2006 POWDER METALLURGY
World Congress

C01-05-1
*Invited

Development of Exhaust Valve Seat Material for the High Performance Engine

Hiroshi Oshige[1, a], Teruo Takahashi[1, b]

[1]No.1111 Nogi Nogi-Machi Shimotsuga-Gun, Tochigi-Pref, Japan
[a]hoshige@notes.npr.co.jp, [b]ttakahas@notes.npr.co.jp

Abstract

In late years, from a trend for ecology of auto motive engine, low emission and low fuel consumption of engine become a social assignment. At the same time, the high output (high efficiency) is required, too. In order to meet those requirements, in comparison with conventional engines, lean A/F (Air fuel ratio) setting is becoming popular for the high performance engines of late years. Exhaust valve seat (sintered material) used in these engines has a problem in wear resistance, because it is exposed to the surroundings that is clean and a high temperature in comparison with the conventional engines.
Therefore, wear mechanism with lean A/F of engine was analyzed.The exhaust valve seat (sintered material), that was superior in wear resistance, was developed.

Keywords : High performance engine, Air-fuel Ratio

1. Introduction

In late years air pollution, exhaustion of petroleum energy resources and global warming by CO_2 gas emission are concerned. Social subject of low emission and low fuel consumption of automotive gasoline engine is strongly required to be solved.

In order to meet these requirements, A/F of recent high performance engines is set leaner than that of conventional engines and the lean zone is set broad by development of combustion technology. Accordingly exhaust gas temperature becomes high and wear resistance of exhaust valve seat made of conventional material had problem due to softening of matrix structure.

Engine valve seats, combined with the intake and exhaust valves, serve as seals for high-temperature, high-pressure exhaust gas. Because of this, the valve seat material is required not only to have its own wear and heat resistance, but must also ensure low aggressiveness to mated valve.

2. Experimental and Results

Fig.1 shows wear ratio of valve and conventional valve seat (VSI) running at wide open throttle under full road. The valve seat wear of the new developmed engine (high performance engine) is largely increased than a conventional engine.

From investigation after endurance test, combustion product was not found on the seat face in the new developed engine and valve-contacting face had mirror-like appearance of metal contact (a contact between metals to each other), although combustion product is found on the seat face in conventional engines.

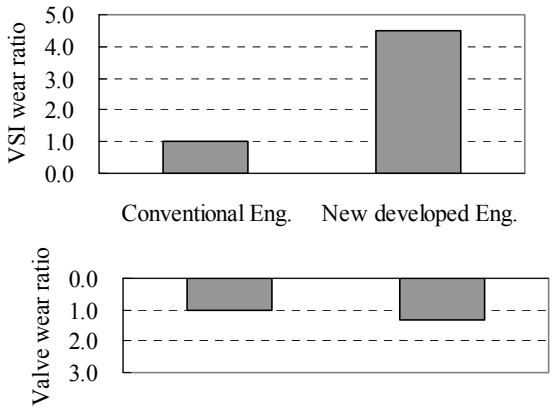

Fig. 1. Comparison of Conventional Eng. And New developed Eng. in Valve/VSI wear ratio

This cause is considered to be as follows: Combustion product that is effective for lubrication of valve seat face decreases resulting in easiness of metal contact with the valve, because A/F of fuel-air mixture is leaner than that of conventional engines and the combustion gets closer to complete combustion. Furthermore, softening of valve seat matrix by high-temperature combustion gas leads to easy adhesion of valve seat. Table 1 shows the effect of lean A/F on VSI wear.

Basing on the thought that metal contact and adhesion affect increase in valve seat wear in the new developed engine, materials design was conducted with studying enhancement of heat-resistance of valve seat which is effective for preventing its adhesion to valves.

Table 1. Effect of lean A/F on VSI wear

	Conventional eng.	New developed eng.	The effect that lean gives VSI
Combustion products	Much	A little	The appearance of metal contact and adhesion
Temperatuer	High-temperature	Higher-temperature	

Fig. 2 shows concept of developed material.

Conventional material	Developed material
・ Matrix reinforcement by high hardness alloy steel ・ Addition of hard particle ・ Heat-resistance improvement by addition of Ni, Co powder	・ Heat-resistance improvement ・ Addition of hard particle that has high toughness, high diffusion property and self-lubrication

Fig. 2. Concept of material

We selected types and appropriate adding quantity of based iron powder, allyed steel powder and hard particle to enhance wear resistance of exhaust valve seat used in high performance engines.

In order to verify wear resistance of valves and VSIs in the new developed engine, on-engine endurance test was conducted using VSIs of developed material which showed good wear resistance in the single piece rig test.

Fig.3 shows test results.

The wear ratio of developed material decreased to approx. 1/4 of that of conventional material.

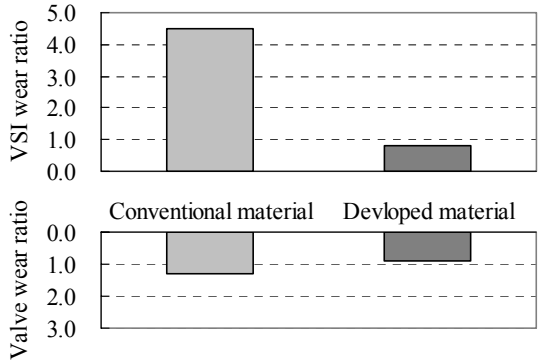

Fig. 3. Valve/VSI wear ratio in new developed engine

We investigated conventional material and developed material after endurance test.

The valve-contacting face of VSI showed flat surface texture. Neither mirror-like surface which was seen in the conventional material, adhesion nor metal contact was found. We consider that the developed material shows good wear resistance under the high temperature conditions of the new developed engine by effects of heat resistance enhancement and by positively forming oxidation films that are good for wear resistance.

3. Summary

(1) From analyses of valve seat wear mechanism in a high performance engine, we found that main cause of valve seat wear is adhesion of valve seat matrix by high temperature exhaust gas.

(2) We could enhance wear resistance of exhaust valve seat used in high performance engines by selecting types and appropriate adding quantity of powders.

4. References

1) Teruo Takahashi, Arata Kakiuchi: Development of valve seat insert material for HLA-eliminated engines, NPR Technical Review, Vol. 4, P41-45 (1997)

2) Tomonori Niizato, Aruto Hayashi: Development of New 2.0L Lean-burn Engine, HONDA R&D Technical Review, Vol. 12, P45-54 (2000)

3) Shouichi Furuhama: Internal combustion engine