PIPES COATINGS FOR BOILER THAT GENERATE STEAM FROM MINERAL COAL BURNING

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1 Introduction

About 28% of the installed capacity of electric power generation in the Brazilian electric sector comes from thermoelectric generation [1]. Brazilian thermoelectric plants that use coal as a thermal source use boiler pulverized combustion technology [3]. The low calorific value of Brazilian coals requires a high volume of coal to obtain the appropriate temperature conditions in the boiler. The heat released at the burning of the coal is transferred to the water circulating in the tubes that surround the boiler furnace, transforming it into superheated steam. Tubes forming what is called a "water wall" in which water circulates to be transformed into the steam that will drive the turbine are subject to high temperature, aggressive environment and erosion caused by the gas and particulate fluxes resulting from the burning of coal. From the material point of view, considering the high percentage of ashes present in Brazilian coal, the metallic parts of the interior of the boiler and, in particular, the pipes of the water wall, suffer heavy wear due to the composition of the ashes. This process of attacking the metal surfaces, potentially, is able to reduce the thickness of the pipes and, consequently, increase the frequency of occurrence of perforations causing the unavailability of the unit. The unavailability of the boiler causes substantial losses to the generators for lost profits. If the make changes on the design of the boiler (burning coal, gas flow, positioning of burners, etc.) is not possible, one way of minimizing occurrences caused by pipe wear is the detailed investigation of the wear on the walls of the pipes caused by the impact of particles present in the ash of burnt coal and the research of metallic or composite coatings in the critical regions of the boiler. In this context, the objective of this work is to develop and characterize a coating made of material composed of the inorganic refractory ceramic adhesive system and a carbon fiber for steel pipes subjected to the impact of coal particles resulting from the incomplete combustion of the same, in boilers used in thermoelectric plants that use Brazilian mineral coal.

2 Materials and Methods

The initial tests used a coating composed of a carbon steel sheet with a chemical composition similar to carbon steel used to make water boiler pipes in Brazilian boilers ($\approx 0,2\%C$), resistant ceramic adhesive High temperature Three Bond and carbon fiber with bidirectional frame designation RC 200T / 1270. The resin and carbon fiber assembly was placed on the carbon steel plate previously prepared (sanded with 600 metallographic sandpaper and cleaned with acetone) according to two different preparation schemes. Fig. 1 shows the arrangement of the materials for forming the two coating schemes. After assembly, the samples coated with both schemes were heated for 45 minutes at $150\,^{\circ}C$ in an EDG 1800 3PS oven.

Adhesion tests were performed on the assembly according to ASTM 4541 [2] which establishes minimum technical requirements for the Pull-Off test.

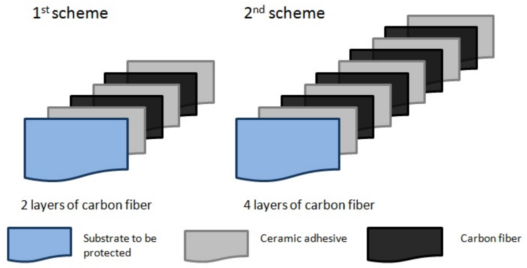

Figure 1: Schematic assembly of the two proposed coating schemes for the water wall piping of thermoelectric boilers.

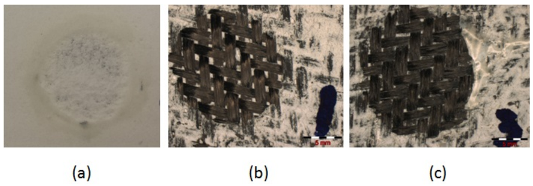

Figure 2: (a)Aspects obtained from the adhesion test for the substrate with only the first layer of ceramic adhesive. The nature of the Cohesive B failure was observed.(b) Result of the first protection coating assembly scheme. Nature of the type C failure.(c)Result of the second protection coating assembly scheme. Nature of failure: type C.

Were used the Positest AT-A: Automatic Adhesion tester from Defelsko. Tests were initially done only on the substrate covered with ceramic adhesive and, later, in the assemblies, as Fig. 1.

3 Results and Discussion

The adhesion test performed on the substrate coated with only one layer of ceramic adhesive showed average binding strength of 25 MPa. The nature of the force was cohesive B. It means that the ceramic adhesive actually adhered to the surface of the substrate in a manner considered stable by ASTM 4541 [2]. Fig. 2 presents the aspects obtained for the surface of the steel coated with the ceramic adhesive resin and after the adhesion tests. The purpose of these tests was to verify the behavior of the steel - resin system in an individual way, without the influence of the carbon fiber.

The succession of the individual steel-resin system was followed by adhesion tests on the coatings shown in Fig. 2 (b) and (c). The two-layer carbon fiber scheme had a mean adhesion strength of 1.27 MPa (1 MPa - spool 1 and 1,54 MPa - spool 2) and nature of failure type C - cohesive of the last layer - Fig. 2 (b). The four - layered carbon fiber scheme as shown in Fig. 2 (c) had a mean adhesion strength of 1.93 MPa (1.66 MPa - spool 1 and 2.20 MPa - spool 2) and a C - type cohesive nature of the last layer. The results were similar for both schemes.

4 Conclusion

The preliminary adhesion tests were similar in nature to all proposed schemes: cohesive failure type C. According to ASTM 4541 [2], this nature of failure is desirable, since cohesive failure indicates that in the event of any damage being caused to the coating , It will not detach itself from the substrate (force of an adhesive nature) and it will be protected.

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