

HIGH TEMPERATURE GAS SIDE CORROSION IN WATER-TUBE BOILERS*

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INTRODUCTION

High temperature corrosion may be defined as the wastage, caused by flue gas or deposits, of boiler surfaces operating at temperatures above 400°F. Instances of wastage of the high temperature sections of boiler plant have been reported with increasing frequency over the past 20 years, and the most recent comprehensive review of both corrosion and deposits in boilers and gas turbines was published in 1959.¹ The present Review is concerned mainly with information published since then.*

Corrosion of furnace tubes occurs most often in pulverised-fuel-fired boilers with cyclone or slagging furnaces. In Germany, where slagging combustion is widely used,^{2,3} the extent of the problem is shown by the results of a survey carried out by the Vereinigung der Grosskesselbesitzer (V.G.B.)^{4,5} among its members. This showed that 33% of all the slag-tap boilers in Western Germany had suffered some tube wastage. It was suggested that the total incidence of corrosion might be double that revealed by the survey.

Wastage of surfaces that operate at temperatures above 1100°F has been found to occur in both coal-fired⁶⁻¹³ and oil-fired¹⁴⁻²² boilers. Such corrosion has been associated with deposits formed while burning high alkali, high sulphur coals in both slagging and dry bottom furnaces, and with vanadium-containing deposits formed when burning residual fuel oil.

Most occurrences of high temperature corrosion have been reported from the U.S.A. and Western Germany where slagging combustion and advanced steam conditions have been used more widely than in this country. However, design steam temperatures in newly commissioned power station boilers in this country have been increasing for many years and it is expected that this trend will continue.²³ Thus the problem of high temperature corrosion, particularly with superheaters, is likely to become of greater importance.

CORROSION IN COAL-FIRED BOILERS

(1) General

High temperature corrosion of furnace and superheater tubes in coal-fired boilers may result from accelerated oxidation, subsurface penetration by sulphides, attack by molten salts, or a combination of these factors. The oxide film forming on a tube surface inhibits further oxidation up to a limiting temperature. Above this temperature the film breaks down and scaling occurs. Deposits on tube surfaces, particularly those formed when burning high alkali, high sulphur coals, may act as a flux progressively removing the oxide film, allowing further oxidation and possibly sulphide penetration at grain boundaries. Generally such wastage is found over two ranges of metal temperature: 500°-900°F in the furnace, and above 1100°F in the superheater. It is convenient to consider these two aspects of high temperature corrosion separately.

Furnace Tube Wastage: The first instance of serious corrosion in boilers probably occurred during the early 1940's in the U.S.A. when thinning of furnace wall tubes in a number of plants was reported. A comprehensive investigation²⁴⁻²⁶ of 16 furnaces, of slag-tap design, showed that wastage was associated with an ash or slag layer on the tube surface, and usually with reducing

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*It is understood that the Institute of Fuel will be holding a symposium on high temperature corrosion early in 1962, and it is intended that the proceedings will be reviewed in the *B.C.U.R.A. Monthly Bulletin* later that year.