

## Production of Anticorrosion Coating Material by Converter Dust with MgO and Cr<sub>2</sub>O<sub>3</sub>

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### Abstract

Using converter dust as salt packing, adding MgO and Cr<sub>2</sub>O<sub>3</sub>, a high anticorrosion solid coating material was produced. The influences of adding MgO and Cr<sub>2</sub>O<sub>3</sub> (ranging 10%~20%) on the performance of high anticorrosion solid coating were studied. The results show that when the amount of MgO(10%~20%) in converter dust increases, feeding MgO and Cr<sub>2</sub>O<sub>3</sub> is beneficial to the decrease of coating solid component, but feeding only Cr<sub>2</sub>O<sub>3</sub>(10%~20%) has little effect. Thus, it is advisable to add MgO and Cr<sub>2</sub>O<sub>3</sub> to improve the resistance of the coating to salt water and acid. The coating of 120h acid corrosion was almost no corrosion phenomenon.

Key words: CONVERTER DUST, ANTICORROSION COATING, SALT SPRAY TEST, MGO, CR<sub>2</sub>O<sub>3</sub>

Converter dust is a kind of byproduct achieved by cooling and filtering the converter flue gas in steelmaking process. The dust is characterized with large amount, fine granularity and high metal content and can be used as fillers to make ecofriendly coatings <sup>[1]</sup>. In addition, the dust is rich in oxides, such as SiO<sub>2</sub>, CaO, MgO, and Cr<sub>2</sub>O<sub>3</sub> <sup>[2]</sup>, of which MgO is usually employed as inorganic fillers with good insulation (the thermal conductivity is about 341.3W·m<sup>-1</sup>·k<sup>-1</sup>); it is also widely used to produce high-temperature

refractory materials and coatings <sup>[3]</sup> based on its thermal conductivity. Cr<sub>2</sub>O<sub>3</sub> plays as an important ingredient in the production of colorant, which generally does not react with acid or alkali solution and is with great corrosion resistance. The current study focuses on the influences of different amounts of MgO and Cr<sub>2</sub>O<sub>3</sub> on the performance of high anticorrosion solid coating <sup>[4,5]</sup> which is made of converter dust.

### 1. Experimental scheme

**Table1.** Experimental formula of added oxides

No.	Fillers				Epoxy resin/g	Thinner/g
	Converter dust/g	Mica powder, quartz powder, talcum powder/g	Oxide/g	Total amount/g		
1	7.74	0.39	0.77	9.68	9.68	0.97
2	7.41	0.39	1.11	9.68	9.68	0.97
3	7.10	0.38	1.42	9.68	9.68	0.97

The total amount of the coating is 30 g and the fillers contain converter dust with a certain amount of stone powder, quartz powder and mica powder. The proportion of converter dust is 3%-5% (4% in this experiment), flatting agent 0.5%-1% of the main reagent (0.75% with the actual amount is 0.22 g in this experiment); thixotropic agent 0.25%- 0.5% of the main reagent (0.3% with

the actual amount of 0.09g in this experiment); dispersant agent 0.5%-1% of the main reagent (0.75% with the actual amount of 0.22g) coupling agent 0.25%-0.5% (0.3% with the actual amount of 0.09g), as shown in Table 1.

The amounts of MgO and Cr<sub>2</sub>O<sub>3</sub> are 10%, 15% and 20% respectively in studied cases. The experimental arrangements are shown in Table 2.

**Table2** Experimental arrangements of added oxides

No.	Dust particle / size	Fillers/g	Thinners/g	Oxide/%
1	250	100	10	10
2	250	100	10	15
3	250	100	10	20

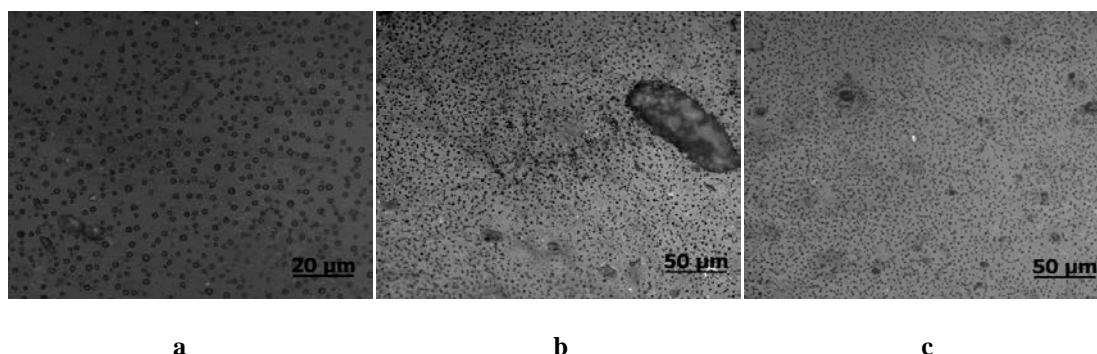
The converter dust was firstly filtered by a sifter of 250 meshes. Epoxy resin, thinners, sifted converter dust and promoters were mixed and stirred to get the agent with the consistent content. Then, the agent was coated on the surface of a steel plate, and was dried to measure the performance of the coating.

Laser Particle Size Analyzer (LPS) of JL-1177 and the fluorescent spectroscope, Quanta 650 FESEM, Zeiss microscope, NK-2 viscosity cup,

Axiovert200MAT and Salt spray devices were employed to analyze and test the coating.

**2 Results and Discussion**

Fig. 1 shows the result of the coating surface and the salt fog test without adding oxides. Small shrinkage cavities can be discovered on the surface. After the salt fog test, big corrosion pits and a few corrosion points appear. And after the resistance to acid test, dispersed corrosion points show up on the sample surface.



**Figure1.** The result of the coating surface and the salt fog test without adding oxides  
(a) coating surface (b) the result of NSS (c) the result of ASS

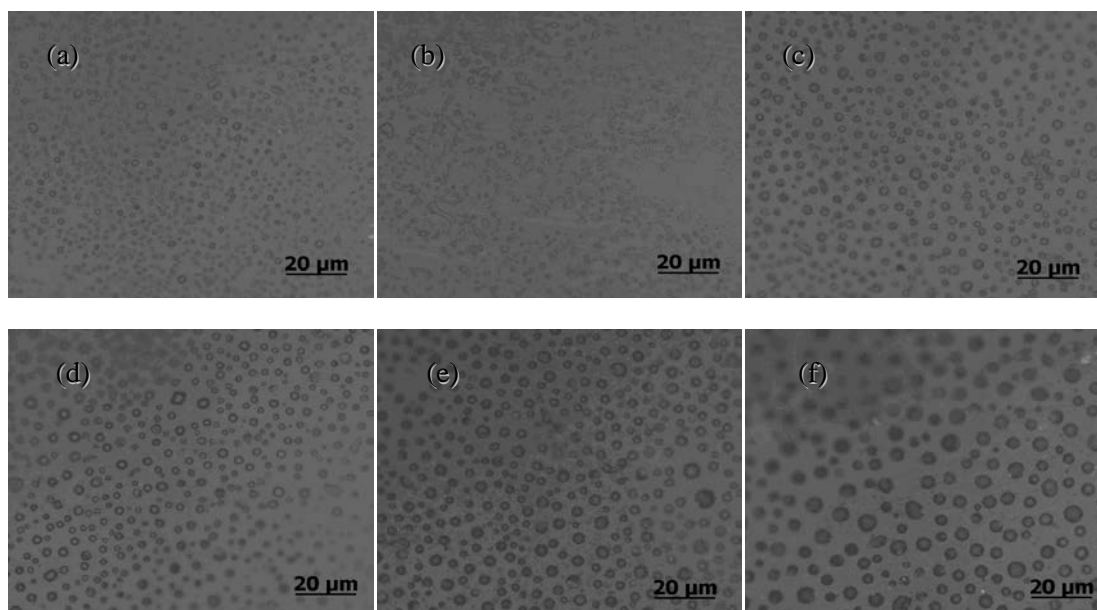
**2.1 The influences on the coating and the coating surface after adding oxide**

Different amounts of MgO and Cr<sub>2</sub>O<sub>3</sub> were added and stood for some moments and then observed to test the coating surface. There appears a certain gloss on the coat surface without layering, precipitation or skinning. As the amount of MgO increases from 10% to 20%, the bubbles on the coat surface increase as well. There appears a certain gloss after adding Cr<sub>2</sub>O<sub>3</sub>, without layering, precipitation or skinning. Cr<sub>2</sub>O<sub>3</sub> belongs to green fillers. With increased amount of Cr<sub>2</sub>O<sub>3</sub>, the color

is changed. The coat appears dark green when Cr<sub>2</sub>O<sub>3</sub> reaches 20%.

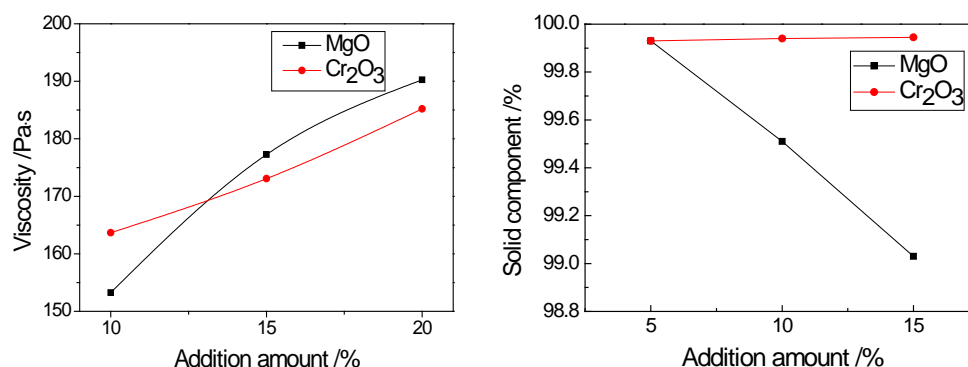
Zeiss microscope was used to observe the curing coat with different adding amounts of MgO and Cr<sub>2</sub>O<sub>3</sub>, which are shown in Fig 2. It can be drawn in the figure that the shrinkage cavities get bigger when oxides are feed. As the amount of MgO and Cr<sub>2</sub>O<sub>3</sub> increases, the shrinkage cavities get increasingly bigger. When the size of MgO and Cr<sub>2</sub>O<sub>3</sub> in the experiment is -2000, the powder is ultrafine, and much likely to gather and then form secondary particles, which means that the particle size increases easily. In addition, the surface of MgO is hydrophilic which is tend to hydrate into

Mg(OH)<sub>2</sub> and then dissolve the oxide in air or water. Thus air bubbles are easily to generate.



**Figure 2.** Influence of adding MgO and Cr<sub>2</sub>O<sub>3</sub> on film (a) 10% MgO (b) 15% MgO (c) 20% MgO (d) 10% Cr<sub>2</sub>O<sub>3</sub> (e) 15% Cr<sub>2</sub>O<sub>3</sub> (f) 20% Cr<sub>2</sub>O<sub>3</sub>

## 2.2 The influences on the viscosity and solid component of coatings after adding oxides



**Figure 3.** The change curve of coating viscosity and solid after adding oxides

After adding MgO and Cr<sub>2</sub>O<sub>3</sub>, the test results of the viscosity are shown in Fig 3(a). When the amount of the oxide is increased, the viscosity increases. The viscosity increases more apparent when the same percent of MgO is added. When the percentages of MgO and Cr<sub>2</sub>O<sub>3</sub> are both 10%, the viscosities are 153.25Pa·s and 163.68Pa·s respectively; when 15%, the viscosity of MgO case is 4.18Pa·s larger than that of Cr<sub>2</sub>O<sub>3</sub>. This is due to particle size is thinner for MgO, and the inelasticity increases which encourage the increase of viscosity. In addition, the epoxy resin in coat is mostly acidic, and MgO is alkaline oxide. Therefore, the viscosity appears a tendency of apparent increase. Considering the influence of

MgO on the viscosity, the amount of MgO cannot be added too much.

After adding MgO and Cr<sub>2</sub>O<sub>3</sub>, the change of coating viscosity and solid are shown in Fig 3(b). With the amount of MgO and Cr<sub>2</sub>O<sub>3</sub> of 10%, 15% and 20%, the solid components of the coat are all larger than 99.0%, which can satisfy the solid coat. After adding MgO into the converter dust, the distribution curve becomes steady. But after adding Cr<sub>2</sub>O<sub>3</sub>, the solid component plummets. Considering the amount of the volatile matters content in high solid anticorrosion coat, the adding of MgO has no influence but after adding Cr<sub>2</sub>O<sub>3</sub>, the solid of the coat falls quickly. So the adding amount of Cr<sub>2</sub>O<sub>3</sub> cannot be too much.

**2.3 The influences on film attachment and hardness after adding oxides**

Adhesion test and film coating thickness meter were used after adding different amounts of oxide into converter dust to test the attachment and hardness. The result is shown in Table 3. When the

amounts of adding MgO are different, the expulsion rates are 3%, 2% and 5%. After adding MgO and Cr<sub>2</sub>O<sub>3</sub>, the solid hardly changes. It is shown that the attachment and hardness are seldom influenced by the amounts and types of the fillers added in the converter dust.

**Table 3.** Influence of adding oxides on film attachment and hardness

The oxide added the amounts of /%		The left tables	Expulsion rate/%	Solid
MgO	10	96	4	4H
	15	100	0	4H
	20	98	2	5H
Cr <sub>2</sub> O <sub>3</sub>	10	97	3	5H
	15	98	2	4H
	20	95	5	5H

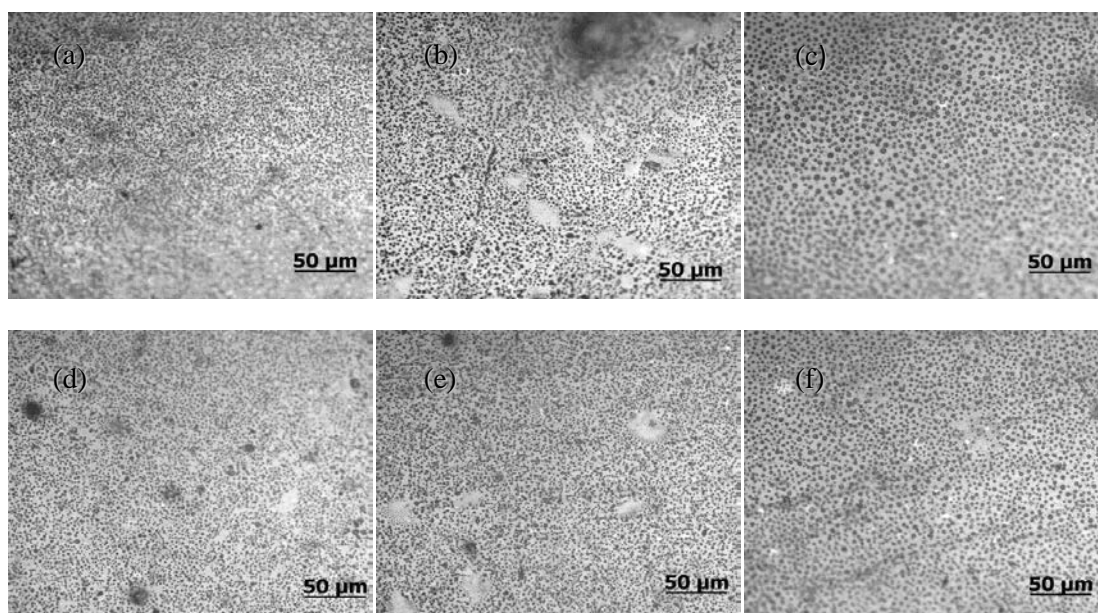
**2.4 The influence on the coating anticorrosion after adding oxides**

1) The resistance to salt water for the film coating

The resistances to salt water test was carried out to the prepared coating film for 120h. Observe the corrosion status by Zeiss microscope in 200 times zoom, as is shown in Fig 4.

Compared with (b) in Fig 1, it is clear that after adding MgO in the converter dust, the resistance to the salt water increases greatly. But the resistance changes little. It is known from (b) in

Fig 4 that there is a big corrosion point on the surface of the film coating after adding 15% MgO, but there are no other obvious corrosion points. It is known from (a) and (c) in Fig 4 that when the amount of MgO are 10% and 20%, after the salt fog corrosion, there are a few corrosion points on the surface of the film coating, which is slightly corroded. It is known from (e), (f) and (g) that after adding 10% Cr<sub>2</sub>O<sub>3</sub>, there are more corrosion points on the surface, while when the amount is 20%, the film coating is perfect.



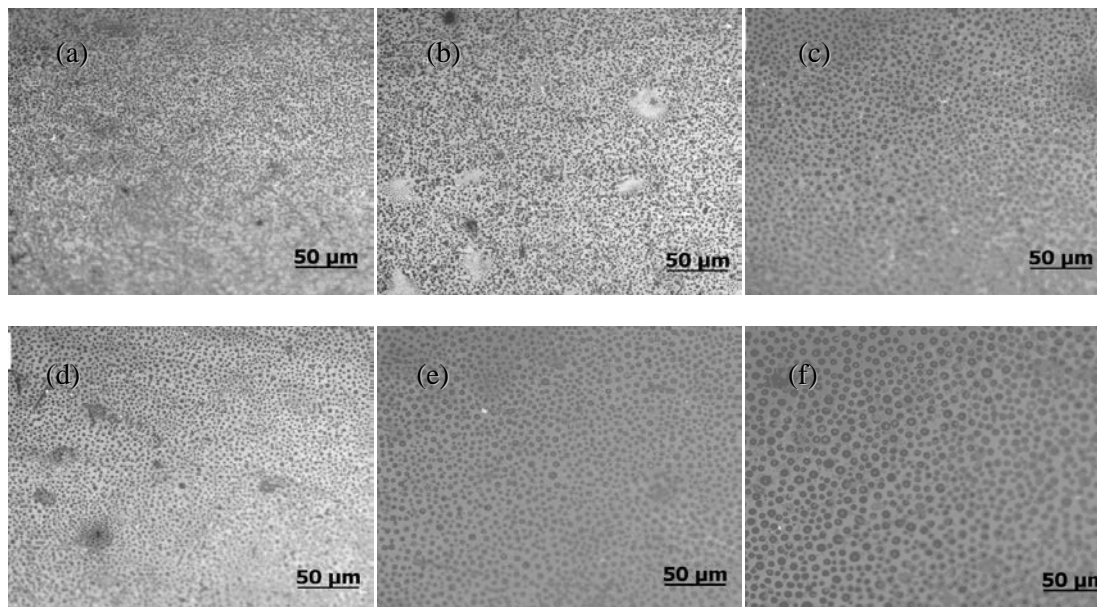
**Figure 4.** NSS results after adding MgO and Cr<sub>2</sub>O<sub>3</sub> (a) 10% MgO (b) 15% MgO (c) 20% MgO (d) 10% Cr<sub>2</sub>O<sub>3</sub> (e) 15% Cr<sub>2</sub>O<sub>3</sub> (f) 20% Cr<sub>2</sub>O<sub>3</sub>



2) The resistance to acid of the film coating

After adding MgO and Cr<sub>2</sub>O<sub>3</sub>, the prepared film coating as color fillers is tested by the acid salt

fog test. And then in Zeiss microscope roomed to 200 times, the corrosion status is shown as Fig 5. Compared with (c) in Fig 1, the resistance to acid increases.



**Figure 5.** ASS results after adding MgO and Cr<sub>2</sub>O<sub>3</sub>(a) 10% MgO (b) 15% MgO (c) 20% MgO (d) 10% Cr<sub>2</sub>O<sub>3</sub> (e) 15% Cr<sub>2</sub>O<sub>3</sub> (f) 20% Cr<sub>2</sub>O<sub>3</sub>

It can be seen from Fig. 5(a) and (b) that when the adding amounts of MgO are 10% and 15%, after the salt fog corrosion, there are a few corrosion points on the surface of film coating. When the amount is 20%, the film coating is perfect without corrosion points, as is shown in Fig 5(c). It is clear that with the amount of MgO increases, the resistance to acid of the film coating is strengthened. Fig 5(e) shows that after adding 10% Cr<sub>2</sub>O<sub>3</sub>, after the salt fog corrosion, there appear many big corrosion points. With the increase of the amounts, the corrosion points decrease. When to 20%, the film coating is perfect, with no corrosion.

The prepared film coating as color fillers are filmed on the silicon steel sheet. When it is corroded, MgO can be corroded as cathode, which can protect the substrate from being corroded. In addition, MgO, used as fillers, which is usually combined with SiO<sub>2</sub>, exists as 3Mg·4SiO<sub>2</sub>·H<sub>2</sub>O. Its oil-absorbed value is high, which can be used to improve the rheological properties, reduce the contraction stress in the film and avoid appearing cracks and voids. At the same time Cr<sub>2</sub>O<sub>3</sub> does not easily make reactions with acid and alkali. When it is added into the converter dust as color fillers, it can increase the resistance to corrosion of the film

coating. So, adding MgO and Cr<sub>2</sub>O<sub>3</sub> can both increase the anticorrosion of the film coating.

### 3 Conclusions

1) The viscosity of the coating increases with the increasing amounts of MgO and Cr<sub>2</sub>O<sub>3</sub>, and goes up more obviously by adding more MgO. When the amounts increased to 15%, the viscosity increased largely with adding MgO and is 4.18Pa.s bigger than adding Cr<sub>2</sub>O<sub>3</sub>. The paint solids are more than 99% when adding MgO and Cr<sub>2</sub>O<sub>3</sub> separately for 10%, 15% and 20%, but the value slightly changes by adding more Cr<sub>2</sub>O<sub>3</sub>.

2) Shrinkage cavities are generated on the surface of film coating by feeding MgO and Cr<sub>2</sub>O<sub>3</sub> in the converter dust, and tend to be bigger when more MgO and Cr<sub>2</sub>O<sub>3</sub> are added.

3) The performance of the high solid anticorrosion coating is improved by adding 10%~20% MgO and Cr<sub>2</sub>O<sub>3</sub> in the converter dust. After adding MgO, the resistance to salt water is enhanced greatly, and it's not sensitive to the amount of MgO. And with the increase of Cr<sub>2</sub>O<sub>3</sub>, the resistance of the coating against salt water and acid goes stronger. The coating of 120h acid corrosion test showed nearly no corrosion sign.

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