Development of Coating Technology for Preventing Sulfide Corrosion on Boiler Tubes in Coal Fired Power Plant

Background

In coal fired power plant, operating that controls the amount of NOx generation is promoted. Due to the low NOx firing combustion, a reducing atmosphere becomes strong in the burner area. Therefore, the concentration of H_2S becomes higher and the boiler tubes are damaged due to sulfide corrosion. The damaged tube should be repaired by buildup welding or thermal spraying. If the damage by the sulfide corrosion is large, the boiler tubes need to be replaced. These repairs cost is from tens to hundreds of million yen. Therefore, an effective and economical technique of coating on the hot parts is demanded in order to increase efficiency and improve equipment reliability. Therefore we have developed an economical and straight forward technique of coating for preventing sulfide corrosion.

Objectives

In order to develop economical and straight forward technique of coating for preventing sulfide corrosion, the performance of TiO_2 film is evaluated and the coating method is developed.

Principal Results

1. Function of mitigating sulfide corrosion by TiO_2 film

TiO_2 was selected as a film material to evaluate by using three methods (thermal spraying, physical vapor deposition, spraying the liquid solution). The coating cost of thermal spraying and physical vapor deposition is much higher than that of spraying the liquid solution. On base metal specimens of STBA24 coated with TiO_2 by thermal spraying and physical vapor deposition, the iron sulfide layer and chromium oxide layer are not observed (Fig.1 (b), (c)). TiO_2 film proves to have the function of mitigating sulfide corrosion. However, specimens coated with TiO_2 by spraying the liquid solution are not effective in protecting the surface from sulfide corrosion (Fig.(d)). This is caused by micro cracks generating on the film during the coating process.

2. Development of film consisting of TiO_2 film and carbon film

In order to decrease the influence of micro cracks that decreased the function of environmental interception, we have contrived a new type of film consisting of TiO_2 film and carbon film (Fig.2). As a result of the sulfide corrosion test performed, the growth of iron sulfide layer and chromium oxide layer on the specimen coated with this film is much less than that on the original specimen (Fig.1 (e)). Moreover, these layers don't peel off. Thus, the developed film proved to have superior corrosion resistant to the conventional TiO_2 film.

3. Durability evaluation of developed film in the simulated environment of coal thermal power boiler.

Base metal tubes of STBA24 coated with and without developed film were tested in the simulated environment of coal fired power plant boiler (MARINE boiler). On the part without developed film, the corrosion layer is thick and some pieces peeled off. On the other hand, the corrosion layer on tube coated with developed film was not observed clearly (Fig.3, Fig.4). The developed film proved to have superior corrosion resistance.

Future Developments

In order to prove reliability of developed film, the long term corrosion test and the various gas composition tests will be performed in the simulated coal fired power plant boiler (MARINE boiler) and bench scale test stands. After that we will try to apply the result to real coal fired power plant boiler.

Main Researcher: Makoto Kawase, Ph. D.,
Research Scientist, Energy Conversion Engineering Sector, Energy Engineering Research Laboratory

Reference

M. Kawase, et.al., 2006, “Development of coating technology for preventing sulfide corrosion on boiler tubes in coal fired power plant”, CRIEPI Report W05018 (in Japanese)

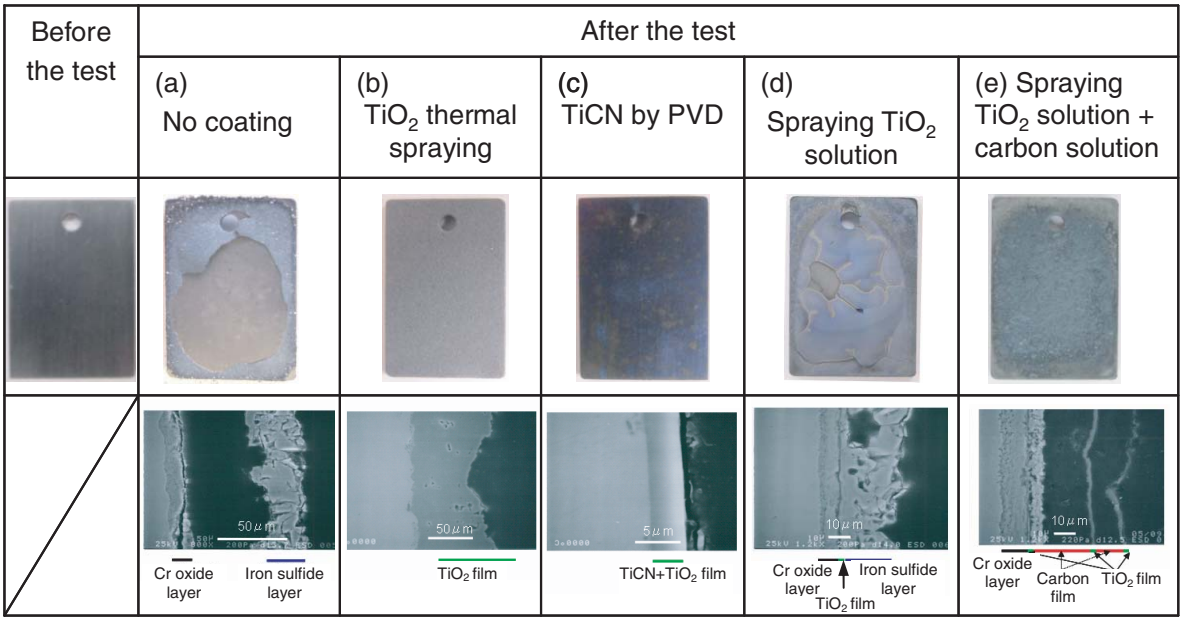

Fig.1 Comparison of sulfide corrosion before and after the tests (Base metal:STBA24)

Testing time:200hr, Temperature:500ºC, Gas composition:$N_2/H_2/CO/CO_2/H_2O$=73.1/2.7/6.8/8.8/8.6, H_2S:290ppm

A new type of film consisting of TiO_2 film and carbon film is coated by the spray method using the liquid solution. The developed film proved to have superior corrosion resistance to the conventional TiO_2 film.

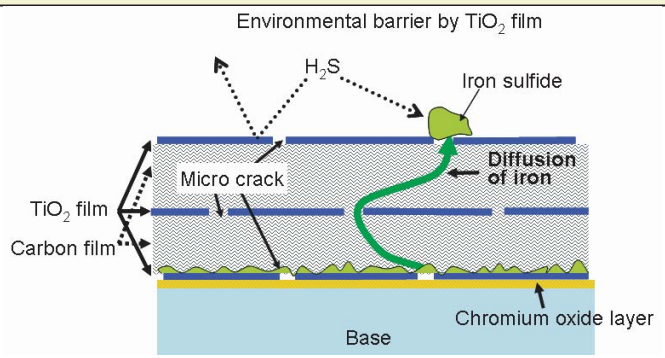

Fig.2 Schematic diagram of developed film consisting of TiO_2 film and carbon film

The influence of the micro crack that decreased the function of environmental barrier was controlled by alternately accumulating TiO_2 film and carbon film. Therefore, the growth of the sulfide corrosion layer is prevented.

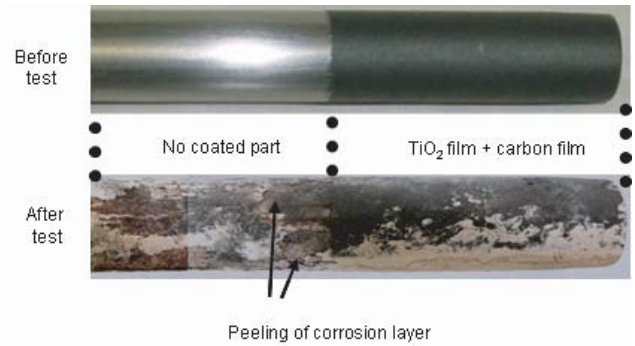

Fig.3 Photo of sample tube before and after exposure test in MARINE boiler

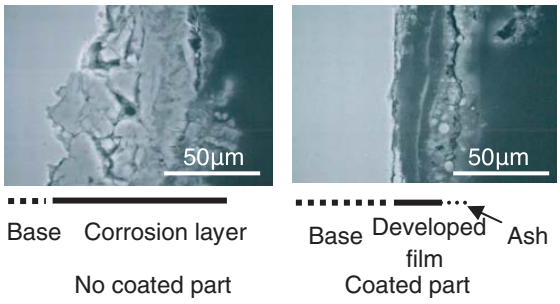

Fig.4 Cross-sectional SEM images after exposure test

As a result of tests in the simulated environment of coal fired power plant boiler (MARINE boiler), the developed film proved to have superior corrosion resistance.