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Experimental Investigation of Heat Transfer Enhancement on polished and unpolished (Corroded) pipe

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Abstract- Heat exchanger is one of the major equipment in process industries, chemical industries. Corrosion affects the heat transfer rate from pipe in Heat Exchanger application. So it is needed o evaluate the effect of corrosion on heat transfer coefficient to study the change in heat transfer rate. The present paper covers experimental investigation of heat transfer enhancement on polished pipe and corroded (unpolished) pipe. Few effective coating solutions are discussed to avoid corrosion and improve heat transfer performance of tube/pipe.
Key Words-Heat Transfer; Corrosion: Polished Pipe

I. INTRODUCTION

The failure of industrial boilers has been a prominent feature in fossil fuel fired power plants. Many Corrosion problems occur in the hottest areas of the boiler-the water wall, screen, and superheater tubes. Other common problem areas include deaerators, feed water heaters, and economizers. Methods of corrosion control vary depending upon the type of corrosion encountered. The most common causes of corrosion are dissolved gases (primarily oxygen and carbon dioxide), under-deposit attack, low pH, and attack of areas weakened by mechanical stress, leading to stress and fatigue cracking. These conditions may be controlled through the following procedures:

- maintenance of proper pH and alkalinity levels
- control of oxygen and boiler feed water contamination
- reduction of mechanical stresses
- operation within design specifications, especially for temperature and pressure
- proper precautions during start-up and shutdown
- effective monitoring and control
- Long term over heating tube failures are due to operating metal temperature of the boiler tubes going above the allowable limit.

These types of failure are seen in steam cooled tubes like superheaters and reheaters and in water cooled tubes of water walls. Boilers used for industrial steam generation and power generation have kilometers of tubes that carry water and steam in circulation system and superheaters, respectively. These tubes are of various sizes and thicknesses depending upon the pressure and the mid-wall metal temperature. The tubes selected are boiler quality tubes manufactured under various standards like ASME, BS, DIN, JIS, etc. While selecting the tube there is a requirement to select the correct material for withstanding the metal temperature. This will depend upon the

location where the heat transfer surface is located. Normally the water cooled areas like economizer and water walls are made of carbon steel of boiler quality. Superheaters and reheaters will have combination of low alloy tubes to stainless steel tubes selected to withstand the metal temperature.

II. LITERATURE REVIEW

Boiler tube failures are a major problem in the power production industry. As a means for improving gas set availability, many power generation executives are making significant capital investments in new tube bundles. While full tube wall thickness may reduce the frequency of leaks, varying operating conditions can accelerate deterioration of the new tubes. New tubes made of commonly accepted materials, including carbon and stainless steels, are not necessarily designed to withstand the current operating variables of today's power generation industry. Reduced reliability due to corrosion attack is one of the main problems in boiler systems costing billions of dollars per year.

III. EFFECTIVE COATING SOLUTIONS

Different coatings can be applied to improve corrosion performance of different materials. Galvanizing is one of them. Galvanized steel is used for, house hold appliances like washing machines, air conditioning housings, hairdryers, etc. It is used in high tension electrical towers, protective gears, highway signs, used to make wrought iron gates, its frames are used to build houses, Car parts, body of trucks and buses.

Life of hot-dip zinc coating that is Galvanized steel is less in aggressive environments like high humidity, presence of different chemical in industrial applications & high temperature application. Galvanized steel have low corrosion resistance, poor weldability & paintability. White rust formation occurs in rainy season.

The Zn-Ni alloy coatings are superior to pure zinc coating in the sense that the former has high corrosion resistance and good weldability. Tio_2 can be used to improve different metallic and organic coatings. It can reinforce metallic coatings including zinc electroplate to improve wear resistance, hardness and other characteristics such as corrosion resistance.

Addition of Rare Earth Metals improves the physico-chemical properties and corrosion behavior of hot-dip zinc coated steel. [1] Increase in nickel concentration of the coating can improve physical properties, corrosion resistance also formation of nickel-rich barrier inner layer improves the galvanic performance of coating. [2] The enrichment of Tio_2 in the coating surface can yield high corrosion resistance. [3]

Incorporation of elements like REM, Ni, Cd, Ti, Al and their alloys in the galvanic Coatings can have significant influence in improving the structure and performance of the coating. The main use of the REM in zinc is in the form of Galfan, a Zn-5Al-0.05REM alloy used in galvanizing bath. [4] Galfan was found to be superior in corrosion resistance and formability and equal in weldability and paintability when compared to the normal galvanizing steel.

IV. SYSTEM LAYOUT

The block diagram for the whole system is illustrated below.

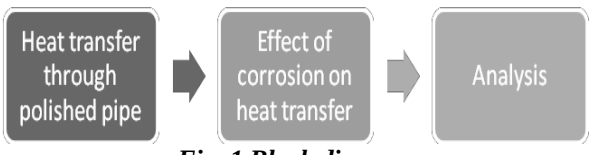

Fig. 1 Block diagram

4.1 Overview

In order to study the change in heat transfer coefficient two pipes were taken 1) Polished pipe, 2) corroded pipe of length 500mm and inner diameter 32mm. The experimental set up was established to carry out the observation. Based on the different output from the two establishments, an observation table has been recorded. Experiments were done to study the heat transfer rate for both pipes. Based on this analysis we can conclude that the heat transfer rate in both cases varying significantly.

Fig. 2 Experimental Set-up

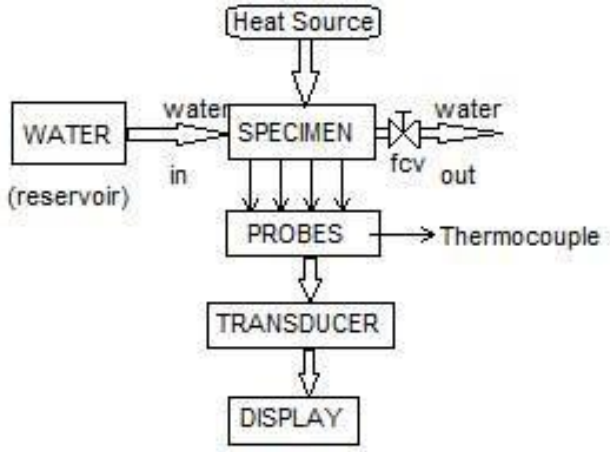

Fig. 3 Layout of Experimental Set-up

4.1.1 Stage1 (Polished Pipe)

A polished pipe was taken and heat transfer coefficient was recorded in this case.

4.1.2 Stage2 (unpolished Pipe)

In order to understand the obliquity of heat transfer due to corrosion, a corroded pipe was taken.

V. RESULTS

The percentage enhancement in the heat transfer coefficient is illustrated inTable1.The maximum heat transfer enhancement we got after polishing is 25%.

Table No. 1 Heat Transfer Enhancement

Sr. No	Re	hp	hup	%enhancement
1	99.5	38.88	29.2	24.89711934
2	995.9	176.27	149.48	15.19827537
3	1496.5	195.37	146.39	25.07037928

Figure 4 below shows the variation of heat transfer coefficient with the variation in Reynolds number. The Polished specimen shows higher heat transfer coefficient than the unpolished specimen.

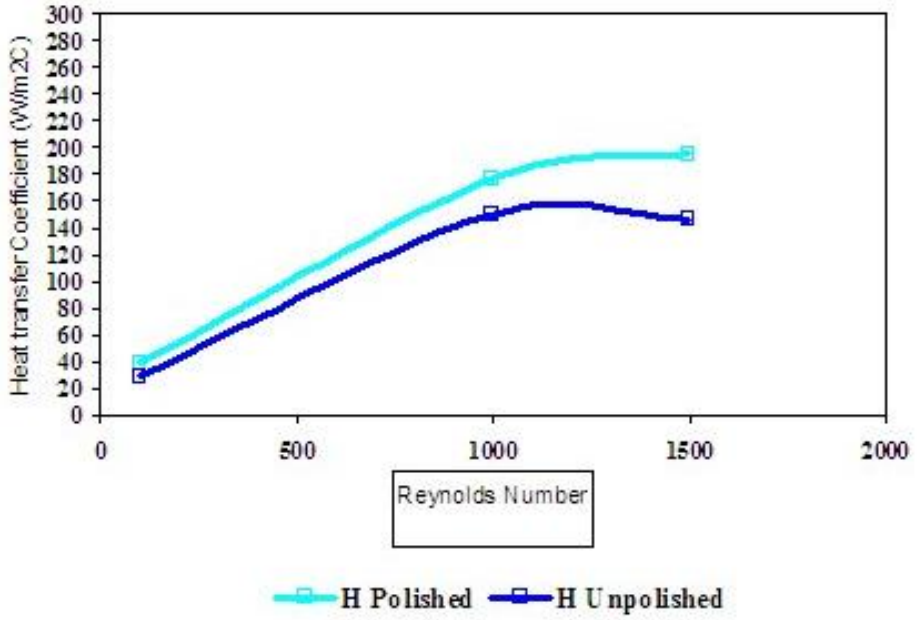

Fig. 4 Comparison of Heat Transfer Enhancement for Polished and Unpolished Pipe.

CONCLUSIONS

Corrosion affects the performance of heat transfer from pipe in heat Exchanger application. Experimental investigation was done to evaluate the effect of heat transfer enhancement on polished pipe and corroded (unpolished) pipe. The maximum heat transfer enhancement we got after polishing is 25%. The Polished specimen shows higher heat transfer coefficient than the unpolished specimen. Incorporation of elements like REM, Ni, Cd, Ti, Al and their alloys in the galvanic coatings also use of Galfan can have significant influence in improving the structure and performance of the coating. It is found to be superior in corrosion resistance and formability and equal in weldability and paintability when compared to the normal galvanizing

REFERENCES

[1] Amadeh, B. Pahlevani, S. Heshmati-Manesh, Effects of rare earth metal addition on surface morphology and Corrosion resistance of hot-dipped zinc coatings, Corrosion Science 2002.

[2] S.M.A. Shibli, R. Manu, Improvement of hot-dip zinc coating by enriching the inner layers with iron oxide, Applied Surface Science, 2005.

[3] S.M.A. Shibli et. al, Incorporation of Tio_2 in hot dip zinc coating for resistance to biogrowth, Surface & Coatings Technology, 2005.

[4] Pritee Purohit, S.T. Vagge, Comparative study of addition of REM, Ni, and Tio_2 on hot dip zinc coatings : A Review, IEPLC Technical journal No 37, 2013.

