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Short Communication

Influence of Surfactants on the Activity Powders of Barium Hexaferrite, Prepared by Wet Grinding

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Study the influence of citric acid and isopropyl alcohol on processes of wet grinding mixture of starting ferrite constituting components and synthesized ferrite charge. Found that the introduction of additives during wet grinding allows to significantly reduce the temperature of synthesis and sintering ferrite raw blanks. Increased activity of powders is explained by the formation of active the gelled layers on the surface of particles in the process of wet grinding.

Keywords: Barium hexaferrite, Wet grinding, Surfactants.

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1. INTRODUCTION

Barium hexaferrite produced by ceramic technology, widely used as magnetic materials through a combination of high coercivity and a relatively low cost. One way of increasing the coercive force and magnetic energy is to achieve a dense fine-grained microstructure [1]. In order to form a dense fine-grained structure requires decrease temperatures of synthesis and sintering, while ensuring high activity powders to sintering.

It is known [2] that wet grinding of the initial mixture of barium carbonate with iron oxide allows to increase the activity of the resulting mixture to the subsequent synthesis as compared with dry grinding, wet grinding a synthetic charge - to increase their activity to sintering. Increased activity of barium hexaferrite particles during wet grinding explained by the formation of active gel layers of barium hydroxide on the particle surface.

In this study, conducted studies of the effect of surfactants on the process of wet grinding in order to increase the activity of powders obtained. Since the solubility of barium compounds increases in acidic medium, as surfactants used citric acid and isopropyl alcohol, forming a slightly acidic aqueous medium.

2. THE EXPERIMENTAL TECHNIQUE

Wet grinding was carried out in a vibratory mill M-10, a mixture of barium carbonate $BaCO_3$ GOST 2149-75 mark "p" and iron oxide Fe_2O_3 TU 14-106-340-89 mark "p", citric acid (GOST 908-2004), isopropyl alcohol (TU 6-09-402-87) for 2 hours. Humidity obtained suspension was 40 wt %. For comparisons were made wet grinding a mixture of barium carbonate and iron oxide without additives.

After drying prepared mixture was calcined in furnace TC-4000 at 800-1000 °C. The residence time of charge in the zone with the maximum temperature in the furnace was 3 hours. The synthesized charge in all experimental batches milled by wet method in an attritor "Ararat" over 2 hours by adding water in an amount of 40 wt %. As surfactants also used citric acid and isopropyl alcohol. From the suspension after wet grinding were pressed blanks in the form of plates 20 × 40 × 5 mm in a magnetic field of 700 kA/m at 06FFG press. After drying blanks were sintered in the tunnel furnace "El" in the temperature range from 800 to 1200 °C.

3. RESULTS AND DISCUSSION

Data on the effect of surfactants by wet grinding a mixture of the starting ferrite forming components and temperature synthesis on specific magnetization synthesized powders are shown in Fig. 1. The results obtained by averaging ten measurements As can be seen from the data, the use of surfactant during wet grinding allows to markedly reduce the temperature firing charge that provides the specific magnetization of not less than 50 nT·m³/kg. The greatest effect is achieved by co-administration of isopropyl alcohol and citric acid.

Increased activity can be explained by the fact that the molecules of isopropyl alcohol, expanding the particles of barium carbonate on barium hydroxide and carbon dioxide to cause saturation of the water environment of barium hydroxide. Citric acid, binding to barium cations form insoluble complexes, which are deposited on the surface of the active particles in the form of gelatinous layers. As a result, significantly increases the activity of the original ferrite forming components to the synthesis that allows to reduce synthesis temperature of barium hexaferrite. Reduced synthesis temperature from 950 °C to 840 °C provides a more

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active to sintering fine powders hexaferrite, which allows to reduce the sintering temperature of the raw pressed blanks hexaferrite.

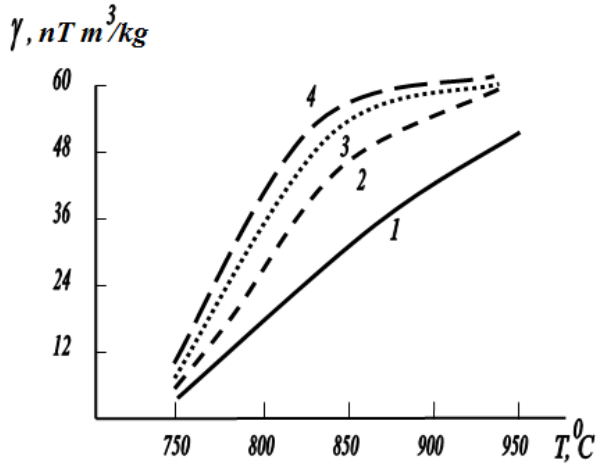

Fig. 1 – Influence of surfactants by wet grinding mixture of initial ferrite forming components and temperature synthesis on specific magnetization of barium hexaferrite powders synthesized: 1 – without surfactant, 2 – 1,0 wt. % isopropyl alcohol and 3 – 0,2 wt. % citric acid, 4 – 0,2 wt. % citric acid and 1,0 wt. % isopropyl alcohol

Figures 2-4 shown data on the effect of surfactants used in the wet grinding mixture of initial ferrite forming oxides on the density of sintered preforms. Moreover, the data in Fig. 2 correspond to wet grinding of synthesized charge without surfactants, and the data in Fig. 3 and 4 corresponding to the introduction of 0,2 wt %. citric acid and 1,0 wt %. isopropyl alcohol, respectively.

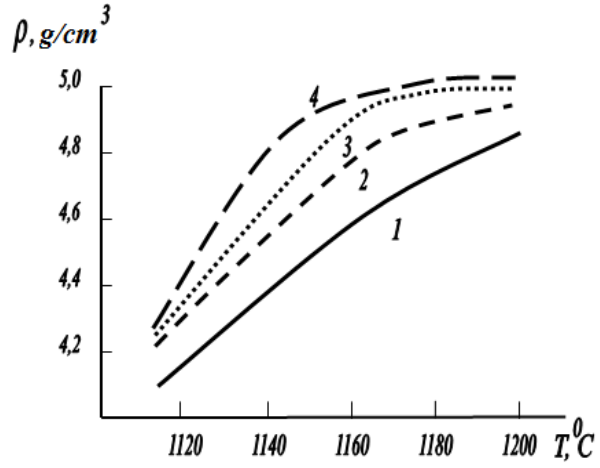

Fig. 2 – Influence of surfactant during wet grinding mixture of the starting ferrite forming components and sintering temperature on the sintered density of the blanks barium hexaferrite (grinding synthetic charge without surfactant): 1 – without surfactant, 2 – 1,0 wt. % isopropyl alcohol and 3 – 0,2 wt. % citric acid, 4 – 0,2 wt. % citric acid and 1,0 wt. % isopropyl alcohol

From the data shown in Fig. 2-4, it is seen that the use of surfactants by wet grinding mixture of initial ferrite forming components and wet grinding synthesized charge allows a greater density sintered body and to reduce the sintering temperature of blanks.

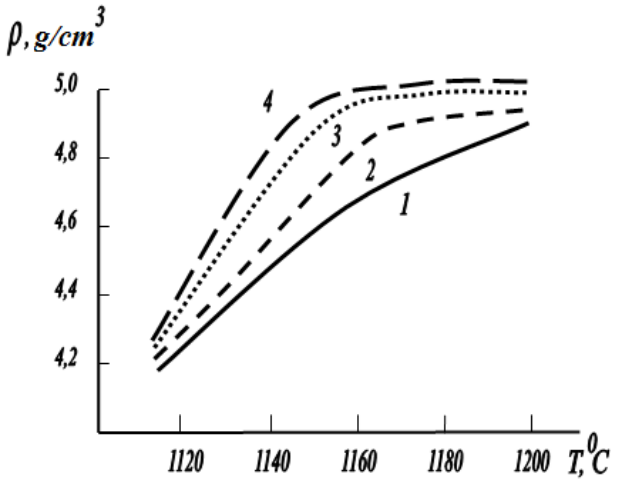

Fig. 3 – Influence of surfactants by wet grinding mixture of initial ferrite forming components and sintering temperature on the sintered density of the blanks barium hexaferrite (grinding synthetic charge with 0,2 wt. % of citric acid): 1 – without surfactant, 2 – 1,0 wt. % isopropyl alcohol and 3 – 0,2 wt. % citric acid, 4 – 0,2 wt. % citric acid and 1,0 wt. % isopropyl alcohol

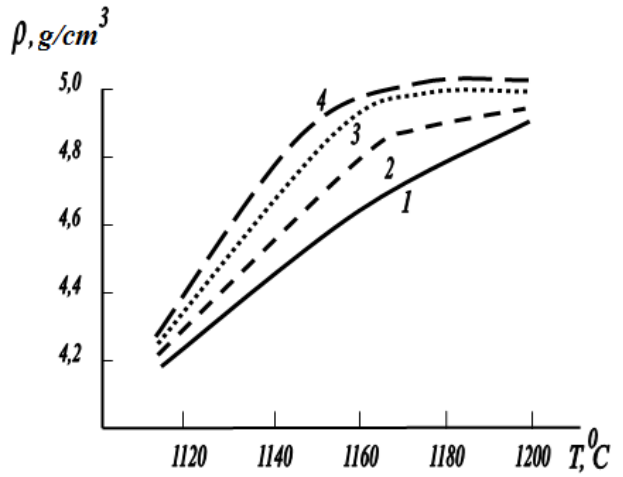

Fig. 4 – Influence of surfactant during wet grinding mixture of initial ferrite forming components and the sintering temperature on sintered density of the blanks barium hexaferrite (grinding synthetic charge from 1,0 wt. % isopropyl alcohol): 1 – without surfactant, 2 – 1,0 wt. % isopropyl alcohol, 3 – 0,2 wt. % citric acid, 4 – 0,2 wt. % citric acid and 1,0 wt. % isopropyl alcohol

Tables 1-3 present data on the effect of surfactants, synthesis temperature ferrite charge and subsequent sintering of the molded blanks on the coercive force of the magnetization and the residual induction of barium ferrite. As seen from the data table, the use of surfactants by wet grinding mixture of initial ferrite forming components and wet grinding of synthesized charge allows to lower optimum temperatures of synthesis and sintering, improve level of the electromagnetic properties of barium ferrite.

Table 1 – Influence of surfactants, the synthesis temperature of ferrite charge and subsequent sintering of pressed blanks on the coercive force on magnetization and residual induction of barium ferrites (grinding synthesized charge without surfactant)

№ p/p	Composition of the surfactant during wet grinding, wt. %	T synthesis, °C	T sintering, °C	Hci, kA/m	Br, T
1	Without surfactant	950	1220	231	0,37
2	Citric acid – 0,1	910	1180	257	0,38
3	Citric acid – 0,2	850	1160	271	0,39
4	Isopropyl alcohol – 0,5	920	1190	248	0,40
5	Isopropyl alcohol – 1,0	900	1170	257	0,40
6	Citric acid – 0,2 Isopropyl alcohol – 1,0	840	1150	284	0,41

Table 2 – Influence of surfactants, the synthesis temperature ferrite charge and subsequent sintering of pressed blanks on the coercive force on magnetization and residual induction of barium ferrites (grinding synthesized charge with 0,2 wt. % of citric acid)

№ p/p	Composition of the surfactant during wet grinding, wt. %	T sintering, °C	Hci, kA/m	Br, T
1	Without surfactant	1190	230	0,37
2	Citric acid – 0,1	1160	256	0,38
3	Citric acid – 0,2	1150	269	0,39
4	Isopropyl alcohol – 0,5	1170	249	0,40
5	Isopropyl alcohol – 1,0	1160	259	0,40
6	Citric acid – 0,2 Isopropyl alcohol – 1,0	1150	288	0,41

Table 3 – Influence of surfactants, the synthesis temperature ferrite charge and subsequent sintering of pressed blanks on the coercive force on magnetization and residual induction of barium ferrite (grinding synthesized charge from 1,0 wt. % isopropyl alcohol**)**

№ p/p	Composition of the surfactant during wet grinding, wt. %	T sintering, °C	Hci, kA/m	Br, T
1	Without surfactant	1210	233	0,37
2	Citric acid – 0,1	1160	259	0,38
3	Citric acid – 0,2	1140	271	0,39
4	Isopropyl alcohol – 0,5	1170	255	0,40
5	Isopropyl alcohol – 1,0	1150	262	0,40
6	Citric acid – 0,2 Isopropyl alcohol – 1,0	1130	291	0,41

4. CONCLUSION

As a result of experimental studies have shown that the use of surfactants during wet grinding a mixture of the starting ferrite forming components and ferrite charge allows to lower the optimal temperatures of synthesis and sintering, increase the level of electromagnetic properties of barium ferrite. Maximizing activity of mixture of initial ferrite constituting components by co-administration of citric acid and isopropyl alcohol can be explained by the fact that the molecules of isopropyl alcohol, decomposing barium carbonate particles on barium hydroxide and carbon dioxide, cause saturation the aqueous medium of barium hydroxide. Citric acid, binding to barium cations form insoluble complexes, which are deposited on the surface of particles in the form of the active of gelatinous layers. As a result, significantly increases the activity of the starting ferrite forming components to the synthesis that allows to reduce synthesis temperature of barium hexaferrite.

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