STUDY OF EROSION BY IMPACT OF SOLID PARTICLES ON METALLIC COATING OBTAINED BY THERMAL ASPERSION

Author: Márcio Cossenza[1] *marciocossenza@uol.com.br*
Advisor: Marília Garcia Diniz[1]
[1]State University of Rio de Janeiro

PPG-EM Seminars: season **2017**
www.ppg-em.uerj.br
November 29, 2017

Keywords: Erosion, Metallic Coating, Thermal Spraying.

1 Introduction

In thermoelectrical plants, the generation of electric energy is based on the steam production from thermal energy. Some plants use mineral coal as fuel to keep the pressure that moves the generators.
In these kinds of plants, some problems are common in the boilers, due to the ashes of the coal. The erosion process takes place on the pipe walls, caused by the particles of ashes, composed basically by hard oxides.
The failures in acquatubular boilers happen on the pipe outer walls inside the combustion chambers of the boilers. The mechanism of degradation is a combination of corrosion and erosion, due to the impact of the ashes. The fan that feed the air into the combustion chamber is responsible for the velocity of the impact.
Some coatings have been developed along the decades to improve the resistance of the pipes against the degradation by the abrasive wear.
This paper has the objective to present the evaluation of a new metallic coating,in relation to abrasive wear. The metallic alloy is composed by Nb, B, Ni, Si, Mn, Al and Fe, with 13% of Chromium, obtained by arc spray method of thermal spraying process.
This method of application presents a porosity from 2% to 10% [1].
The erosion mechanism in laboratory conditions shall be as similar as possible to the real conditions, that occur in fact on the walls of pipes in acquatubular boilers.
This metallic coating was applied on the samples with the same composition, same application process and same parameters of the application that will be used on the pipes in the pressure vessels on the field.

2 Materials and Methods

The proposed process for evaluating the resistance of the coating uses alumina particles (Al_2O_3) as abrasive, flowing together with compressed air.
Inside the blasting chamber, a device was installed that allows the nozzle to be positioned with the correct distance of 10 milimeters to the sample, according to the standard ASTM G76.
This standard will be the direction of this test [2].
The support also can adjust the jet nozzle with different angles of attack (90°, 60°, 45°, 30°). These angles mean the ones between the axis of the nozzle and the surface of the plates used as samples, simulating the different directions of the ashes in real situation, between the region of the chamber from where the ashes come, with the tangent of the pipes.
A compact blasting chamber shown in the Figure 1 was coupled to the air compressor, similar to the common systems used in industrial processes of blasting [3].

Figure 1. Blasting chamber with the support inside

2.1 Target Material

The samples are presented as ASTM-A-178 steel plate with 8 mm thickness, and a 0.4 mm average thickness metallic alloy coating applied by thermal spraying process.
Few pieces of information are known about the mechanical strength of the coating material. Its microhardness was measured with the average value of 1042 HV.
Its density and level of porosity are unknown.

2.2 Shocking Particles

The alumina used is certified as 50 μm particles size.

2.3 Calibration of the Machine

The reference for the velocity used in the machine was made with the values established in ASTM G76 standard, defined as 0.0205 milligrams lost1020 carbon steel for each gram of abrasive alumina blasted, considering as 30 m/s the velocity of the particles. The machine was calibrated to achieve the same velocity of the particles as in the standard, for the 1020 steel samples, with the compressor output pressure equal 1.3 bar.

3 Results

After finishing the calibration of the machine, the blasting on the sampleswas started with the metallic coating.
On figure 2, it is possible to observe the impressions made by the alumina for the attack angles of 90, 60, 45, 30 degrees, on the samples covered by the alloy. Four samples were already blasted: the first on the top/left with three impressions with 90° attack angle; on the top/right with two 60° impressions; on the below/left with two 45° impressions; on the below/right with just one 30° impression.

Figure 2. Four samples already blasted

Figure 3 shows the comparison of the erosion rate with 90° angle of attack between the metal alloy and the A-178 steel substrate.

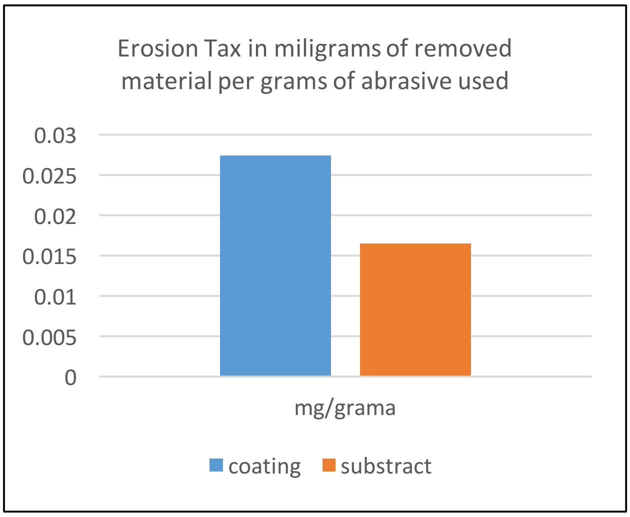

Figure 3: Erosion rate (mg/gram) of coating and substrate with 90 ° angle of attack.

Figure 4 shows the evolution of the erosion rate of the coating as function of the attack angle, from 30 to 90 degrees.

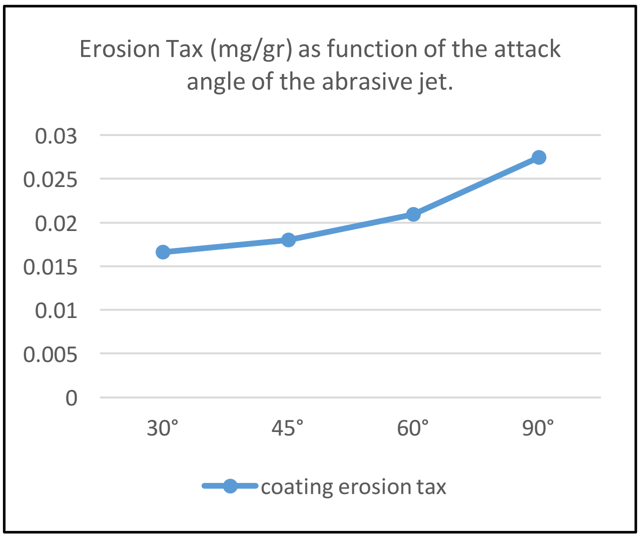

Figure 4. The difference of Erosive Tax when applied in different attack angles.

4 Conclusions

Based on the experiments carried on the samples, it was possible to observe, with the information presented on the figure 3, that the substract is more resistant than the coating, when both were blasted on laboratory conditions.
We must observe, on the thermal spraying process, that it leaves porosities in the coating material. It is possible that the lack of material could contribute for the erosion of final product.
The superficial roughness also is different from the ASTM-A178 plate received, laminated, and the coated surface, with a visible and considerable higher roughness.
Both the porosity and the roughness contributed for the less resistance of the coating, although the metallic alloy could present higher hardness than the ASTM-A178 carbon steel.
Also, it is possible to be observed, from the information of the figure 4, that the bigger angle, perpendicular to the surface, causes higher erosion rates than sharper angles.
Anyway, other tests shall be carried out, as corrosion test and thermal simulation, to evaluate if the coating configuration could be better in higher temperatures conditions.

References

[1] MORAIS, T.C. Estudo dos Processos de Aspersão Térmica em Materiais Metálicos de Forma a Auxiliar a Aplicação de Camadas para Diminuição de Desgastes e Corrosões na Superfície do Metal, Itajubá, 2016.

[2] ASTM G-76, Standard Test Method for Conducting Erosion Tests by Solid Particle Impingement Using Gas Jets, United States, 2005.

[3] ARAÚJO, A.C. Erosion by Impact of Solid Particles in Duplex Stainless Steel UNS S32205, Rio de Janeiro, 2015.