Influence of Water Volume on Particle Characteristics of Iron Powder with Insulated Coating for a Compacted Magnetic Core

Norikazu Funato[1,a] and Masayuki Yamamoto[1,b]

[1] FINE SINTER CO.,LTD. 438,Daisenji-cho,Kasugai,Aichi,Japan
[a]n-funato@fine-sinter.com
[b]m-yamamo@fine-sinter.com

Abstract

Seasonal changes have been recognized in particle characteristics and forming characteristics of iron powder with insulated coating for a compacted magnetic core because of its high hygroscopicity, due to its phosphate coating and resin binder additives. For this reason, particle characteristics and molding characteristics of the powder with diverse water absorbtivity have been studied. The result shows that the higher the volume of absorbed water, the worse the fluidity becomes, resulting in the reduction in both springback during the molding process and expansion reduction after the heat treatment. The requirement on dimension accuracy for the finished product can be satisfied with an additional drying process on the material powder, which contributes to maintain its water volume constant.

Keywords : iron powder with insulated coating, springback, dimension change, binder

1. Introduction

The compacted magnetic core using iron powder with insulated coating has superior dimension accuracy because of its heat treatment with a temperature of approximately 600℃ or lower instead of the high temperature sintering common in conventional powder metals. With its recent applications in the fields of motor core and sensor[1), 2)], a higher dimension accuracy is strongly required. On the other hand, seasonal changes have since long been recognized in particle characteristics and forming characteristics of the iron powder with insulated coating.

Because of the high hygroscopicity due to its phosphate coating and resin binder additives, negative impact on the particle characteristics and molding characteristics constitutes the main concern in its application. To solve this issue, commercially marketed iron powder with insulated coating was used to determine the particle characteristics, the springback of the finished compact and the dimension change after heat treatment by changing the absorbed water volume.

2. Experimental and Results

Commercially available iron powder with phosphate c oating including binder additives was used for the powd er material. The material powder was molded into test sa mples of Φ28mm × Φ20mm × L10mm by using metal die for ring specimen and applying a pressure of 500-800 MPa, followed by heat treatment at 200℃ for 30 minutes in atmospheric conditions. Figure 1 shows the relationship between the compact density and the springback of outer diameter, and the outer diameter after the heat treatment. Figure 2 shows the relationship of the volume of binder additives and the outer diameter.

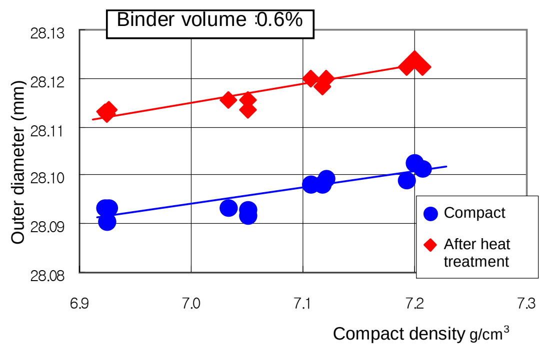

Fig. 1. Relationship between compact density and out er diameter.

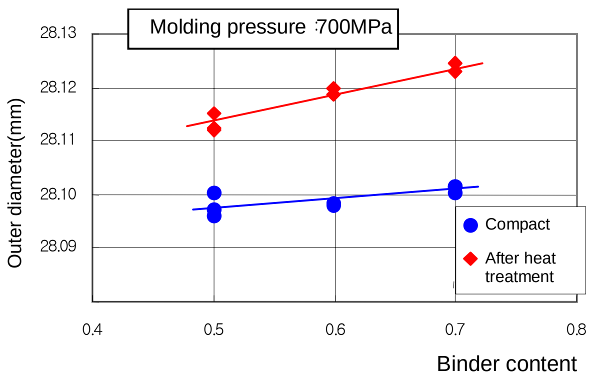

Fig. 2. Relationship between binder volume and outer Diameter.

The outer diameter springback increases with the increase in compact density and volume of binder additive. Also, the outer diameter will expand with the heat treatment, and the expansion rate increases with the volume increase of binder additives.

In the next step, using the material powder impregnated in water for 3 hours in a 95% atmospheric humidity with temperature of 30℃, different drying conditions were applied to change the volume of absorbed water. The springback of the outer diameter and the dimension after heat treatment of the specimens were measured. The drying conditions of the material powder for the test, its volume of absorbed water after drying it and its fluidity are shown in Table 1. A Karl-Fischer moisture meter was used for the measurement of absorbed water, and the volume of water dissociated at 120℃ was measured.

Figure 3 shows the volume of absorbed water in the material powder, the springback in compact outer diameter and the outer diameter after the heat treatment. With the increase in volume of absorbed water, the level of springback in compact outer diameter and the expansion of outer diameter after the heat treatment decreased.

Table 1. Material powder used for the experiment

No	Hydration condition (3 hr)	Drying condition (3 hr)	Volume of absorbedwater (ppm)	Flowability sec/50 g
1	30℃、95%	–	80	31.0
2	↑	80℃	51	26.1
3	↑	90℃	35	25.9
4	↑	100℃	24	25.7

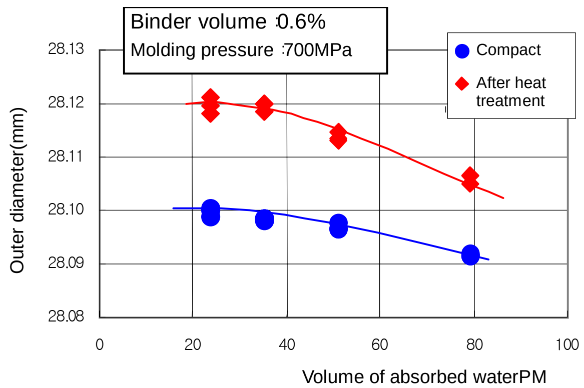

Fig. 3. Relationship between the volume of absorbed water and the compact outer diameter.

Also, as shown in Table 1, a higher volume of absorbed water results in deterioration of fluidity in material powder, which may be a cause of non-uniform material filling in the molding process. To solve this issue, an additional drying process on the material powder was considered, which made it possible to maintain its water volume constant. A stable dimension accuracy was obtained based on this modification.

3. Summary

It was understood that the springback behavior and the expansion of the dimension of the compact made from iron powder with binder additive with insulated coating are affected not only by the compact density and binder additive volume, but also by the volume of absorbed water. Considering that the higher the volume of absorbed water, the smaller the dimension change is, and that the fluidity of the material powder deteriorates, it is essential to maintain constant the volume of absorbed water in the material powder to improve dimension accuracy.

4. References

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