

Surface Coating on Engine Valve

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ABSTRACT: Surface coating on the mating zone of engine valve will be discussed in this paper. Coating of Diamond Like Coating (DLC) on the stem and tappet end part of the engine valve will reduce coefficient of friction and also wear rate in this area. The DLC is done by physical vapor deposition method in a controlled atmosphere by exposing the parts to be coated with the deposit. The cost effective way of the surface coating is to be identified for implementing in production. The DLC have a property of self lubricating by transferring some of the coat to the mating part this will reduce the coefficient of friction. The same DLC can be applied to other mating parts such as crankshaft and connecting rod piston skirt and oil rings of the engine with operating temperature less than 180°C. This will reduce the frictional horse power and improve the SFC of the engine.

KEYWORDS: DLC, Surface coating, Reduce coefficient of friction, Frictional horse power.

1. INTRODUCTION

In a rapidly - evolving demanding on the engine performance and stringent emission norms the engines are down sized and the power to weight ratio is increased on the engine. The demanding environment put lot of pressure on the engine components such as piston, valve train, etc. Here the application of surface coating on the mating parts of the engine components is studied especially on the engine inlet valve. The DLC coating is applied by physical vapor deposition method on the stem part and tappet end of the valve where high wear is observed. When the coating is applied the surface finish of the sample does not change and the same finish is maintained as the base material. The DLC coated sample has self lubricating property by transferring some of coat to the mating part which leads to betterment in frictional property and improvement in wear property.

The application of the same coating on the engine valve and other mating parts of the engine components which operates below 180°C will improve the performance of the engine as a whole. The reduction of co-efficient of friction will ultimately reduce the frictional horse power and improve the power, torque and SFC by theory. This has to be validated for long run with a suitable engine manufacturer validation setup.

II. APPLICATION OF DLC AND VALIDATION SETUP

The DLC is applied by physical vapor deposition in the controlled atmosphere and the sample is exposed to the vapor of DLC. The coating thickness will be 4 to 5 microns so the surface finish of the sample will remain same as the base material. The typical setup of the PVD is shown in the fig 1.

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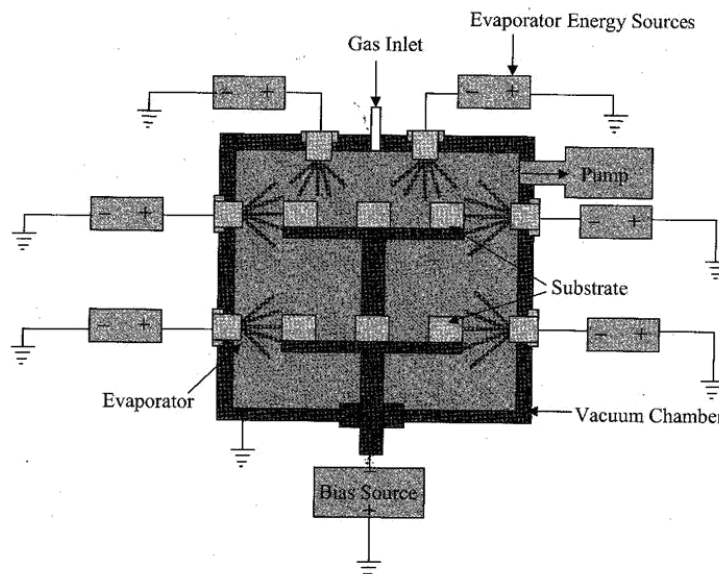


Fig 1

The coating of DLC on the engine valve system was done with the help of Oerlikon Balzers who are leading global supplier of the physical vapor deposit coating. The coating presently done on the cutting tools but on the engine components is to be tried for the first time in industry.

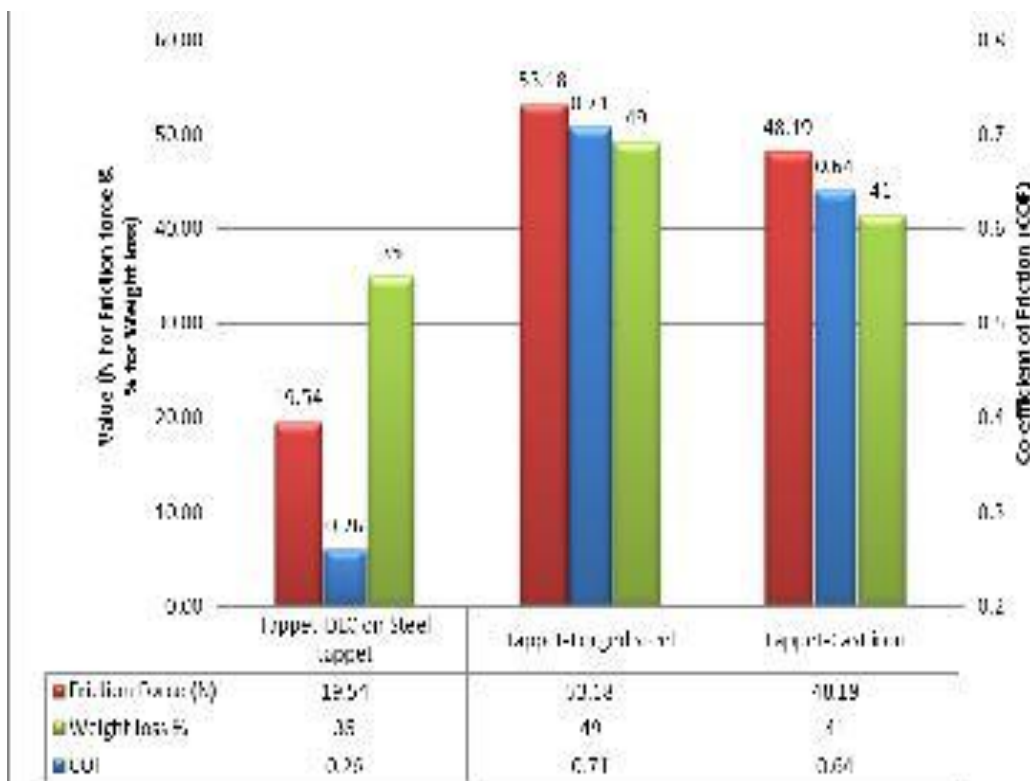
After the coating is applied on the surface of the sample this has to be validated for its strength and ability to withstand the actual engine condition and check the improvement in terms of co-efficient of friction and wear rate. This requires a setup to measure the co-efficient of friction, wear rate with the mating part which is simulated with the setup shown in fig 2. The sample is placed in 180°C atmosphere with a vigorous motion at a defined rate with the mating part. This is sensed and integrated with the system to generate the co-efficient of friction between the two mating parts. The sample before placing into the test weight is measured and after the defined time of test it is measured again to know the weight loss.



Fig 2

III. VALIDATION RESULT

The coated sample was tested for co-efficient of friction reduction and wear measurement. This is compared with the existing forged and cast part with repeating the same test procedure and plotted the graph with coefficient of friction, weight loss and frictional force. Refer the graph no. 1. The co-efficient of friction with DLC was 0.26 and wear rate was 35% which was less compared to other uncoated sample. In the forged material COF was 0.71 and cast material was 0.64 which is double the value of the DLC coated sample.



Graph no. 1

The coated piston skirt, valve, camshaft, tappets, rocker arm, gudgeon pin, crankshaft bearing and connecting rod bearing were assembled on the engine and tested for performance improvement and frictional horse power reduction. The result was positive with marginal improvement of power, torque and SFC. This is plotted in the graph below. (Graph no.2, 3 & 4)

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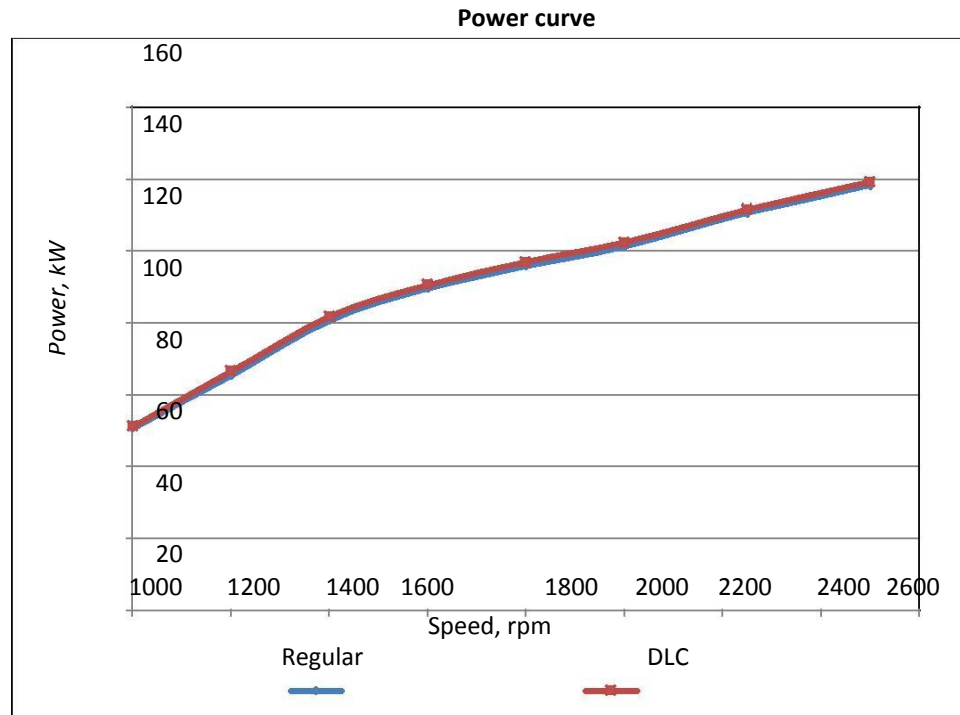
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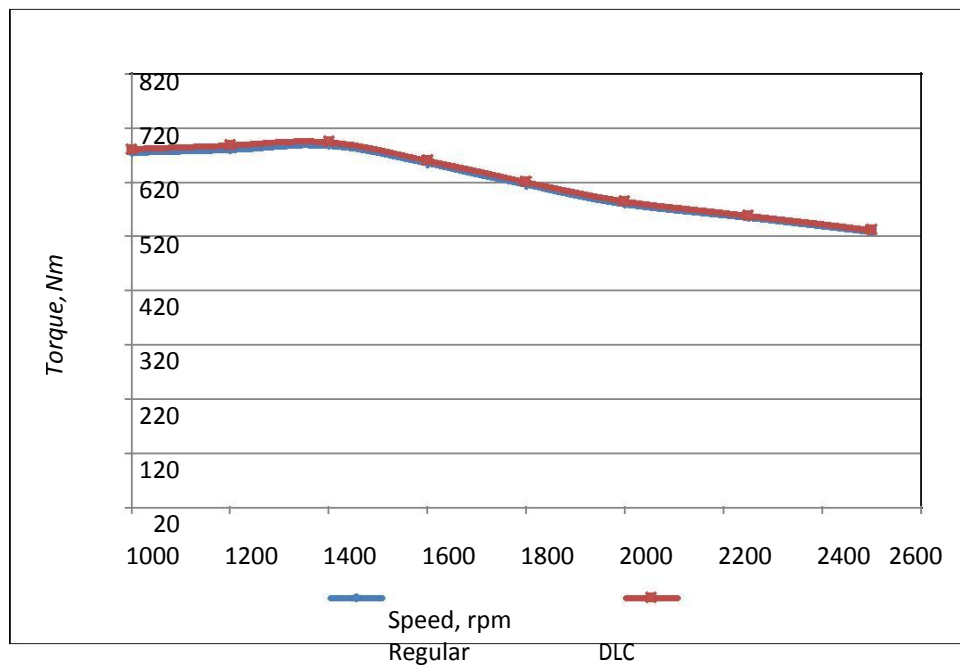
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Graph 2

Torque curve



Graph 3

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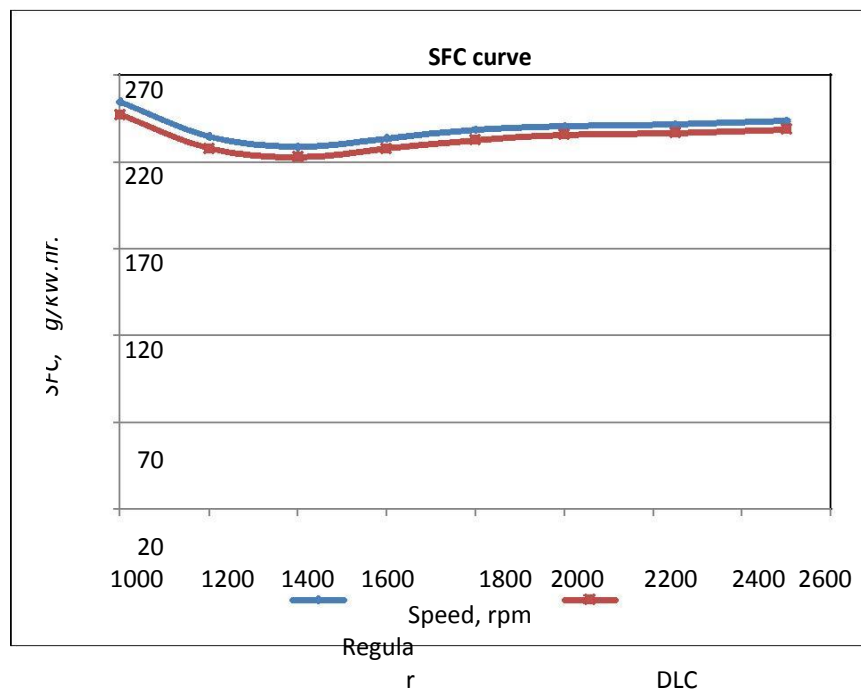
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In the power and torque curve we observe that there is slight improvement by 0.7 to 1.0 % with just coating the surface of the moving parts by DLC. This is significant which has to be tested for long run for durability test. We also observe in the below SFC curve improvement of SFC by 2.0 to 3.0 % which reduce the fuel consumption on the vehicle.



Graph 4

IV. CONCLUSION

The DLC coating on the material improves the co-efficient of friction to 0.26 which is 2.5 times lesser than the original COF of the base material. This also ensures the surface finish of the material remains same as the base material. The DLC used in engine moving components reduces the frictional horse power and SFC of the engine. This will significantly improve the life of the engine and also fuel consumption reduction will attract the customers.

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