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A Study on the Fluoro-polymer Composite Coatings for Protecting the Corrosion of Fossil-fuel Power Plants

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Several heavy duty coatings at an every kind industry facilities to various systems currently have been applied review to the many industry fields. Corrosion-protective characteristics in the case of novolac epoxy among them and unsaturated polyester have been applied most widely. epoxy and flake heavy duty coatings are applied for such reason in an every kind facilities(stack, FGD, cooler, chemical tank etc) of a fossil-fuel power plants

Cases of the fossil-fuel power plants are exposed to more severe corrosion environment compared with other facilities and It is difficult to display the performance of long-term method at apply to be the partial. Our study shows fluoro-polymer composite coating method to overcome of the limit.

The comparison did previous method and heavy duty coating about FGD plants most at a corrosion environment among fossil-fuel power plants. Additionally, other facilities examined different heavy duty method.

The design mode of fluoro-polymer composite coating according to an every kind facilities show extensive methods that are characteristic revelation of film(top, middle and primer layer) composition of the paint, film thickness in accordance with a facilities corrosion and the corrosion protective effectiveness to come into being use fluoro-polymer composite with heavy duty paint(epoxy).

Keywords *: FGD, fluoro composite Coatings, sulfuric acid resistance, corrosion protective coatings*

1. Introduction

As the construction of industrial plants such as ocean platform, vessel, oil refinery and power plant has recently increased with industrial development. It is accompanied with the technical enhancement and the spread of the market of the heavy-duty paint for the maintenance of equipments.

But, as the required performances (heat, acid, wear and freeze resistance) of anti-corrosion have become highly extreme and complex along with industrial diversity and advance, it has exceeded the limit of the normal level of anti-corrosive paint (based on epoxy, unsaturated polyester, fluoro-polymer, silicone resin). For the intensive troubleshooting of corrosion of FGD (Flue Gas Desulphurization) facility in fossil fuel power plant which is one of the plants requiring highly extreme and complex performances of anticorrosion, we have proceeded the research for the application of heavy-duty paint (fluoro-composite resin) and the analysis of corrosion environment of it.

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2. Environment and corrosion problem of FGD facility

Many plants have installed all over the world along with industrial advances, and now the number of it is increasing. However, it has brought about environmental problems about acid rain and poisonous gases derived from fuels containing sulfur compound in the power plants. Nowadays, the introduction of FGD facility to the power plant is performed through short time to solve the environmental problem. But, in the case of FGD facility, many problems have appeared such as increase of cost for the facility maintenance, emission of exhaust gas, corrosion of equipments resulted from severe corrosive environment. Especially, in the case of the diesel power plant which deals high content of sulphur compound, it is exposed to more severe corrosive condition.

Fig. 1 shows examples of corrosion damages in an FGD plant of one of diesel power plants in Korea. The corrosion

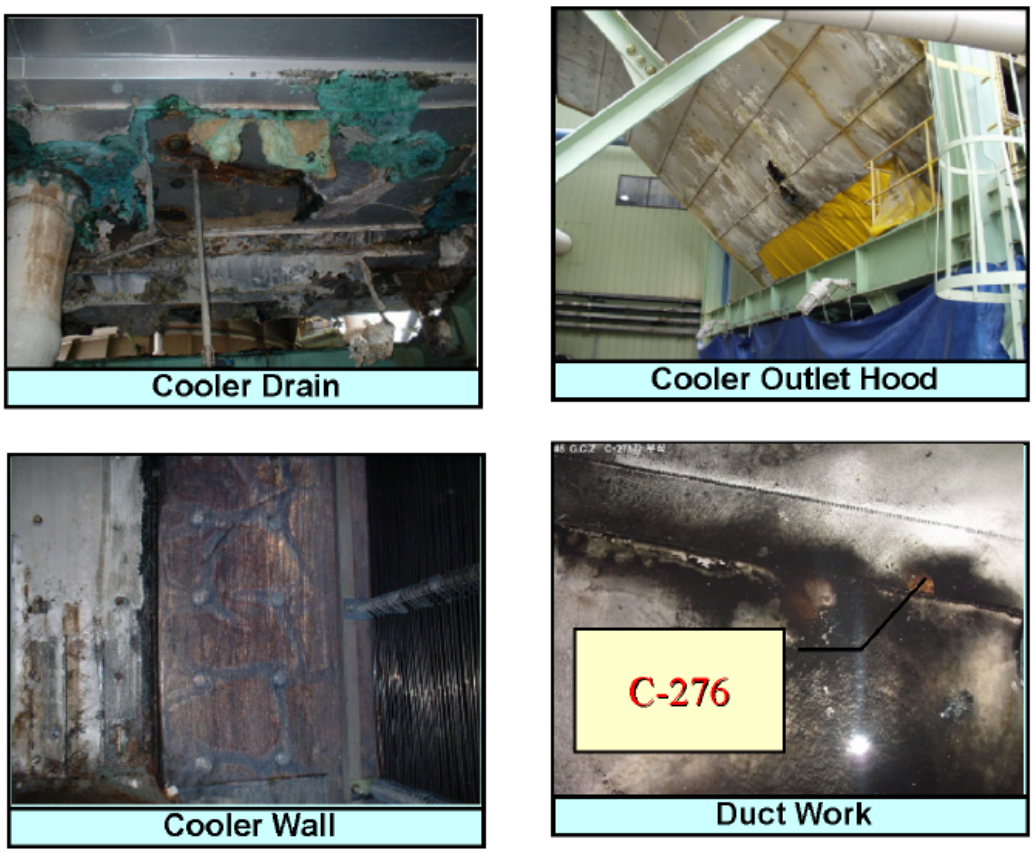


Fig. 1. Examples of corrosion damages in an FGD facility of a diesel power plant.

occurs vigorously in the cooling zone of sulfuric acid solution and also in the part claded with highly anti-corrosive alloy(C-276) as shown in Fig. 1. From it, you can be aware of the seriousness of corrosion of FGD plant.

Because of these problems, improvement works have been carried out as short-term countermeasure including repair of metal material and change of Teflon lining, and as long-term countermeasure as shown in Table 1 in many directions. However, no satisfactory result has obtained under complex environment of corrosion in FGD facilities as shown in Table 1.

Through the analysis of corrosion environment in FGD facility, a variety of corrosion discovered along the segment of the facility (wall, ceiling, slope, drainage) as combustion gas of sulphur compound passes through the condensing line as shown in Fig. 2. Main factors of corrosion happening are as below,

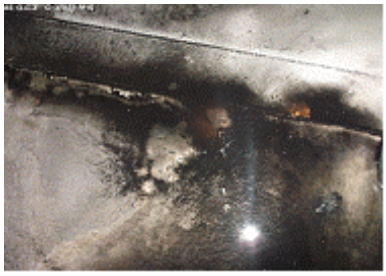
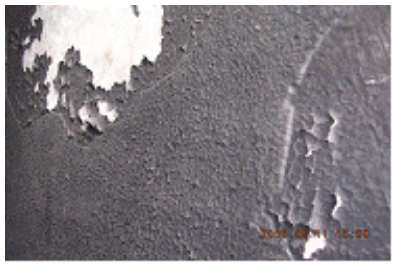
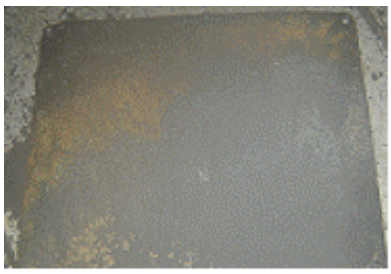
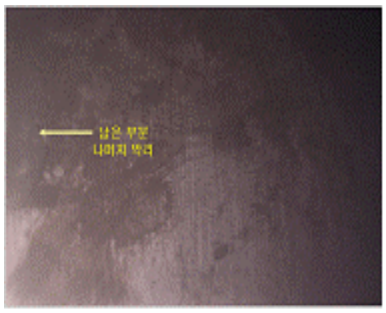
- Forming of Sulfuric acid solution of high temperature and high concentration.
- Occurring of a variety of corrosion (condensing of sulfuric gas, soaking and contacting of sulfuric solution).
- Inner vibration by facility operation.
- Happening of wear by combustion dust.
- Internal thermal expansion or contraction by periodic operation.

We confirmed the need of approach in many aspects on the development of anticorrosion paint for FGD facility from the result of the above.

3. Development of the paint of fluoro-polymer composite for the anticorrosion of FGD facility

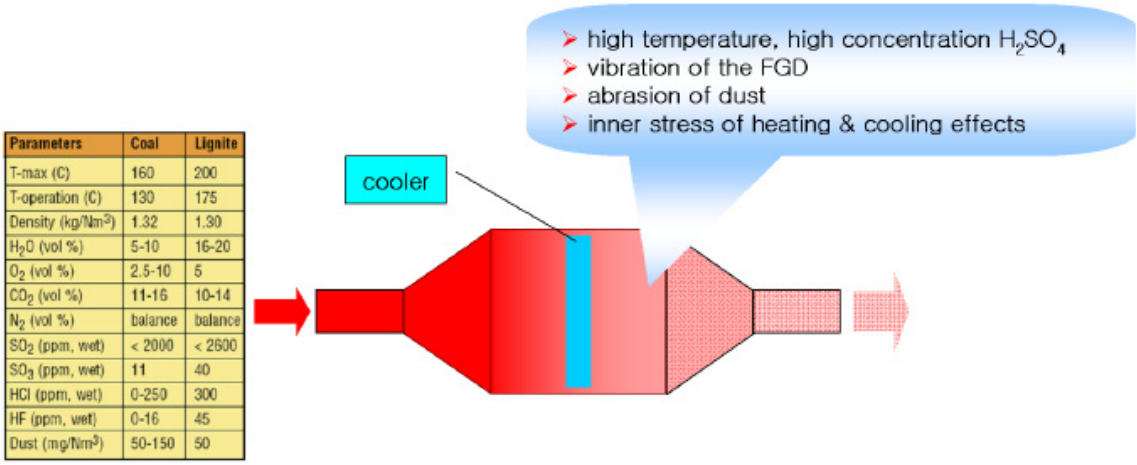
As mentioned above, we found that normal heavy-duty paint cannot display anticorrosion performance on the FGD facility of the fossil fuel power plant which is exposed to extreme and complex corrosion environment. We have developed fluoro-polymer composite paint to satisfy these properties in our research. Fluoro-polymer paints made of normal PTFE, FEP, PVDF, etc exhibit excellent heat resistance and acid resistance, but require heat resource of high temperature for forming coating so that it is difficult to apply on the FGD facility. Therefore,

Table 1. Corrosion history of FGD facilities of fossil fuel power plant.

	Corrosion damages	Result
High anti-corrosion alloy C-276	Corrosion damage	
Novolac epoxy coatings	Carbonation and crack	
Flake unsaturated polyester coatings	Carbonation and crack	
Nano titanium coatings	crack	
Inorganic ceramic coatings	Crack and peeling off	

we have developed the paint for a FGD facility exhibiting acid resistance and heat resistance like fluoro-polymer by making paint with thermosetting fluoro-polymer of high contents of fluorine.

Prior to the application of the paint of fluoro-polymer composite, the verification was first performed to compare with the existent paint. Fig. 3 indicates the test method of the resistance to sulfuric acid, which is the corrosion



Parameters	Coal	Lignite
T-max (C)	160	200
T-operation (C)	130	175
Density (kg/Nm^3)	1.32	1.30
H_2O (vol %)	5-10	16-20
O_2 (vol %)	2.5-10	5
CO_2 (vol %)	11-16	10-14
N_2 (vol %)	balance	balance
SO_2 (ppm, wet)	< 2000	< 2600
SO_3 (ppm, wet)	11	40
HCl (ppm, wet)	0-250	300
HF (ppm, wet)	0-16	45
Dust (mg/Nm^3)	50-150	50

Fig. 2. Factors in FGD facility

Fig. 3. Soaking test on acid resistance (sulfuric acid)

test by sulfuric fluid occurring in the region of drainage in the FGD facility, by soaking each coated specimen into 95% sulfuric solution as shown in Fig. 3.

Fig. 4 shows the result of the soaking test in sulfuric solution of high concentration. Seeing a coating of cross-cut specimen we recognized the effect of low corrosion spread of fluoro-polymer composite paint showing no erosion on coating even at the high temperature of 90 ℃, whereas in the case of the paint of novolac epoxy or flake-like unsaturated polyester coating was damaged at the temperature as low as 40 ℃.

Fig. 5 indicates the test on the another corrosion by the condensed sulfuric gas forming on the ceiling and wall of FGD facility. In this test, the carbonation of coating which occurred on the wall of FGD facility appeared again in the case of novolac epoxy paint, whereas in the case of fluoro-polymer composite paint it didn't happen but only wetted trace by sulfuric acid. From the above result, it is proved that the new paint is superior to the existent heavy-duty paint in heat resistance and acid resistance.

We tested reliability on fluoro-polymer composite paint verified by the previous test procedure painting partially and installing specimens in the FGD facility of the diesel power plant. Fig. 6-a) shows the location of specimens coated with fluoro-polymer composite paint. As you can see, each specimen has installed at three points to check the regional condition of corrosion. Fig. 6-b) indicates the final result tested totally, where all five specimens except two has proven to be reliable in anticorrosion of the FGD facility. In addition, the above two specimens have no carbonation of coating as well as crack appeared in the coating of the mentioned novolac epoxy paint but only two to eight of swelling by the permeation through pinholes. We could see almost no propagation of corrosion in the case of swelling formed by the permeation through pinholes, although 6 months has passed. From the above result, we know it is certainly possible to operate stably the anticorrosive facility with low cost of simple and partial maintenance during periodic pause after long operation because of the low growth rate of corrosion in spite of coating defects such as swelling.

4. Conclusion

As described above, we can draw conclusions as below, combining the results of reliability test in the field and the lab, as well as development of the paint of fluoro-polymer composite from the analysis of corrosion environment in FGD facility of the diesel power plant.

(1) Severe corrosion problem of the FGD facility of the diesel power plant compared to a normal industrial facility have occurred by the complicated interaction of

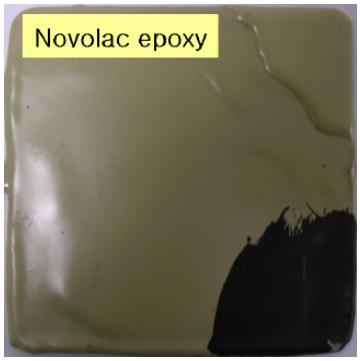
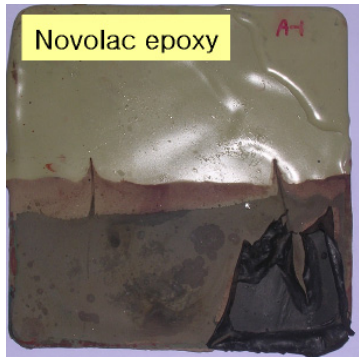
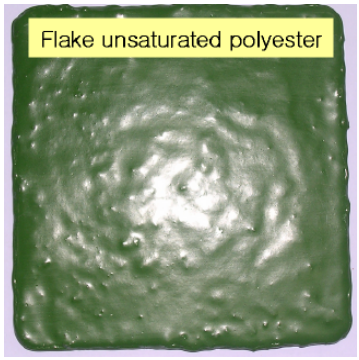
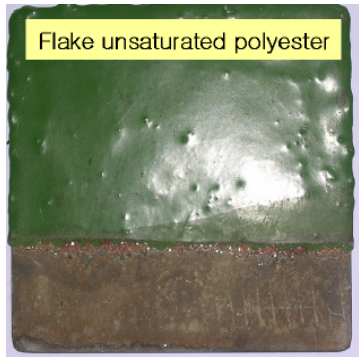
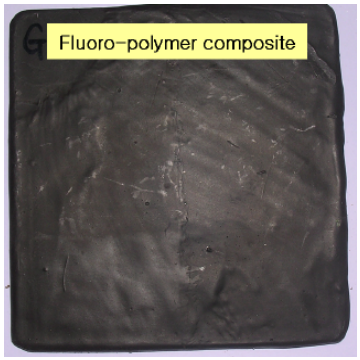
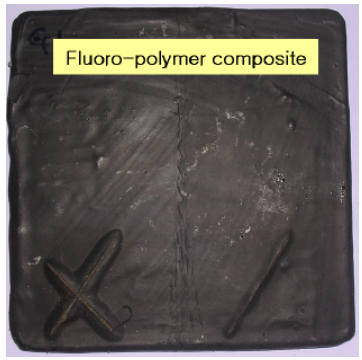
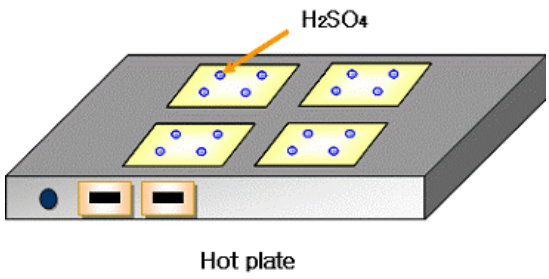
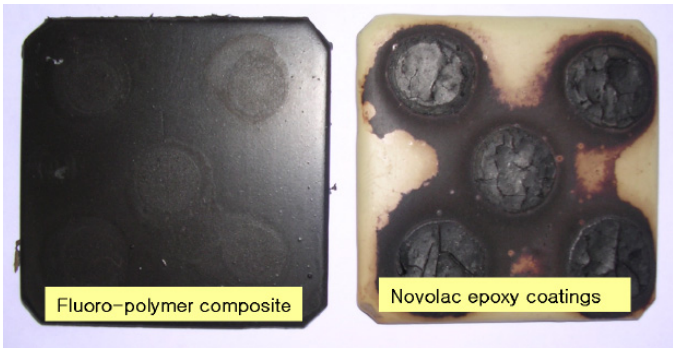
classification	before	after
Novolac epoxy coatings		
Flake unsaturated polyester coatings		
Fluoro-polymer composite coatings		

Fig. 4. Result of soaking test on acid resistance (sulfuric acid)

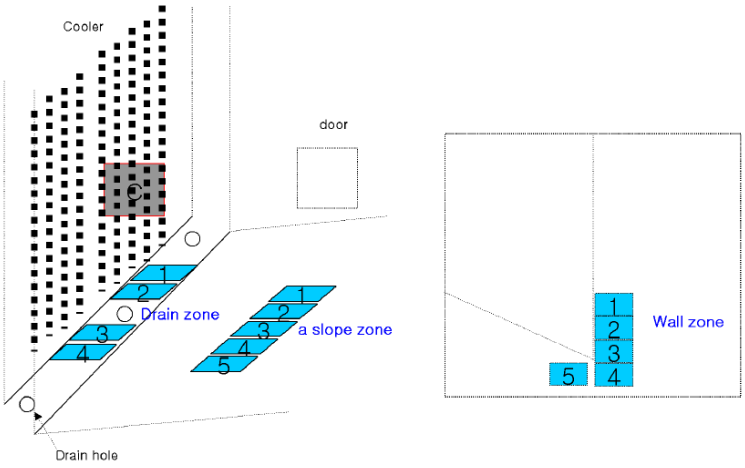


(a) test process

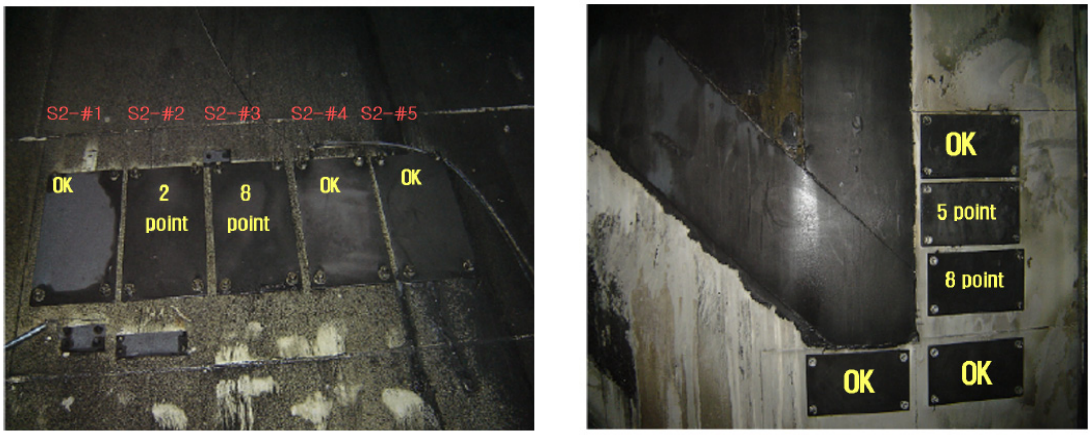


(b) test results

Fig. 5. Test of acid resistance



(a) Location of specimens in the FGD duct



(b) Result of field test (period: 2006.01~2007.03)

Fig. 6. Test of anti-corrosion in FGD duct

each
corrosion factor and cannot be solved by general coating system of heavy-duty paint.

(2) Prior to field test on the FGD facility, performing the comparative test of acid resistance between the paint of novolac epoxy or flake-like unsaturated polyester used widely in the facility of fossil fuel power plant and the paint of fluoro-polymer composite, the former showed carbonation and crack of coating but the latter did excellent acid resistance.

(3) From the lab test, we found excellent anti-corrosion and low spread rate of corrosion through about a year of test by installing specimens by position in the FGD facility of diesel power plant which condition of corrosion is extremely severe and applying fluoro-polymer composite paint of verified anticorrosion.

4) From the total test results, it is believed that fluoro-polymer composite coating is most suitable to prevent the corrosion of FGD facilities of diesel power plant.

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