Valve Seat Insert Material with Good Machinability

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Abstract

Sintered materials have been applied widely in Valve Seat Inserts (VSI). The demands for VSIs are not only good heat and wear resistance but also good machinability.
The sintered materials, which are made of a mixture of manganese containing iron powder and certain types of sulfide powder, have superior machinability due to precipitation of the fine MnS particles in the matrix. This report introduces a new VSI material, which has both superior machinability, and wear resistance due to applies of this "MnS precipitation" technique.

Keywords : Wear resistance, Machinability, Valve seat insert

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.

There is various demand level of wear resistance to VSI materials on engine type. It depends on combustion camber condition of engine such as temperature and surface pressure etc. Generally, the load of intake VSI of gasoline engines is assumed to be comparatively light. Therefore there is a tendency that lower cost materials have been applied for intake VSI. (1)

Recently, the load on intake VSI is increasing because of both drier environments for proceeding of lean-burn and thinner shape for improvement of intake gas efficiency.

To correspond to such cases, the higher wear resistant material that dispersed hard particle in the martensite matrix has been applied. However, the cost increases. One of the reasons is that this material has to apply resin impregnation for its machinability. (1)

From such a background, the development of new intake VSI material, which has not only good wear resistance but also good machinability without resin impregnation, was carried out.

2. Experimental Results

2.1 Machinability Improvement Method

As well known, sintered materials are difficult to machine due to intermittent cutting resulting from the existence of pores. Therefore there are many studies to improve the machinability of the sintered materials. (2)

The machinability-enhancing additive (Example: MnS) addition is enumerated as a typical technique of machining improvement. It is widely used because this technique does not require much labor due to the machinability-enhancing additive powder being added in the mixing process. However any dramatic improvement in the machinability cannot be expected.

When the pores are filled by process such as Cu-infiltration and resin impregnation, etc., machinability is greatly improvement.However it results in the number of processes increasing.

A new technique “MnS precipitation” was selected for new material. “MnS precipitation” is the production method that is a mixture of manganese containing iron powder and certain types of sulfide powder and is able to improve greatly because of distribution of fine MnS particles in the matrix. The rise of cost is slightly in this technique because it doesn’t need any additional process.

Figure 1 shows the results of machinability evaluation with "MnS addition" and "MnS precipitation". As can be seen from this figure, “MnS precipitation” shows superior machinability compared with MnS addition.

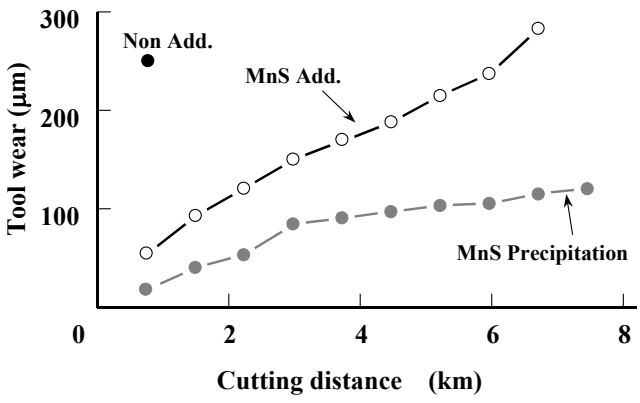

Fig. 1. Evaluation results of machinability.

2.2 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. Recently, Fe-Mo-Si alloy was developed as high performance hard particle. (3) This alloy is also lower cost because of Co-free. Therefore this Fe-Mo-Si alloy was decided to apply to the developed material.

Figure 2 shows the effect of additional amount of hard particle to wear resistance. There is a tendency that wear amount decreases by increasing of additional amount of hard particle. When the additional amount is 3mass%, wear amount become almost equal to the conventional material.

Based on this result, additional amount was decided to be 5mass% to ensure the equal wear resistance to the conventional material.

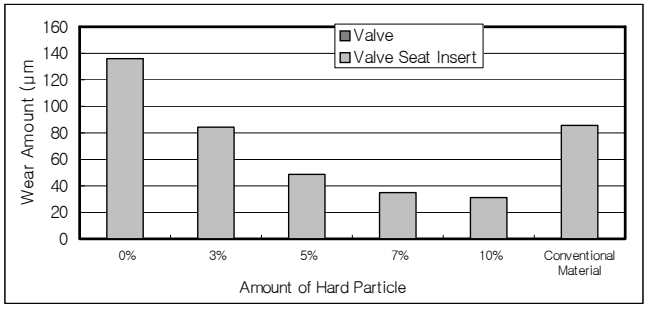

Fig. 2 Wear resistance of each hard particle amount.

2.3 Machinability

Machinability of 5mass% hard particle dispersion material, which is applied "MnS precipitation" method, was evaluated. The samples, which were produced with several additional amount of sulfide powder, were evaluated because the effect of "MnS precipitation" is greatly affected by the amount of sulfide powder.

Figure 3 shows the machinability test results. In the case of 0.5mass% addition of sulfide powder, machinability is almost same level compared with conventional material. On the other hand, it is confirmed that the 1mass% sulfide material shows superior machinability than the conventional material.

Based on this result, additional amount of sulfide powder was decided to be 1mass% to ensure the equal machinability to the conventional material.

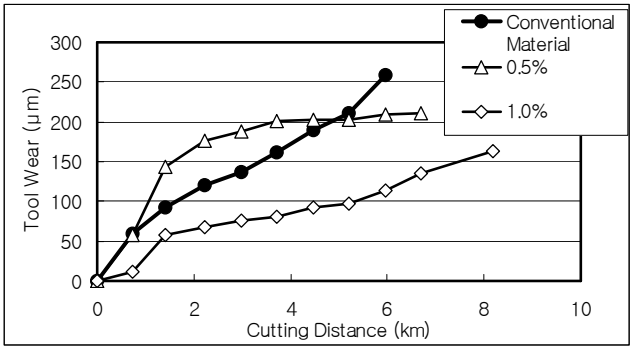

Fig. 3 Comparison of machinability.

3. Summary

In order to develop an intake VSI material, which has superior wear resistance and machinability without resin impregnation, additional amount of hard particle and machinability improvement technique were investigated.

The conclusions are as follow-

1) Wear resistance of conventional material was achieved by 5mass% addition of Fe-Mo-Si alloy as hard particle.
2) “MnS precipitation” was applied as a technique that can replace resin impregnation for machinability improvement. The additional amount of sulfide powder to precipitate MnS particle was decided to be 1.0mass% in order to ensure equally machinability to conventional material.

4. References

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