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Property of New SEGLESS that is Segregation-free Steel Powder Mixture for Warm Compaction

Satoshi Nishida[a], Satoshi Furuta[b]

Kobe Steel, Ltd
2-3-1,Sinhama,Arai-cho,Takasago,Hyogo,676-8670, JAPAN
[a]nishida.satoshi@steel.kobelco.co.jp, [b]furuta.satoshi@steel.kobelco.co.jp

Abstract

Recently warm compaction techniques are focused on and commercialization of one high-density compaction process in the P/M industry. Another development is a new SEGLESS using a developed lubricant that reduces ejection force at room temperature compaction. It is possible to achieve high-density by reducing lubricant amount. In this paper we confirmed that green density was 7.35 g/cm^3 at 686MPa of compaction pressure when the new SEGLESS was applied to relatively lower temperature warm compaction process, such as 80 ℃.

Keywords: **Segregation-Free, Lubricant, Warm compaction**

1. Introduction

Typical P/M parts production starts with mixing steel powder, lubricant, alloying elements, such as graphite powder and copper powder, prior to compacting and sintering process. Kobe Steel LTD. has already developed and placed on the market a steel powder mixture named SEGLESS containing a binding agent, which prevents segregation and dusting of graphite.[1] An other interesting technique recently focused on in the P/M industry is high density compaction process by warm compaction, aiming at enhancing mechanical properties of P/M parts by eliminating pores. [2-3]

In this background, Kobe Steel LTD. has also developed a new SEGLESS using the developed lubricant (new Wax) that lowers ejection force at room temperature compaction. It could easier obtain high-density to decrease admix of lubricant.[4] In this paper, the properties of the newly developed SEGLESS compared to warm compaction are reported.

2. Experimental Procedure

In this experiment, the following two segregation free mixtures were prepared using the developed lubricant and conventional Wax for warm compaction.

(1) NEW SEGLESS
300NH-2.0%Cu-0.8%Gr+0.4% new Wax+0.1%binder
(2) KHD-SEGLESS
300NH-2.0%Cu-0.8%Gr+0.6%Wax+0.1%binder

300NH is the water atomized high compressibility iron powder. The binding agent was used for warm compaction, and typical amount of binding agent is 0.1wt%. Lubricant is the most important additive for this test. Then two types of SEGLESS were prepared by adding different lubricant. New SEGLESS was the powder mixture admixed 0.4wt% new Wax consisting of polyhydroxyl amide compound. KHD-SEGLESS was the powder mixture admixed 0.6wt% conventional Wax consisted of polyamide and melamine. (Table1.)

Table 1. Lubricant of SEGLESS

SEGLESS TYPE	Proportion of lubricant	Main component of lubricant
New SEGLESS	0.4wt% new Wax	polyhydroxyl amide
KHD-SEGLESS	0.6wt% Wax	polyamide and melamine

The powder mixtures to be tested were heated for 20 minutes in an oven with Hall flow meter. Apparent density and flow rate were measured from 20℃ to 150℃.The orifice diameter of the flow meter is 2.63mm based on JIS standards.

Each powder was compacted at temperature from 60℃ to 150℃ by heated die. The die is heaed by band heater. The compaction pressure was 686MPa.

Test specimen for ejection force measurement was cylinder shape with a diameter of 25mm and a height of 25mm. They were used to evaluate the ejection force from the die at a stroke speed of 2.0mm/s.

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For mechanical properties, tensile strength, Charpy impact value and hardness were measured after sintering. The condition of sintering temperature was 1120℃ for 20 minutes in nitrogen.

3. Results and Discussion

At each temperature, the properties of powder mixture were shown in Table2. New SEGLESS has higher apparent densities than KHD-SEGLSSS. Flow rate of the New SEGLESS was getting higher value as higher temperature, however, it was fewer than KHD-SEGLESS (150℃).

Table 2. Properties of powder mixture

SEGLESS TYPE Lubricant	Temperature ℃	Apparent Density g/cm^3	Flow Rate, s/50g
New SEGLESS 0.4wt% new Wax	20	3.51	23.6
	60	3.43	24.8
	80	3.37	28.5
	100	3.34	28.7
KHD-SEGLESS 0.6wt% Wax	20	3.29	24.1
	130	3.26	27.5
	150	3.20	29.7

Fig. 1. shows the relationship between the compaction temperature and the green density at 686 MPa. The Green density of New SEGLESS was 0.1g/cm^3 higher than KHD-SEGLESS at each temperature. The reason to obtain higher density is due to an effect of new Wax. Since the new Wax is made from a kind of fatty acid amide with -good lubricity, New SEGLESS is enable to decrease lubricant content at each of temperatures.

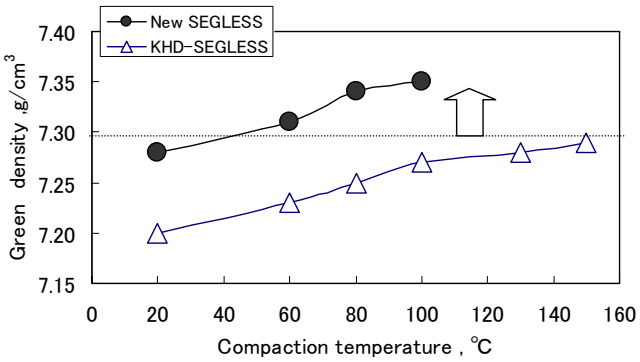

Fig. 1. Relationship between Compaction temperature and Green density

Fig. 2. shows relationship between compaction temperature and ejection force at 686 MPa. It confirmed that the ejection force of New SEGLESS could be less than 22MPa when compacted at 80℃or lower compacting temperature.

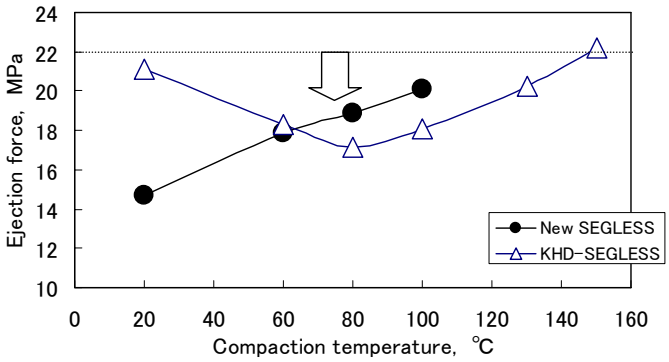

Fig. 2. Relationship between Compaction temperatures and Ejection force

The sintered properties are shown in Table3. Tensile strength of New SEGLESS compacted at 80℃ was improved by 4% and impact value by 14% as compared with KHD-SEGLESS compacted at 150℃ under the same compacting pressure.

Table 3. Sintering Properties

SEGLESS TYPE Lubricant	Sintering Density g/cm^3	Tensile Strength MPa	Impact Value J/cm^2	Hardness HRB
New SEGLESS 0.4wt% new Wax	7.29	665	25	85
KHD-SEGLESS 0.6wt% Wax	7.23	640	22	84

4. Summary

(1) Newly developed SEGLESS has higher apparent density than and similar powder flow as the KHD-SEGLESS at 130℃.
(2) Newly developed SEGLESS was applied to a relatively lower temperature warm compaction process, and 7.35 green density was achieved under 80℃ and 686MPa compacting conditions. Ejection pressure was 22MPa or lower to obtain the density.
(3) Tensile strength and impact value of newly developed SEGLESS is improved by 4% and 14% respectively under same compacting pressure, compared with conventional KHD-SEGLESS.

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