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Development of High Performance Valve Seat Insert Materials for Gas Engines

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Abstract

Sintered materials have been applied widely in Valve Seat Inserts (VSI).
The amount of wear on VSIs increases when used in gas (LPG, CNG) engines because of their dry environments.
In this paper, two newly developed high performance VSI materials for gas engines are introduced. These materials applied new techniques, which are both high performance hard particle and new distribution method of solid lubricant, to increase wear resistance.

Keywords : Wear resistance, Valve seat insert, Intermetallic compound, Lubrication

1. Introduction

Sintered materials have been applied widely for Valve Seat Inserts (VSI) due to their high flexibility of material design. Hard particle dispersion type materials, which have specific microstructures in sintered material, are popular for VSIs.

The load - temperature, combustion pressure, etc. - on the VSI has become severer along with increasing demands for better engine performance. (1) Especially, there is increasing tendency of the amount of wear on VSIs when used in heavy-duty engines such as gas (LPG, CNG) engines because of their dry environments.(2)

In this paper, two new developed high performance VSI materials for heavy-duty engines are introduced. These materials adopt new hard particles and a new method of distribution of the solid lubricant to increase wear resistance.

① Hard Particles : The new developed hard particle has superior wear resistance due to increasing the amount of intermetallic compounds.

② Lubrication : A new method has been developed that has superior lubrication by distributing the lubricant in the matrix using precipitation during sintering.

2. Experimental Results

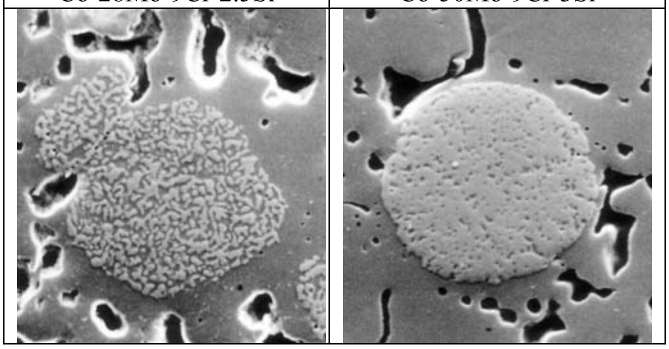
2.1 Hard Particle

Conventionally, Tribaloy or Stellite-based Co-containing powders, and ferroalloy powders as represented by Fe-60mass%Mo and Fe-60mass%Cr, have been widely used as hard particles for VSI. The Tribaloy T-400 is an example of a hard particle with high wear resistance. The T-400 is a hard particle with a Co–28Mo–9Cr–2.5Si composition and forms a hard phase of intermetallic compounds consisting of mainly Mo-silicide.

Increasing amount of Mo-silicide is expected to enhance of hard particle effects. Therefore, this study focused on increasing the content of Mo-silicide. Specifically, the aim is to develop a hard particle with superior performance by increasing the contents of Mo and Si.(3)

Figure 1 shows SEM images of hard particle of both Triballoy T-400 and higher Mo, Si content hard particle. From this result, larger amount of intermetallic compounds is confirmed in the new hard particle.

Tribaloy T-400 Co-28Mo-9Cr-2.5Si	New Hard Particle Co-50Mo-9Cr-3Si



10 μ m

Fig. 1. SEM images of hard particle.

Figure 2 shows the result of the VSI wear amount of materials, which contain 25mass% hard particles. These results were gotten by VSI wear rig tester.

From these results, it is found that new hard particle shows 30% smaller of wear amount compared with Tribaloy T-400.

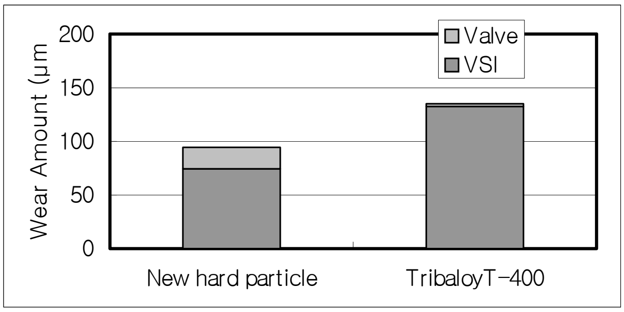


Fig. 2. Wear amounts after VSI wear rig tester.

2.2 Solid Lubricant

In the gas engines, such as LPG and CNG, the valve seat is needed to have high self-lubrication because surface condition is drier. Considering the background, almost of valve seat materials for gas engine have been applied lead impregnation. However, the recently demands on VSI materials is not only good performances but also the absence use of environmentally hazardous materials such as lead.

A new technique to improve lubrication, which can replace lead, was examined. Figure 3 shows the comparison results of seizure load of each lubricant method by ring-on-disc tester.

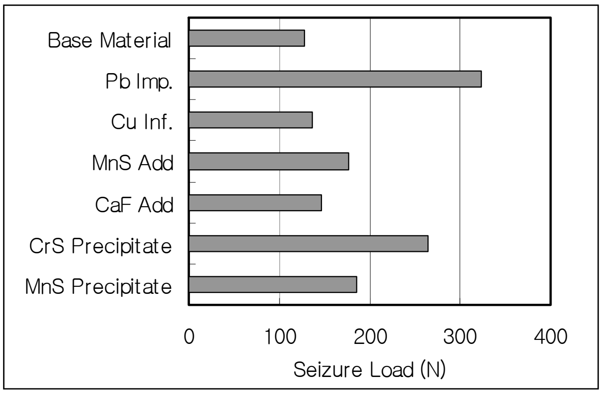


Fig. 3. Comparison of lubricity effect.

Lead impregnation is confirmed to have excellent lubrication. On the other hand, improvement effects of general methods such as addition of MnS or CaF are poor. In these various methods, precipitation of CrS shows better lubrication next to lead.

2.3 Wear Resistance

The evaluation of wear resistance of new VSI materials, which were applied both new hard particle and new lubrication method, were carried out by VSI wear rig tester.

The result is shown in Figure 4. As shown in this result, new materials EH-51H and EH-52H have superior wear resistance than conventional material. Incidentally, EH-51H is 30mass% hard particle dispersion material and EH-52H is 50mass% hard particle dispersion material, and they have already been in mass-production.

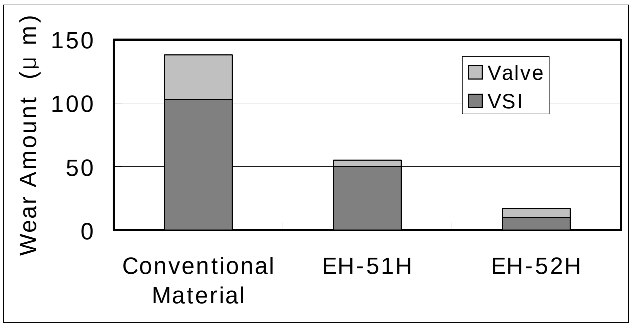


Fig. 4. Comparison of wear resistance of VSI materials.

3. Summary

1) Focusing on the content of Mo and Si in the hard particle, a Co–50Mo–9Cr–3Si alloy was developed. With this hard particle, a 30% reduction in wear is achieved in comparison with the conventional hard particle Tribaloy T-400.
2) As replacement method for lead, CrS precipitation shows better lubricity than general methods such as additions of MnS or CaF.
3) High performance VSI materials, which are applied both new hard particle and CrS precipitation, have been developed. These materials were confirmed to have superior wear resistance than conventional material.

4. References

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