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15th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2011, Prague, Czech Republic, 12-18 September 2011

RESEARCH INTO THE EFFECT OF CORROSION ON DAMAGED THERMAL POWER PLANT EQUIPMENT

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ABSTRACT
The research was conducted at several power plants where defects of boiler exchangers were detected. The analysis of damages on fire tubes and exchangers were performed considering selected materials and influence of different types of corrosion. Critical areas on both the side of flue gasses and the side of water/steam working fluid were considered.
A series of tests on damaged tubes made of various materials and exposed to corrosion processes were also carried out. Based on those tests and analysis of results some insights into the matter were gained and proposed for repair of damaged power plants.
Keywords: process equipment, corrosion induced failures, materials

1. INTRODUCTION
Boiler plant tubes are often exposed to damages caused by different types of corrosion. The analysis of damaged equipment showed that several factors were involved:
- equipment service life is exceeded
- designed operating specifications were not observed
- selected materials do not satisfy exploitation conditions.

Selection of the material – steel is of particular importance for high pressure
welded vessels that operate at increased temperatures. Welding causes stress corrosion due to the resulting stresses.
Inconvenient design solution of the boiler unit of the plant in terms of the welding procedure applied to the material, increases the possibility of damage caused by corrosion.
Besides the selected steel quality and the operating conditions (pressure, temperature) the corrosion processes in boiler plants are also affected by the quality of fuel (coal, oil and gas) and the quality of water.
Layers of deposit are frequently formed on the outer side of tubes on the fuel gas side. The deposit corrosiveness depends on type of the boiler parts. To reduce corrosion a fuel with a lower content of corrosive elements is recommended along with the control of combustion.

2. TESTING (OF CORROSION DAMAGED PARTS)

By testing the corrosion damaged parts of boiler plants, characteristic defects of parts and equipment have been detected. It is the cut out sections of screen tubes, considerably damaged by corrosion, that are most often subjected to testing.

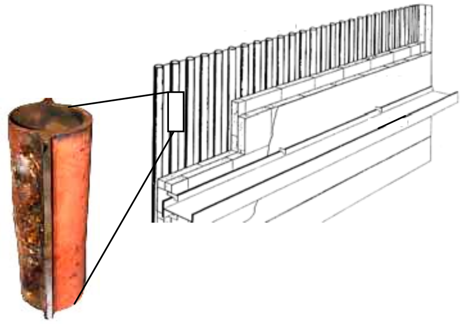

Figure 1. Sample of a tube subjected to testing

Figure 2. Sample of membrane tube baffle

Laboratory tests include:

- visual examination of defect and scheduling of testing
- dimensional testing of damaged parts
- metallographic tests –microstructure of tubes
- deposit analysis, most often from the tube outer side (water tube boilers)

By visual examination of the tube outer and inner surface the following is usually detected:

- all along both sides of the tube weld on the fire tube outer surface, deposits of the combustion and corrosion products are formed
- on the other half of the outer surface, insulation side, there are no visible processes of deterioration
- inner side of the tube (water) has no visible changes and defects.

Dimensional tests were carried out on the tube cross section by measuring the outer and inner diameter and the wall thickness as in Figure 3. Nominal dimensions of the tube are: ϕ 60,3 x 5 mm and the testing results are shown in Table 1.

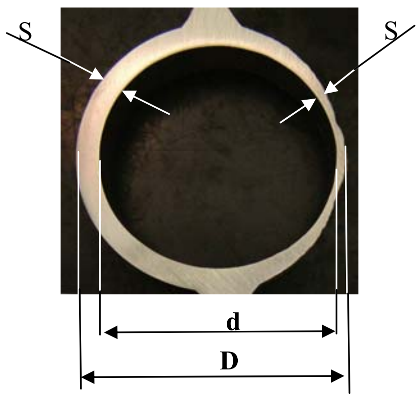

Figure 3. Cross-section dimensional control

Table 1 Values of the tube dimensional tests

Measuring area	mm	
	min.	max.
d	48,8	49,7
D	56,6	58,2
S_1 – tube fire side	1,9 – 3,8	
S_2 – insulation side	5,05 – 5,12	

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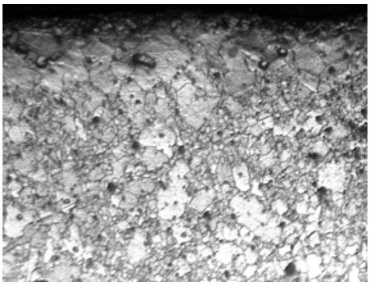
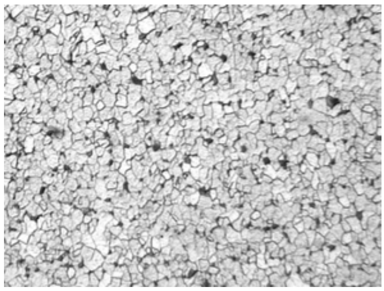
Figure 4 Tube fire side outer surface

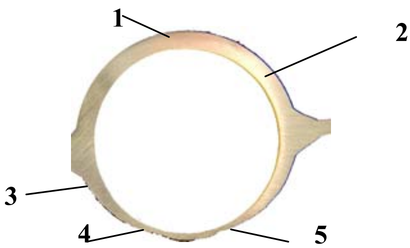
Figure 5 Tube insulation side outer surface



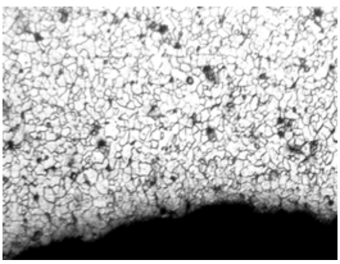
1. Outer edge, insulation side Magnification 250:1



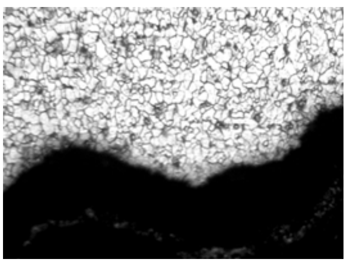
2. The wall middle, insulation side Magnification 250:1



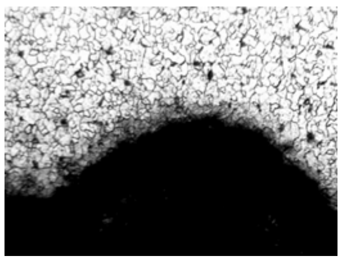
Microstructure photographed areas



3. Outer edge, fire box side Magnification 250:1



4. Outer edge, fire box side Magnification 250:1



5. Outer edge, fire box side Magnification 250:1

Figure 7 Photographed areas and the damaged tube microstructure photographs

Hardness tests were performed by HV 0,1 method (9,81 N loading). Tested areas are shown in Figure 6. Area 1 is on the tube cross section insulation side that is not damaged by corrosion. Five percent measurement was carried out on this part from number 1 (wall outer edge) to number 5 (tube wall cross section inner edge) respectively. The same method of measurement was applied to area 2 (damaged side) and the measured values are shown in Table 2.

Figure 6. Hardness test areas

Table 2. Hardness testing values

HV 0,1 (loading 0,981 N)		
Measurement No.	Area 1	Area 2
1.	132	153
2.	145	146
3.	160	142
4.	135	151
5.	128	139
Mean value	140	146,2

Metallographic tests were performed on the tube cross section in two steps:
- preparation of samples by destructive method
- structure analysis by the Leitz optical microscope

3. CONCLUSION

Boiler plant units are exposed to failures due to corrosion processes, most often on the tube fire side. Most frequent cause of corrosion processes is the presence of aggressive elements in fuel and specific operating conditions.
Based on the results of tests conducted at several boiler plants it can be concluded that the main causes of corrosion induced failures of screen tubes from the boiler fire side are:
- deposits (build-ups) on tube walls resulting from combustion of used fuels
- low temperature corrosion as a result of the action of condensed sulphuric and sulphurous acid caused by the boiler plant operating procedures (cold „start-up“ procedures)
- use of lower quality materials. Therefore higher quality ones should be applied.

Corrosion processes cannot be stopped but only slowed down and thus their effects reduced.

4. REFERENCES

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