ARTICLE IN PRESS

Materials Today: Proceedings xxx (xxxx) xxx

Contents lists available at ScienceDirect

Materials Today: Proceedings

journal homepage: www.elsevier.com/locate/matpr

Effect of load on the tribo-performance of 23-8N valve steel against GGG-60 seat material

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A R T I C L E I N F O

Article history:
Received 27 May 2019
Accepted 11 July 2019
Available online xxxx

Keywords:
Tribology
Friction and wear
Exhaust valves
Tribo-film
23-8N
GGG-60

A B S T R A C T

This study presents the effect of load on friction and wear behaviour of 23-8N valve-steel against GGG-60 cast-iron under non-lubricated sliding conditions, at ambient temperature. Co-efficient of friction (μ) was observed to decline steadily with test duration for all tests with salient running-in behaviour discerned at room temperature. This continuous decrement was attributed to the compaction of the glazed layer. The study found that the average value of co-efficient of friction showed an increasing trend as the load was increased, as predicted by Amonton's law of friction. The weight loss incurred in the seat material was found to increase with increasing value of load, which follows Archard's wear-relation.

Selection and peer-review under responsibility of the scientific committee of the 1st International Conference on Manufacturing, Material Science and Engineering.

1. Introduction

Combustion engines have a wide variety of applications, essentially in the transport sector. The operation of I.C. engines involves conversion of the high pressure and temperature gases to mechanical energy, via displacement of piston in a cylinder. The cylinder-head consists of engine-valves, which are required to regulate the fluid exchange. Sealing effect in the cylinder is provided by the inlet and exhaust valve and the corresponding seat insert. Valve seat-inserts are employed to prevent the contact of the valve into the cylinder head. In addition to this, the seat absorbs a portion of the combustion heat. As the combustion gases exit the combustion chamber, the exhaust-valves are exposed directly to the intense pressure and high temperature, and thus operate in a severe environment.

The valve and valve seat-insert are exposed to high-cyclic contact-stresses and extreme temperature generated due to the combustion. The severe operating parameters, in addition to micro-sliding, results in the wear of engine valves. Moreover, the reduction of lead from fuel, as a result of environmental concerns, resulted in increase in the wear of the engine valve-seat arrangement. The removal of lead from fuel led to depletion of tribo-films and resulted in the formation of hard brittle iron-oxides, causing rapid wear. As a result of the recession caused due to wear, the valve system is unable to seal against pressure [1].

Wear of the sealing-surface is undesired due to several reasons. Surface modification, as a result of wear, often leads to rougher surfaces, which in turn results in reduced real contact-area and hence, increases the shearing forces produced during sliding. As a result of reduced contact-area, temperature rise takes place in the valve, since transfer of enough heat to the valve seat insert does not take place. Excessive local deformation leads to leakage, which becomes the cause of guttering. Uniformly-distributed wear leads to a consistently increased distance for the valve to travel in order to seal. This is known as recession of valve. The deformed shape of the valve hinders the through flow of gases, which results in reduced engine performance [2]. As a result of a large recession the combustion-volume is altered when the piston assumes the position at the top dead-center. Therefore, the combustion ratio of the engine is altered. A major cause of guttering of the exhaust valve in diesel engines is ash deposit flaking [3].

Wear of the valve sealing interface is immensely affected by two major components. The first component is the impact energy which is released when contact between the valve and seat-insert takes place. This impact is vigorously dependent on the speed of engine, valve weight and valve-train dynamics.

Second constituent is the sliding that occurs in sealing-interface, as a result of elastic deformation of the valve-head under severe temperature during combustion. The sliding component is

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https://doi.org/10.1016/j.matpr.2019.07.611
2214-7853/
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Please cite this article as: U. Ashraf, S. S. Saleem, M. F. Wani et al., Effect of load on the tribo-performance of 23-8N valve steel against GGG-60 seat material, Materials Today: Proceedings, https://doi.org/10.1016/j.matpr.2019.07.611