INTERNAL CORROSION OF BOILER TUBES

A RECENT EXAMPLE

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Severe hard scab pitting of boiler tubes in H.M. ships had not, until recently, been reported for several years. It would seem that few in the Fleet or in Dockyards had ever seen it, or its devastating results. For this reason it seems timely to review the circumstances of a recent instance, and to remind MEOs of the consequences of an inadequate response to boiler water contamination.

In October, 1969, reports of a fire-row tube failure were received from two G.M. destroyers. In one of them the failure was thought to be associated with impingement from an adjacent superheater tube failure reported at the same time. There was no obvious explanation for the failure in the other case and, although a replacement tube was soon fitted, the old tube was not made available for examination.

The boilers of this (second) ship have recently been durability inspected and as a result of the visual internal examination by endoscope, several fire-row tubes were removed and split to confirm the presence of large hard caps (scabs) over active corrosion pits scattered in some cases throughout the length of the tubes. The minimum remaining thickness was 0·030 in. from an original thickness of 0·128 in. It was reasonable to conclude that the original fire-row tube failure was caused by similar internal corrosion and that further failures were imminent.

The water in this boiler was contaminated with sea water in 1967, a salinity of 350 ppm being reported. It was also reported that the boiler had been steaming from two to four hours before the discovery of this contamination. A full internal clean and boil out was carried out some 24 hours later.

It is difficult to understand why the prophylactic measures carried out as soon as practicable did not prevent the spots from being established. It is possible that the boil out and clean were too late, or that the boiling-out procedure was not followed accurately or for long enough.

This incident serves to underline a few basic facts:

(*a*) Once this particular corrosion mechanism has been established it cannot be removed by mechanical cleaning or boiling out.

(*b*) Bullet brush cleaning is totally ineffective: it rarely disturbs the scabs once they are formed, and will never remove the active contaminant in the craters below the scabs. Similarly, the improved rotary brush cleaning equipment being introduced into the Fleet will not be effective.

(*c*) The procedure (detailed in BR 3000, Chapter 12) to be followed in the event of sea-water contamination of boiler water is effective only if carried out immediately and in the sequence specified; i.e., boil out first before mechanical cleaning, and boil out superheaters separately. Boiling out will not arrest corrosion once it has started.

There will frequently be operational reasons for delaying the remedial measures until a more convenient opportunity, and just as frequently doubts will arise about the severity of the contamination. There will inevitably be the

belief that the figures of maximum salinity quoted in BR 3000 are arbitrary and that one need not clean or boil out after contamination to, say, 150 ppm, for any period. (The book says 140 ppm is the limit.) Experience suggests that when the limits defined have been exceeded, no matter how small the margin, the only sensible course is to boil out and clean.

BR 1335, Boiler Corrosion and Water Treatment, first published in 1945 (a revised edition of which has recently been issued), contains some pertinent remarks on this type of corrosion, for example:

> 'Scab pitting . . . constitutes a very serious form of corrosion'. 'In water tube marine boilers the removal of the hard scabs from the generating surfaces is a mechanical impracticability, and that while these scabs remain, corrosion will proceed underneath irrespective of feed water condition'.

It is possible that acid cleaning of boilers, which is effective in arresting corrosion initiated by chloride contamination, could be adopted for use when circumstances permit. Such a process is expensive, requires specialist personnel and equipment, is just as time consuming as other methods of cleaning and obviously could not be available for emergency boiler decontamination. It also has greater hazards in itself when used on old boilers. However, it is probably desirable to acid clean a boiler at the first convenient opportunity if the presence of scabs is confirmed by experts using endoscopes, and a chloride excursion is known to have occurred. Judgements in such circumstances would be facilitated were a flexible endoscope (fibrescope) available. But, as always, prevention of corrosion—by boiling out and cleaning—is better than cure.

Finally, to illustrate just how serious is this form of attack, there is one notable example in one of H.M. ships of perforation of boiler tubes in six months from new, due to this form of corrosion.

It is believed that the revision of Chapter 12 of BR 3000, at present being carried out, will remove the ambiguities in the current edition, particularly those relevant to boiler feed water condition, etc.