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Investigation of Galvanic Corrosion in Screw Down of Hot Aluminum Rolling Mill

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A complicated problem has been occured in screw down of hot aluminum rolling, in an aluminum rolling mill company. The subject was started as Maintenance Engineering Department stated that there are some inclusions in greases of screw down. After some theoretical, laboratory and practical research works with considering process, technology and environmental aspects, the problem was turned out to be galvanic corrosion. An innovational method was applied to reduce the cathodic area by painting and insulating accessories rolling machine (rolling tables), the corrosion of main machine in screw down stopped and the rolling mill was protected. In this paper the phenomena is fully characterized by scientific aspects of galvanic corrosion and applied in rolling mill technology.

Key Words: Galvanic corrosion, Galvanic protection, Rolling machine.

INTRODUCTION

Corrosion investigation scientifically is not too complicated, but corrosion prevention is more important, technologically. It is known that colour and painting is more engineering than decorative. Painting is used for preventing parts, structures and installation form corrosion. But when painted is used on some structures to prevent other parts from corrosion, it would be more interesting. This is such a case study.

This paper is an experience of galvanic corrosion investigation and its prevention, more likely to a puzzle. The solution which fined out was painting other parts and accessories of rolling machine rather than screw down, on the contrary. In this research, screw down and a 30000 metric tons capacity aluminum hot rolling mill stands was maintained.

Outline of problem: There were some inclusion particles in the grease of screw down of aluminum hot rolling mill stands in an aluminum rolling mill company (Fig. 1). It was recommended to switch to higher quality grease from another supplier. The new grease was used for a week and yet

the supervisor observed the same particles in the grease. However, the Quality Control Department already confirmed that no particles in the grease were present. It was concluded that possible cause of the problem needs further investigation.

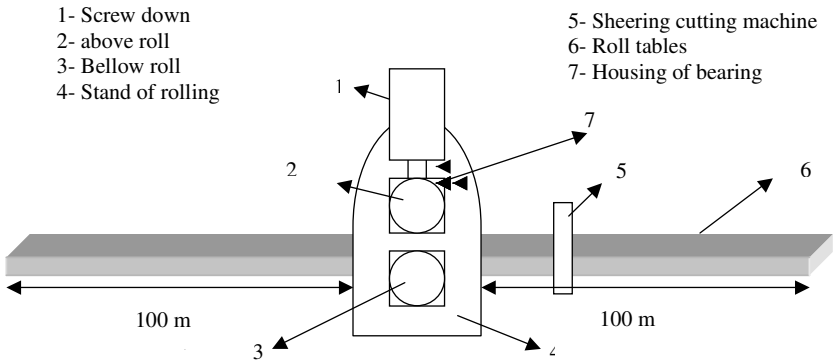

Fig. 1. Schematic diagram of hot rolling machine

Theory

Galvanic corrosion: Usually a potential difference exists between two dissimilar metals when they are immersed in a corrosive at conductive solution. If these metals are placed in contact, this potential difference produces electron flux between them. Less resistant metal becomes anodic and the more resistant metal cathodic. Corrosion of the less corrosion-resistant metal is usually increased and *vice versa*[1].

Effects of environment on galvanic corrosion: The nature and aggressive of the environment determine to a large extent the degree of galvanic corrosion. Sometimes the potential reverses for a given couple in different environment. For example, if zinc and steel are coupled, the zinc corrodes and the steel is protected in aqueous environment. In the exceptional case, such as some domestic waters at temperature over 82 °C (180 °F) the couple reverses and the steel become anodic.

Galvanic corrosion also occurs in the atmosphere. For example, corrosion is greater near the seashore than in a dry rural atmosphere[2].

This means if a metal is in tow different environmental condition it could be attack as galvanic corrosion. In this case, sometime, part of the metal that is in corrosive media becomes anode and the other side of metal becomes cathode.

Area effect: Another important factor in galvanic corrosion is the area effect or ratio of the cathodic to anodic area. An unfavourable area ratio

consists of a large cathode and a small anode[3]. The greater the current density at an anodic area the greater the corrosion rate[4]. The EMF series refers to reversible thermodynamic conditions and cannot be used to predict corrosion rate[3].

If a piece of zinc 1 cm^2 in area is exposed to the acid solution it will corrode with a rate equal to i_A. If this zinc specimen is coupled to a platinum electrode of 1 cm^2 area, the zinc corrosion rate is equal to i_B. However, if we considered a platinum electrode with an area of 10 cm^2 and plot its behaviour to terms of current, it has an exchange current i_0, which is 10 times greater than a 1 cm^2 electrode. Thus, increasing the area of an electrode increases its exchange current which is directly proportional to specimen area. This is illustrated in Fig. 2. As shown; the corrosion rate of the couple is increased as the area of platinum is increased[5].

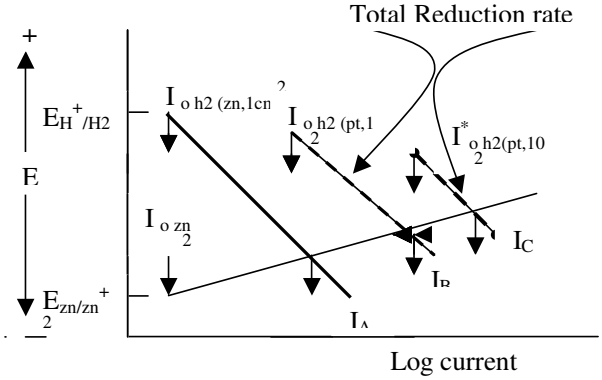

Fig. 2. Effect of cathode-anode area ratio on galvanic corrosion of zinc-platinum couples

As the size of the cathode in a galvanic couple is increased, the corrosion rate of the anode is increased, if the relative area of the anode electrode in a galvanic couple is increased, its overall corrosion rate is reduced.

Procedure: (1) The used greases were examined for particles. It should be mentioned that there were no particles in unused greases. Then, it was concluded that the particle were generated in screw down. (2) The screw down and its screws were inspected. It was seen corrosion pits on screw. (3) The environmental condition of screw down was inspected. It pointed that the screw down works in a corrosive media as below: high humidity; a little warm condition at about 50-80 °C; with respect to atmospheric temperature of 25 °C; existence of mineral oil vapour (aluminum hot rolling lubricant with pH of 9-10); working on a pressing condition of about 100 tons rolling

forces in each screw down; (4) Painting all the rolling tables (accessories of rolling mill) as a solution to prevent corrosion of screw down.

By considering the environmental conditions of screw down, working in corrosive media in respect to the tables of rolling witch worked in a normal condition and inspection of particles it was suspected that galvanic corrosion is taking place in a galvanic condition. In this case all the tables and structural frames of rolling became cathodes in spied of that screw down became anode.

Conclusion

(1) It was suspected in that case, all the tables and structural frames of rolling which were in a normal conditional environment play as a cathode but, screw down worked in a anodic condition and they made together a galvanic pill. (2) In this case, because of a very big cathodic surface (tables surface) and a very small anodic surface (only the surface of screw down), the rate of corrosion was as high as possible. (3) In this case study to prevent galvanic corrosion the best possible way was to reduce the cathodic area. (4) Painting of rolling table was established to reduce the cathodic area. (5) In spied of technicians and engineers surprising the corrosion of screw down of rolling was stopped by painting rolling tables (accessories) of rolling mill. (6) Prevention of corrosion to the zero (completely) is too complicated technologically. In other hand, difference in EMF between anodes and cathodes in a galvanic couple indicates only the direction of current flow (witch part will be in more corrosion attack), not the rate of corrosion.

However, the rate of corrosion is dependent to current flow, which is proportional directly to the cathodic area. Then to combating corrosion the most favourable way is to reduce the rate of corrosion technologically. In which elimination or reduction of cathodic area sometimes by simply painting is a most advantageous way practically.

Recommendation: It can be noted of this case study, that in galvanic kind of corrosion it is recommended, in spied of cored metal (anodic area), the safe part of contacted metal (cathodic area) should be painted.

REFERENCES

1. M.G. Fontana and N.D. Greene, Corrosion Engineering, McGraw-Hill Series in Material Science and Engineering Series, edn. 3 (1995).
2. D. Kuron, R. Kilian and H. Grafen, *Materialwissenschaft und Werkstofftechnik*, **11**, 382 (1980).
3. A.A. Torres-Acosta, *J. Compo. for Constr.*, **6**, 116 (2002).
4. H.A. Sarhan, M.,W. O'Neill and P.D. Simon, Corrosion of Reinforcing Steel in Drilled Shafts with Construction Flaws, Transportation Research Board, 81st Annual Meeting Washington, D.C., January (2002).
5. Corrosion, ASM Materials Handbook, Vol. 13, edn. 10 (1987).

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