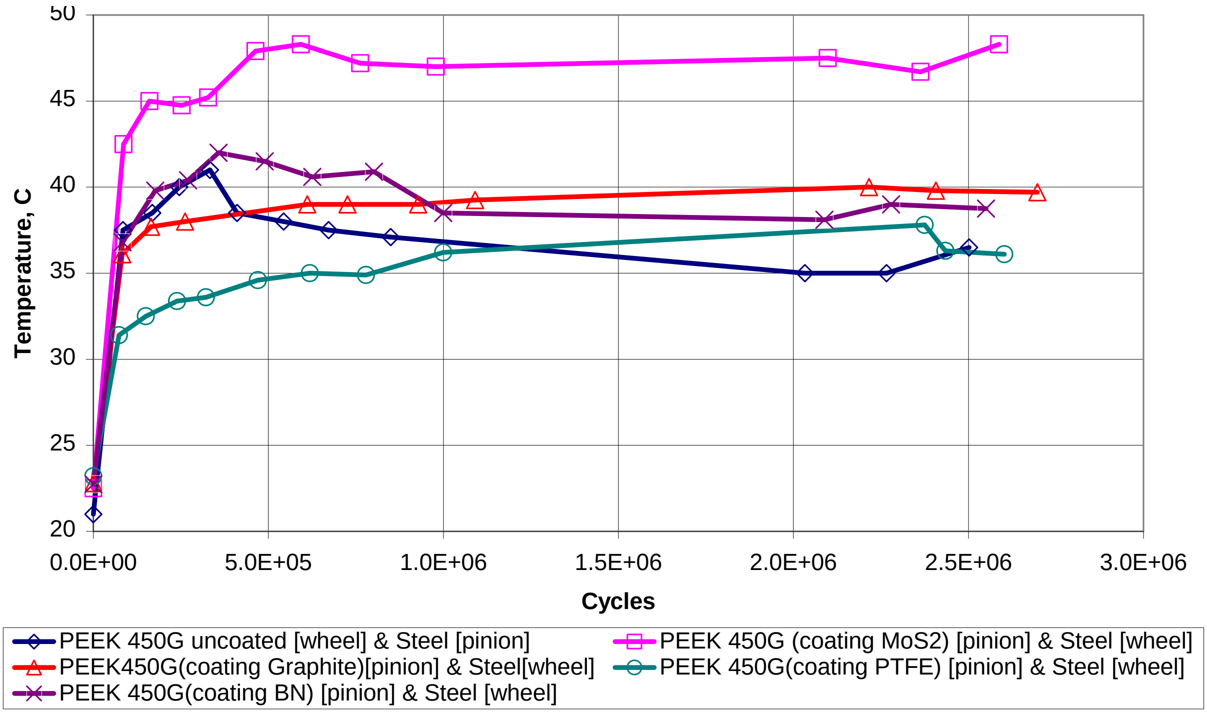

Fig. 6. The mesh temperature in the cases of meshing the gears shown in Figure 5

Figure 5 shows the relative weight loss for the coated and uncoated polymer gears, one by one running against a steel gear. Figure 6 shows the mesh temperatures of the gears shown in Figure 5. Figure 7 shows the wear of coated gears running against uncoated gears and Figure 8 shows the running temperatures for the gears shown in Figure 7.

All the curves shown in Figures 3, 5 and 7 exhibit the characteristic shape of polymer gear wear, namely a high initial wear rate followed by a period of linear wear. The tests were stopped before the wear rate would again have increased towards the end of the gears' life.

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All the results for coated gears, except for the PTFE coated ones, showed worse performance as compared to the uncoated gears.

The best performance was for the PTFE coated gears, uncoated gears were the next best, then followed by graphite, MoS_2 and BN coated gears, which showed similar, but still worse performances. However we should note that polymeric gears with the graphite coating had less slope of relative weight loss than the same for uncoated gear (see Fig. 3 and Fig. 5). So, after approximately 3.10^6 cycles, the polymeric gears with graphite coating would have less wear.

Running of polymeric gears against steel ones gave more wear than in the other cases.

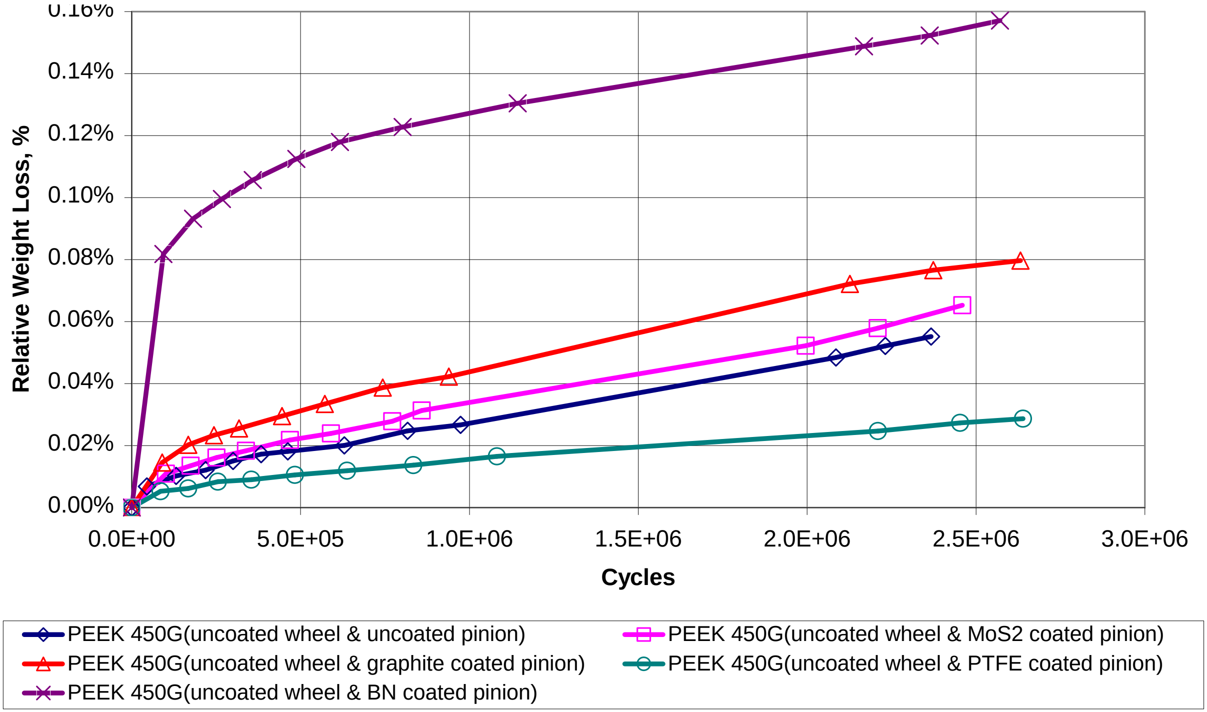

Fig. 7. The relative wear for polymeric gears (coated and uncoated) running against such uncoated gear

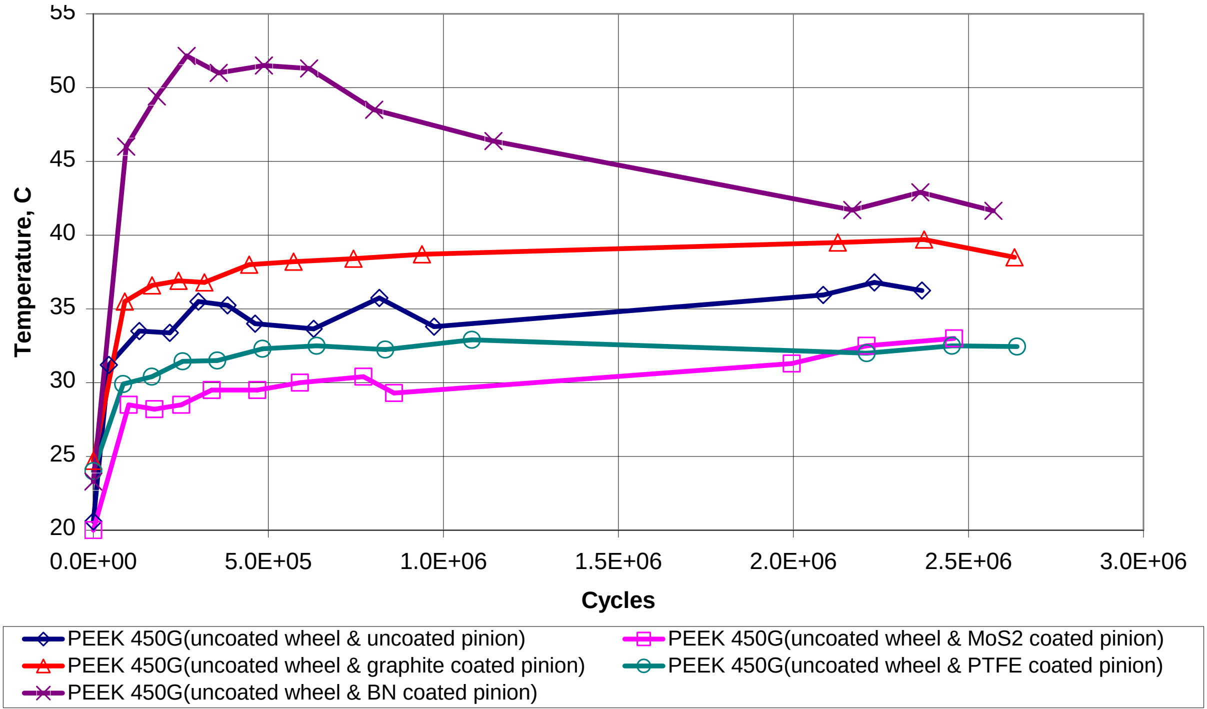

Fig. 8. The mesh temperature in the cases of meshing the gears shown in Figure 7

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4. CONCLUSION

In all the cases of running (coated or uncoated polymeric gears against identical gears or against steel counterparts, coated polymeric gears against uncoated polymeric gears), experimental results showed that the PTFE coated gears had less wear than any of the other uncoated and coated gears, but uncoated gears had less wear than gears covered with MoS_2, graphite or BN.

Polymeric gears with BN coating showed the worst results concerning wear in all cases of running, polymeric gears with MoS_2 coating had the next worst results (excepting the results shown in Fig. 7). Graphite coatings gave intermediate results between the cases with BN or MoS_2 coatings on the one hand, and the cases with PTFE coatings or without coatings on the other hand (excepting the results shown in Figure 7).

Polymeric gears (coated and uncoated) running against steel counterparts showed more wear than in the other mentioned cases. The influence of steel gear surface roughness would need to be included in a longer term project.

As a rule the registered mesh temperature were usually proportional to the wear intensity, the lower the temperature the less the wear.

All the coated gears survived the tests without the coatings separating from the substrate or the substrate and the base polymer.

All the described tests were carried out at one speed and load. Further work needs to be carried out exploring a range of loads and speeds as well as examining the influence of different base polymers.

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