

The Manufacture and Technology of the Ferrite Materials in China

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ABSTRACT

China is a large country for the production of magnetic materials because of its cheap price and abundant raw materials. The total yield of ferrite occupies about 20% fraction in the market of the world. In this report, the characteristics and the yield of the ferrite magnet produced in China were displayed. Also the distribution of manufacturers and research institutes and the China's 10th five-year-plan on the magnetic materials were reviewed.

Key words : raw materials, yield, characteristic, manufactures, magnetic materials

1. Introduction

Ferrite magnets, mainly composed of iron oxides, have the best cost-performance compared with that of other permanent magnet materials. They are widely used in various applications such as motors, speakers, etc., and account for more than 95% by weight of all permanent magnets production.

It is well known that the production of magnetic materials in China plays an important role in the world for their cheap labour force, the abundant raw materials, large yield and great market. The annual yield of permanent ferrite magnet is 85 thousand tons in 1995, 100 thousand tons in 1997 and 160 thousand tons in 2001. The total yield of ferrite occupies about 20% in the world. However, the value of ferrite is so low that the unit price is only half of that in Japan. Most of high-class products are only produced in small scale or depend on import. Table 1 shows the value and the yield of ferrite magnet in China and Japan.

The main manufacturers of magnetic materials are located at the east and south in China, especially in the provinces of Guangdong, Zhejiang, Fujian and Shanghai. The research institutes are mostly located in Beijing, Shanghai and some famous universities. Fig 1 shows

the distribution of manufacturers and research institutes in China.

Here, the red dots represent the manufacturers and the blue squares represent the institutes.

Table 2 shows the manufacturers whose values are at the first 10 tops in China.

1.1. The outline of the soft ferrite production in China

Soft ferrite is akin of nonmetallic magnetic materials, which are made up of ferric oxide and other metallic oxides such as MnO, NiO and ZnO. It has a high resistivity so that its eddy-current loss at high frequency is much less than that of metallic magnetic materials. Soft ferrite cores are widely used in computers, Telecom equipment, and consumers electronics such as TV, VTR and audio sets, industrial automation equipment and various kinds of electronic instruments,

Table 1. The value and the yield of ferrite magnet in China and Japan

Kind of magnet	China		Japan	
	Yield (ton)	Value (million dollar)	Yield (ton)	Value (million dollar)
Permanent magnet	115,000	262	48,300	295
Soft magnet	42,000	296	42,000	580

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Table 2. The 10 tops manufacturers in China

Company	Position (Province)	Production value (RMB)
Fenghua HighTech	Guangdong	2,422,180,000
Hengdian Dongci	Zhejiang	1,419,140,000
Xiamen TDK	Fujian	1,151,420,000
Jingshi Company	Jiansu	856,700,000
Hangzhou YongCi	Zhejiang	394,250,000
Tiantong Company	Zhejiang	283,800,000
Kingshan Company	Shanxi	208,770,000
Nanjing 898 Factory	Jiangsu	167,420,000
Zhenhai Company	Shandong	158,570,000
Yuanyang Company	Jiangsu	150,220,000

etc. From the view of the properties, Chinas soft ferrite industry has some features as follows:

(1) Frequency: From 70's, the high frequency ferrite has been developed largely. In the past years, the types of PC40, PC44 and PC50 have been mainly produced in large-scale batches by some foreign company such as FDK Co., Siemens Co. and Philips Co. Only a few manufacturers of China, such as Tiantong Co., 898 factory and 899 factory have the ability to produce the type PC40 in small scale. Most of manufacturers could merely produce the type PC30. In the technology on

the production of high frequency ferrite, China has a quite large gap with Japan.

(2) Permeability: The magnetic materials with the types of H₅C₂ ($\mu_i=10000$), H50 ($\mu_i=13000$), H5E ($\mu_i=18000$) already have been produced in developed country in batches. In China, only a few company such as Tiantong Co., Laishui magnet factory, 898 factory and 515 factory could produce the ferrites with μ_i of 10000 in small scale. The ferrite with μ_i higher than 10000 is trial-manufactured now. Main product of ferrites in batches is that with the permeability from 5000 to 7000.

(3) Resistance: The resistance EMI materials are at the beginning stage in China, and they only have a few assortments.

1.2. The outline of permanent ferrite production in China

The hard ferrite (permanent ferrite) magnets of China take more than 75% charge in the world ferrite market, and have won wide acceptance due to their good resistance to demagnetization, excellent corrosion resistance and low price. The main chemical composition is iron oxide, barium and strontium elements. The types and sizes are mainly ring and cylinder with diameter of 5-220 mm, block with length of 4-200 mm, segment (tile), ball of magnetic bar, horseshoe magnet, etc. These materials are mainly used for most types of speaker, DC motors, magnetic separators,

Table 3. Some types and standard in China and Japan

Type	Magnetism				Remark
	B _r (T)	H _c (kA/m)	K _{cj} (kA/m)	(BH) _{max} (J/m ³)	
Y30H-1	0.380~0.400	230~275	235~290	27.0~32.0	Trade standard SJ/TT10410-93 in China
Y30H-2	0.395~0.415	275~300	310v335	28.5~32.5	
Y32	0.400~0.420	160~190	165~195	30.0~33.5	
Y33	0.410~0.430	220~250	225~255	31.5~35.0	
FB5N	0.440	227	229	36.7	The standard of TDK Co. in Japan
DB5H	0.405	298	323	31.1	
FB5B	0.420	263	267	33.4	
FB6N	0.440	259	263	36.7	
FB6H	0.400	303	358	30.3	
FB6B	0.420	303	318	33.4	

MRI (magnetic resonance imaging) and automotive sensors.

The production of permanent ferrite is overcapacity in China. However, it also need to import the high-powered permanent ferrite. In China, main production of permanent ferrite is the type of FB54. The 899 factory produce the type FB5 and FB6E in small scale, but couldnt satisfy the need of market for its small amount and low ratio in production.

In fact, it is necessary that China improve its laggard technology and equipment in the production of ferrite magnet. Table 3 shows the type and standard in China and Japan, respectively. Table 4~9 present some characteristic of ferrite magnet made in China.

The ferrite magnet made in China will occupy important fraction in the market of the world for its cheap raw material.

China's 10th five-year plan on the production of magnetic materials is as follows:

1. Soft ferrite
 - High frequency ferrite will be produced in large-scale batches for the type PC44 and small for the type PC50.
 - The materials of HVB38, HV45 and core used in HDD TV and HDD monitor will be produced in large-scale batches.
 - The high permeability ferrite (μ 10000) will be produced in batches.

Table 4. Some magnetic and physical properties of Ni-Zn ferrites

Type	Frequency (MHZ)	Initial permeability μ (25%)	Curie temperature T_c (°C)	Density (g/cm ³)	Loss coefficient $\tan\delta$ ($\times 10^{-6}$ /MHz)	Relative temperature coefficient α_r (10^{-4})
JPR360	0.1~1.5	700	> 140	4.8	< 250(1.5)	0~7.0
JPR361	0.1~1.0	1000	> 130	4.9	< 280(1.0)	2~5.0
JPR362	0.01~0.05	1500	> 110	4.9	< 75(0.5)	0~3.0
JPR371	10~150	10	> 350	4.5	< 400(70)	80~100
JPR372	5~100	20	> 300	4.4	< 400(60)	50~70
JPR373	2~60	40	> 300	4.5	< 350(40)	25~50
JPR374	1~40	60	> 300	4.6	< 100(20)	20~50
JPR375	0.5~20	100	> 300	4.6	< 160(20)	55~130
JPR376	0.3~7	200	> 200	4.7	< 105(7)	15~35
JPR390	0.1~2	350	> 125	4.6	< 60(2)	13~30
JPR391	0.1~2	450	> 125	4.7	< 80(2)	8~35

Table 5. Some magnetic properties of Mn-Zn ferrites

Type	Initial permeability μ		Saturation flux density B_s		Remanence B_r		Coercivity H_c		Power loss P_c		T_c
	25	100	25	100	25	100	25	100	25	100	
PP-2	± 3000 25%	470	370	120	85	12	7	57(1)	53(1)		> 200
JPP-3	± 3000 25%	500	390	110	60	12	10	130(2)	90(2)	100(2)	> 230
JPP-4	± 3000 25%	500	390	100	55	14	9	600(3)	460(3)	410(3)	> 215

Table 6. Some properties of Mn-Zn ferrites with high permeability

Type	Initial permeability (10^{-6})	Loss coeff. $\tan\delta_i$ (10^{-6})	Sat. flux dens. (mT)	$B_r \cdot 3$ (mT)	H_c (A/m)	p ($\Omega \cdot m$)	Densd (g/cm^3)
JPH-5	5000 25%	<6.5(10 kHz)	420	140	8	1	4.8
JPH-7	7000 25%	<7(10 kHz)	410	135	7.5	0.3	4.8
JPH-10	10000 25%	<7(10 kHz)	400	90	7.5	0.15	4.8

Table 7. Magnetic properties of permanent bonded ferrites

Classification	Type	B_r (mT)	H_c (kA/m)	H_{cJ} (kA/m)	$(BH)_{max}$ (kJ/m^3)	Composition
Isotropic Rubber Magnet	YNT-4	135~155	85~105	175~210	3.2~5.0	$BaO_{0.6}Fe_2O_3$ $SrO_{0.6}Fe_2O_3$ Mix CPE
	YNT-S5	165~180	95~105	135~160	4.5~5.8	
	YNT-B5	170~185	98~110	160~190	4.6~6.0	
	YNY-65	185~200	90~100	125~150	6.0~7.0	
Anisotropic Rubber Magnet	YNY-10	220~240	145~165	200~235	9.0~10.5	$SrO_{0.6}Fe_2O_3$ Mix CPE/NBR
	YNY-11	230~250	145~165	190~225	9.0~11.0	
	YNY-13	250~270	175~190	200~230	11.5~14.5	

Table 8. Other physical properties of permanent bonded ferrites

Type	Density (g/cm^3)	Shore hardness (shored)	Temperature Coefficient ($\%/^{\circ}C$)	Operating ($^{\circ}C$)	Composition	Mode of production
YNT-4	3.6-3.7	30~45	-0.2	-40~80	$BaOFe_2O_3$ $SrOFe_2O_3$ Mix CPE	Extruding Rolling
YNT-S5	3.6-3.7	30~45	-0.2	-40~80		
YNT-B5	3.6-3.7	30~45	-0.2	-40~80		
YNY-65	3.6-3.7	30~45	-0.2	-40~80		
YNT-4	3.6-3.7	30~45	-0.2	-40~80	$SrOFe_2O_3$ Mix CPE/NBR	Rolling
YNY-10	3.6-3.7	30~60	-0.2	-40~80		
YNY-11	3.6-3.7	30~60	-0.2	-40~80		
YNY-13	3.6-3.7	30~60	-0.2	-40~80		

Table 9. The physical properties of sintered ferrites

Curie point $^{\circ}C$	Specific heat cal/gr $^{\circ}C$	Resistance $\Omega \cdot cm$	Sintering temperature g/cm^3	Anti-winding intensity kgf/mm^2	Coefficient of heat expansion (10^{-6}) $C//^* C^*$	
450-460	0.15~0.2	>104	4.7~5.0	5~10	14~15	9~10

2. Permanent ferrite

- The series of FB5 (FB5N, FB5H, FB5B) will be produced in large-scale batches.
- The series of type FB6 (FB6N, FB6H, FB6B,

FB6E) will be produced in batches.

After China joined WTO organization, the demand for the ferrite magnets has been continuous increasing. The annual increasing ratio of the yield and the market

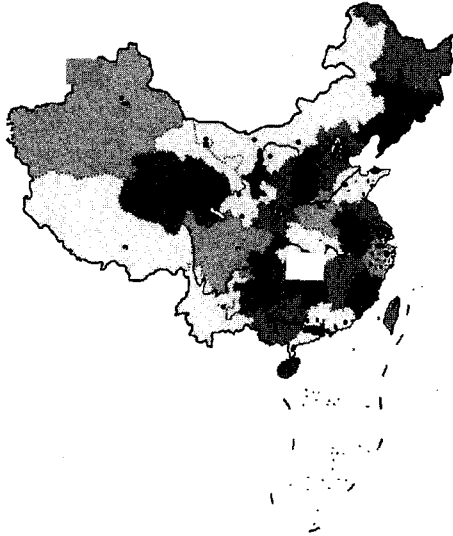


Fig. 1. The distribution of manufacturers and research institutes in China.

of ferrites are estimated as 15% in the future 5 years. The demand will reach 210 thousand tons for permanent ferrite magnet and 94 thousand tons for soft ferrite magnet. Fig. 2 shows the yield of the soft ferrite magnet (SM) and permanent ferrite magnet (PM) in 2001 and 2005 estimated.

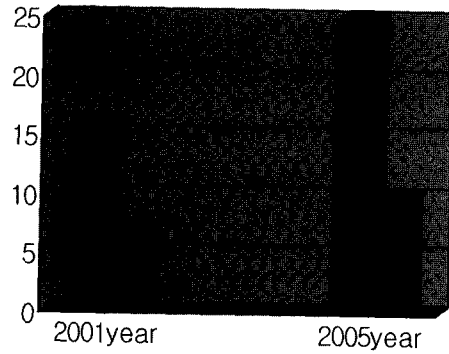


Fig. 2. The yield of the soft ferrite magnet (SM) and permanent ferrite magnet (PM) in 2001 and 2005 estimated.

In a word, though the yield of ferrites materials in China is large, the technology of the product is still low. In the last ten years, the quantity and quality of the production have been developed quickly. The product competition in the world is enhanced ceaselessly. For the production of the ferrite, China has many advantages, such as, price and resources, improving of technology and equipments, development of economy, vast market and continuously increased need. It is believed that China will have the better future in ferrite industry.