Experimental Study of Manufacturing of Chemical De-scaling Materials

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Abstract

This research deals with manufacturing of chemical de-scaling solution used mainly for cleaning turbine blades and internal surface of boiler which are the main component in any power plant. The composition of cleaning solution is very important for efficient removing of scale. The scale from turbine and boiler of Al-Qudus power plant is treated with chemical de- scaling material which is manufactured in Nasser State Company for Mechanical Industries. This chemical solution was applied on the turbine and boiler scales of Al-Qudus thermal power plants. Results reveal that 20% solution of (FLJ) is the most effective to dissolve the scale in period of 2 hours at room temperature. This chemical solution (FLJ) compared with hydrochloric acid and sulphuric acid. Hydrochloric and sulphauric acid show poor de-scaling properties under test conditions and they are non favorable because of their corrosion effect.

Keywords:
De-scaling Materials, Boiler Scales, turbine blades , (FLJ) solution.

Introduction

The deposition of solids within turbine blades and boilers under combustion conditions in thermal power plant results in an accumulation of sludge or in the production of scale. The deposits in the form of scale are highly objectionable, since they are poor conductors of heat, cause reduced efficiency, and are often responsible for burned tubes or plates. The mechanism of scale formation is complex and has been for many years the subject of much controversial discussion. The scale resulting from the deposition of mineral constituents in boilers often consists not of a single salt but of a number of compounds combined in forms frequently unlike the salts originally present in the feed water which is the natural consequence of physical and chemical phenomena resulting from the reactions at high temperatures and pressures existing in steam boilers. Much material has been published relating to fuel losses from scale. Many of the early investigators results are misleading, however, since their conclusions were based upon insufficient and unreliable data. The heat-insulating properties of scale may not be measured in terms of thickness only.

The scale of various compositions on the heat transfer surfaces may be recognized as:

- Corrosion products such as iron and copper oxides.
- Alkaline scale $Ca(OH)_2$ and MgO.
- Additive scales consisting of calcium and magnesium combined with additive materials that are usually soft and easily removed, and Calcium Sulphate

Brief Chemistry of Boiler Scales

The primary constituent of boiler scale is; Magnitide which is formed as a result of reaction of metallic iron with high temperature steam. Other crystalline materials, shown in table 1 may also form the scales. Copper is present due to corrosion of copper alloy, aluminum bronze feed water condensers and pre-heaters, often because of oxygen entrance into these systems. Copper is transported through the steam cycle where it forms on the boiler internals. Other constituents shown in Table 1, are transported through the steam cycle and deposited on boiler internals either from contaminants contained in the boiler feed water system or from use of outdated phosphate-based water treatment chemicals. In addition to these crystalline inorganic compounds, there may be organic residuals present in the scale.

Table 1: Compounds generally found in water boiler scales

Compound	Formula
Anhydrite	CaSO4
Aragonite	CaCO3
Brucite	Mg(OH)2
Copper	Cu
Calcite	CaCO3
Hematite	Fe2O3
Hydroxyapetite	Ca10(OH)2(PO4)6
Magnetite	Fe3O4
Quartz	SiO2
Thenardite	Na2SO4
Wollastonite	βCaSiO3

Advantages of chemical de-scaling of boiler and turbine blades

As far as mechanical cleaning is concerned there are brushes and pigs used for cleaning process, which can only clean the parts of the equipment that are not of

complex shape such as the tubes of boiler and pipes. Some heat exchangers are of complex shape that's why they cannot be mechanically cleaned. So for this purpose chemical cleaning is used.

Experimental

The scale deposits was collected from the turbine blades and boiler from Al-Qudus thermal power plant. The scale samples were treated in department of surface treatment in central tool room plant / Nasser State Company for mechanical industries. Ten experiments were applied with different concentrations of (FLJ) chemical solution for each experiment (10 g) of scale was added into a fixed volume of (FLJ) solution in a flask. The contents were kept for 2 hours at room temperature without agitation. The residue was filtered, dried, and weighed.

Results and Discussion

The test conditions and the weight loss of the scale for various (FLJ) concentration are given in Tables (2).

Table (2) Effect of test conditions and the weight loss of the scale for various (FLJ) concentration

Concentration %	Time min.	Initial weight scale g	Final weight of scale g	Dissolved scale g %
2	120	10	9.5	50
4	120	10	9	10
6	120	10	8.7	13
8	120	10	7.3	27
10	120	10	6.4	36
12	120	10	5.8	42
14	120	10	5.3	47
16	120	10	4.1	59
18	120	10	2.8	72
20	120	10	0.6	94

Table 2, which show a steady increase in dissolved mass of the scale with (FLJ) concentration. Thus higher (FLJ) concentration results in faster de-scaling. The laboratory scale dissolution confirm that 20% (FLJ) concentration produce good cleaning with no corrosion.

The rate of dissolution of the scale in (FLJ) concentration is depicted in Figure 1. The rate is increasing for (FLJ) with concentration.

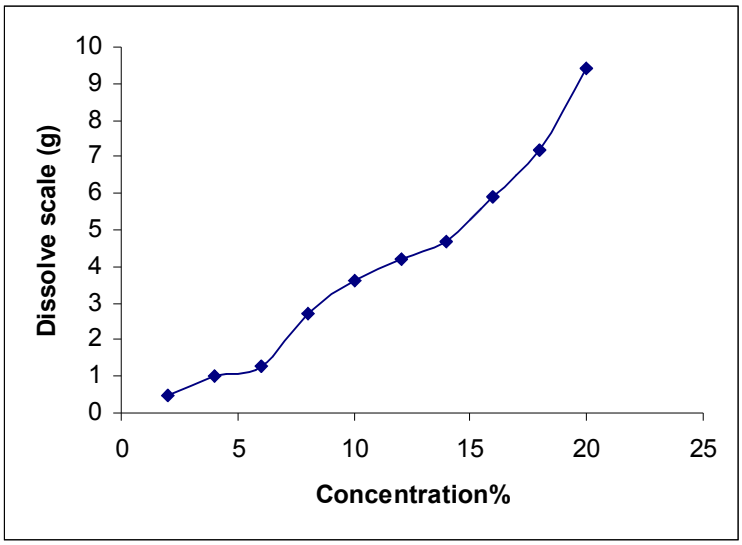

Fig. 1 Percentage of dissolved scale versus (FLJ) concentration

Conclusion

Chemical cleaning is frequently employed for cleaning complex turbine blades and exchanger surfaces. Since the scale compositions vary depending on many factors, a solution has to be customized for specific applications the experiments are performed on the scale obtained from Al- Qudus thermal power plant. Fixed amount of scale sample is allowed to stand in fixed volume of (FLJ) solution for fixed time interval. Mass which is dissolved by the (FLJ) solution is determined gravimetrically.

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