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Design and Investigation of Ceramic Coating on Piston Crown

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Abstract—A ceramic-coated piston may increase the cylinder's material properties. This paper examines the tri biological effects of a cylinder's surface coating in a frictional process. A cylinder in a diesel engine will be plasma-sprayed with Zirconia material, and its surface conductivity will be measured to improve thermal efficiency. The piston is designed and analysed using modern CAD tools. A test is run to see how a coating affects the engine's performance. The thermal productivity and efficiency of uncoated and coated cylinders were evaluated. The results suggest that zirconia-coated cylinders are more efficient.
— (pistons,plasmaspray,efficiency,zirconia coated pistons thermal productivity)

INTRODUCTION

A. General Introduction

In an internal combustion engine, the piston consumes most of the heat created during ignition. This is a cylinder-warming mishap. It diminishes Indicated Power and Internal Combustion Engine Performance.The engine piston is coated with ceramic to boost performance and durability. Many sources say that coating on the components offers greater results than regular diesel engines. The engine coating idea improves fuel efficiency and decreases hydrocarbon and carbon monoxide emissions while reducing noise. Thermal barrier coatings are sprayed on cylinder heads, pistons, and valves. ceramic Corrosion and oxidation are prevented by coating components. In the diesel cycle, decreasing heat transfer reduces energy loss, increasing work output and thermal efficiency. Compared to an uncoated engine, ceramic coated components boost engine performance, reduce fuel consumption, and reduce exhaust gas emissions and smoke density. The engine's heat reduction improves combustion and minimizes exhaust pollutants.

B. Work scope

During the engine's power stroke, heat pulls the piston down. The piston uses all of the heat, which is 100% thermal efficiency. But we only use a third of the overall power. The remaining 23% of electricity is squandered. The cooling process wastes 50% of the electricity. Thermal interpretation in ceramic coating reduces heat loss from coated piston crown to the cooling system. By wrapping the piston crown with a heat barrier. The piston crown will lose less heat to other engine components. Thus the engine's thermal efficiency improves.

Zirconium oxide has a high thermal expansion coefficient. So I used plasma spray to cover the piston crown with zirconium oxide. I took both coated and uncoated piston engine performance figures. Compared to uncoated piston, coated piston has 11% higher indicated thermal efficiency and 6% higher brake thermal efficiency. The ceramic coated piston reduces heat loss.

Ⅱ. SPECIFICATIONS

Thermal barrier coatings protect combustion chamber surfaces in internal combustion engines. Coatings may be applied to the whole combustion chamber or to specific surfaces like piston crowns and valves. The coating is applied to the piston crown in the experiment. The extra heat energy in the cylinder may be used to boost engine power and efficiency. A turbocharger or supercharger may recover more energy by reducing heat loss. Also protects combustion chamber components from thermal strains and simplifies cooling systems. A simpler cooling system reduces weight and costs while increasing engine durability.This experimental study's primary goal is to compare heat losses with and without a ceramic coated diesel engine. The temperature distribution inside the piston is regulated.

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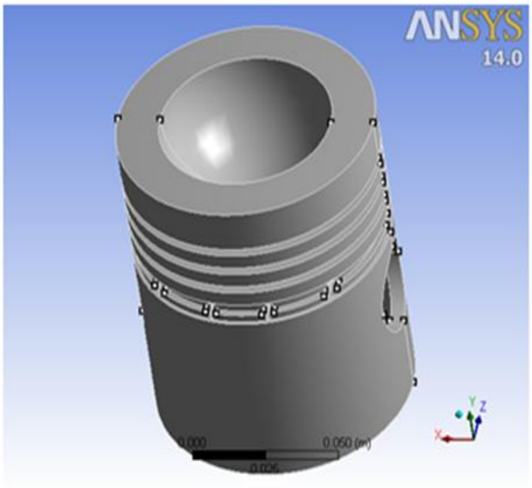

Figure.1 *Uncoated piston model*

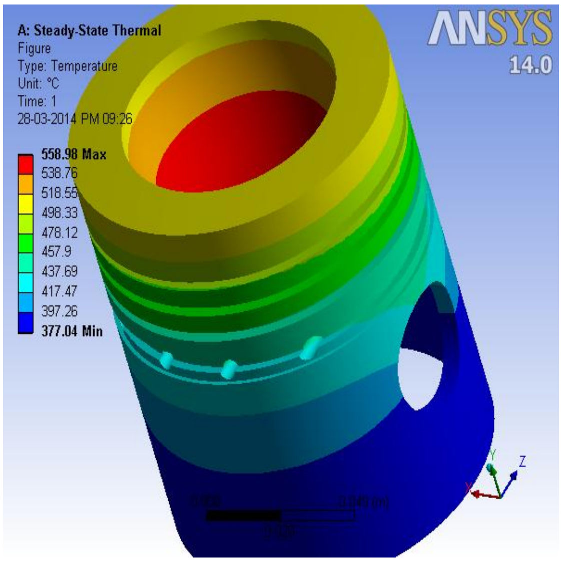

Figure 2. temperature distribution of uncoated pistons

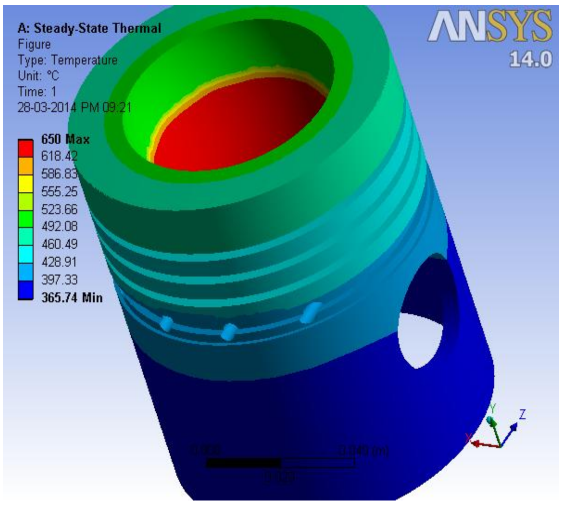

Figure 3. Temperature Distribution for Coated Piston

III. EXPERIMENTAL RESEARCH

A. Plasma spraying

The plasma generator has a copper and thoriated tungsten anode and cathode. The cathode is put in a stabilized water torch to avoid explosions. An arc is formed between the cathode and anode. Which ionizes the plasma-flowing process. The plasma-immunized powdered stock material is melted and incorporated into the working component.A sulzermetco F4 cannon with a maximum power of 50 kW is used for atmospheric plasma spraying. Plasma is formed by combining hydrogen and argon gases. The argon gas is used as a feedstock carrier gas. Plasma spraying used compressed air as a cooling gas.

Table 1 : Plasma spraying parameters

S. No.	**Parameters**	**Value**
1.	Spray gun	3 MB
2.	Nozzle	GH
3.	Current (A)	490
4.	Voltage (V)	60 – 70
5.	Powder feed(g/min)	40-50
6.	Spray distance	76.2 - 127 ± 10 % mm
7.	Particle velocity (m/s)	Up to 450
8.	Arc Temperature (0C)	16,000
9.	Particle size (µm)	14.5 – 45
10.	Inert gas flow rate	
	a) Argon (l/min)	100– 200 ± 5%
	b) Hydrogen (l/min)	100 ± 5%

B. Engine Check

The engine was a four-stroke, single-cylinder direct-injection diesel. After the load, the time spent 10cc fuel consumption was measured. We measure HC and NOx. AVL exhaust gas analyzer detected pollutant emissions such as unburnt hydrocarbon, carbon monoxide, carbon dioxide, and nitrogen oxides. The analyzer uses an electrochemical sensor to transform particle concentrations in exhaust gas into electrical impulses. The smoke metre gauged the exhaust gas temperature.

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Table 2.Technical Specification of the Engine experimented

Manufacturer	Kirloskar Oil Engines Limited, India
Engine Type	Vertical, Four Stroke Diesel Engine
Bore Diameter	87.5 mm
Stroke Length	110 mm

Brake Power	4 KW
Compression ratio	16.5:1
Speed	1500 rpm
Injection Type	Direct Injection
Cooling	Water
Engine Power	5 BHP
No. of cylinder	1
Injection Pressure	) r

C. Piston Specification

Table 3. Piston Specification

Diameter of Piston	87.4 mm
Shank Length	110 mm

Ⅳ. RESULTS

Load	Brake Power (KW)	Indicated Power (KW)	time (sec)	Mass of fuel consumption (Kg/hr)	Fuel Power (KW)	Brake Thermal Efficiency (%)	Indicated Thermal Efficiency (%)
25 %	1.1	2.86	59	0.5064	6.33	17.38	45.12
50 %	2.2	3.80	46	0.6496	8.12	27.09	46.84
75 %	3.3	5.07	35	0.8537	10.67	30.93	47.50
100 %	4.4	6.28	33	0.9055	11.32	38.87	55.52

Table 4:Experimental Calculations of Zirconia Coated Piston

A. Result

The performance and emissions of a zirconium coated piston diesel engine were compared. The engine was tested at 25% load and the following results were obtained:

Calculation:

4.4 total load (KW)

*BP @ 25% load = 0.25 * 4.4 = 1.1 (KW)*

(PLA(N/2)K) / 60 (KW) (at 25% load):

293.79 (KPa)

*A = (/4) * D 2 = 0.0059 m 2 IP = (293.79 * 0.11 * 0.0059 * 802.5 * 1) / 60 IP = 2.59 (KW)*

679, Mf=0.5433 kg/hr (KW)

16% Brake thermal efficiency, 38.14% Indicated thermal efficiency

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Table 5:Experimental Calculations of Uncoated Piston

Load	Brake power (KW)	Indicated power (KW)	Time (sec)	Mass of fuel consumption (Kg/hr)	Fuel power (KW)	Brake thermal efficiency (%)	Indicated Thermal Efficiency (%)
25 %	1.1	2.59	55	0.5433	6.79	16.20	38.14
50 %	2.2	3.43	43	0.6949	8.69	25.32	39.47
75 %	3.3	4.66	32	0.9321	11.65	28.33	40.00
100 %	4.4	5.92	28	1.0671	13.34	32.98	44.38

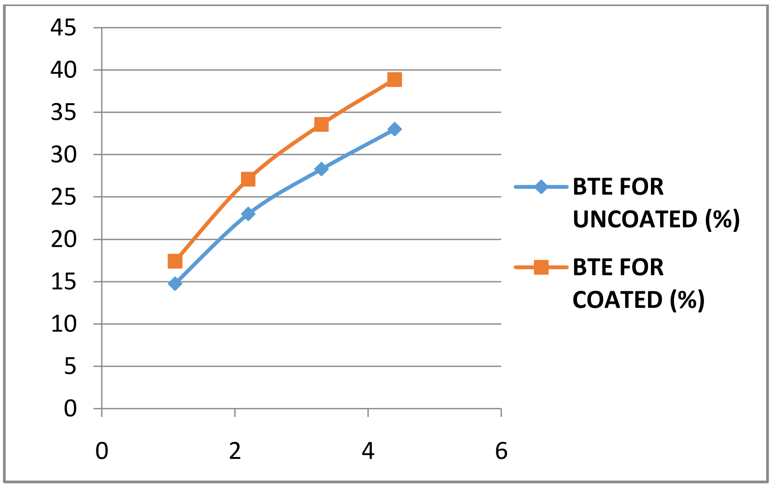

Figure 4. Comparison of brake thermal efficiency

The Maximum obtained brake thermal efficiency of an uncoated piston is 32.98%**. The** Maximum obtained brake thermal efficiency of the coated piston is 38.87%.The Maximum obtainedoverall thermal efficiency of the ceramic piston is 55.52% by applying zirconium coated oxide 11.14% of indicated thermal efficiency is improved.

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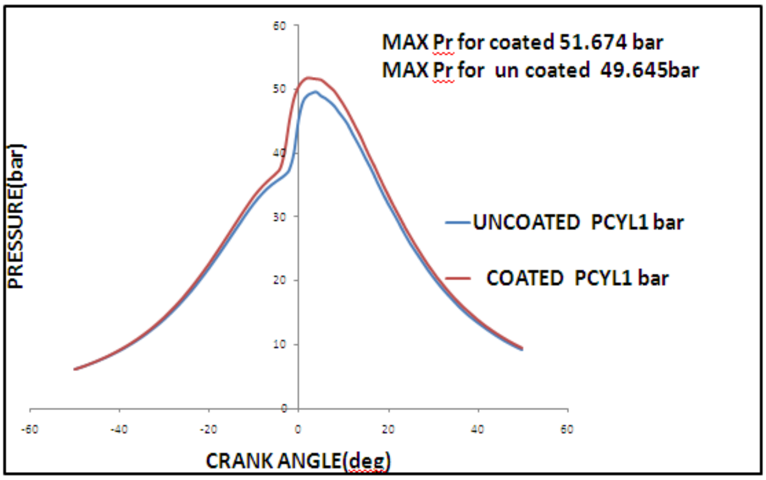

Figure 5. Pressure vs Crank Angle for 25% load

Ⅴ. CONCLUSION

Here are the experimental results:
Uncoated piston thermal efficiency is 32.98 percent.The coated piston's maximum thermal efficiency is 38.87.Using oxide-coated brake material improves thermal efficiency by 5.89%.Uncoated piston has maximum thermal efficiency of 44.38 percent.Thermal efficiency of coated piston is 55.52 percent.The zirconium coating improves thermal efficiency by 11.14 percent.The thermal efficiency and performance of the engine are increased when the piston crown is coated with zirconium.

REFERENCES

[1] Mr. ShaileshDhomne, Dr. A. M. Mahalle and Mr. Mohammad AyazAfsar (2014)"Experimental and performance Investigations of Piston Coated Externally usable S.I. Engine" - IOSR Journal of Mechanical Engineering, (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X PP 81-85

[2] Dr.T.Senthilkumar,B.Kumaragurubaran, Dr.M.Chandrasekar, B.M.Gnanasekaran and J.Rajasekaran (2013) "Combined Effects of boundary Coating and Blending With Diesel oil on Usage of Waste Plastic Oil in Diesel Engines" – International Journal of Innovations in Engineering and Technology (IJIET), Vol. 2 Issue 3 June 2013, ISSN: 2319-1058.

[3] Balkrishna K Khot, Prakash S Patil and Omprakash Hebbal (2013) "Experimental investigation of performance and combustion characteristics of a single cylinder LHR engine using diesel and multi-blend biodiesel" - IJRET: International Journal Research in Engineering and Technology, eISSN: 2319-1163|pISSN: 2321-7308.

[4] A.P. Sathiyagnanam, C.G. Saravanan and S. Dhandapani (2013) "Effect of Thermal-Barrier Coating plus Fuel Additive for Reducing Emission from Diesel Engine" - Proceedings of the global Congress on Engineering 2010 Vol II WCE 2010, June 30 - July 2, 2010, London, U.K.

[5] Taymaz, K. Cakir, M. Gur and A. Mimaroglu (2003) "Experimental investigation of thermal loss in a ceramic coated diesel engine I" - Journal of Surface and Coatings Technology 169 –170 (2003) 168–170.

[6] D. Assanis, K. Wiese, E. Schwarz, and W. Bryzik: "The Effects of Ceramic Coated Diesel Engine Performance and exhausted Emissions," SAE Paper No. 910460, SAE, Warrendale, PA, 1991.

[7] A.C. Alkidas, R.J. Drews, and W.F. Miller, Effects of Piston Crevice Geometry on the Steady-state Engine-out Emissions of a S.I. Engine, SAE Technical paper, No. 952537.

[8] Hejwowski, T., Weronski, A., 2002. Thermal Barrier Coating on Diesel Engine Performance, Surface Engineering,Instrumentation& Vacuum Technology, Vol. 65,pp. 427-432