BOILERS

CORROSION PROBLEMS

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Introduction

The problems being experienced at that time and the proposed remedies and developments in boilers of H.M. ships were summarized in an article published in the *J.N.E.*, Volume 18, No. 3 (December 1969). This followed a conference on 'Boiler Maintenance Repair and Operation' which had been held at the Admiralty Marine Engineering Establishment in May of that year.

It may have been erroneously assumed that, following the decision of the R.N. to go 'all gas', boilers would soon go the way of the dodo and that ships' staff would have to live with the problems in boilers in the interest of financial economy.

Subsequent 'Defence Reviews' have invariably extended the lives of many of the steam-propelled ships and it is considered timely to review what has been done since 1969 to eliminate or reduce the problems but also to indicate in a general way the Headquarters approach to any outstanding difficulties.

The following is then the first of a series of articles intended to indicate the situation as the boiler section (albeit somewhat reduced!) of the Ship Department now sees it.

Boiler Corrosion

For ships burning dieso (that is all except a few older ships fitted with Admiralty three-drum boilers) there has in general been a dramatic improvement in the cleanliness of fire sides of tubes and drums. Fireside corrosion has however not been entirely eliminated and in one particular case was alarming. It resulted in the permissible working pressure of the boiler being reduced immediately by a considerable amount and in the acceleration of the ship's withdrawal from service. The corrosion was first observed by a staff boiler technician at a routine inspection. He noticed a large surface flaw on the water drum adjacent to the angle securing the bottom casing to the drum under the outer generator tubes. On return to the United Kingdom a thorough ultrasonic survey of the drum showed that in a large area below the weld joining the tube plate to the wrapper plate the thickness had been reduced in places by as much as two-thirds of the original. During the subsequent specialist's examination it was noticeable that the condensation —which will be met on cold boilers in the United Kingdom—was running down the tubes and over the drum to accumulate along the line of the joint of the bottom casings to the drums. Under certain conditions of heel this acidic moisture could have remained undrained from this area; a casing repair carried out several years earlier had inadvertently created a larger groove for the retention of moisture possibly with the disastrous consequences outlined already. Subsequent examination of other ships of the class has revealed only one other boiler with similar but far less severe corrosion.

Sticky acidic deposits on all surfaces are a common feature of idle boilers which burn dieso. Most failures of pressure parts can be attributed to poor husbandry—a failure to eliminate the leaks in the furnaces from waste-steam pipes, etc. and failure to keep the external heating surfaces of the boiler dry when cold. Not all classes of ship are fitted with simmering coils to facilitate 'hot wet lay-up' and retrospective fitting is not practicable in most cases. Improved electrical heating facilities for use when alongside for short periods have been approved for some *Leander* Class frigates but the provision of improved portable appliances for use by all classes of ship during maintenance periods, refits, etc. has been delayed by difficulties over the electrical supply requirements.

Fireside corrosion of generator tubes at the water-drum end has been very much reduced by the use of dieso although a pattern of tube failures has been established associated with leaking economizer elements in Y.100 boilers. A leaking economizer is normally only detected after several hours of high feed-water losses. This lost water usually cascades on to the lower ends of tubes in rows Z, AA, and BB frequently very soon resulting in perforation of one or two tubes in these rows and in severe corrosion in other tubes usually at the back end of the boiler.

More recently a disturbing external corrosion pattern has been observed in the front and rear studded water-wall tubes at the lower header ends of boilers in *Leander* Class frigates. The casing side of these tubes has been in contact with wetted insulating block—the moisture being due either to condensation or more likely to the residue of careless splashing of water when water washing during the former days of FFO burning. Long-term corrosion has resulted. Recently a rear water-wall tube on a Y.100 frigate failed at the water-pressure test after the durability inspection. The tube had been in service since 1959. Until these incidents it had been usual to expect a full ship's life from these tubes but arrangements have now been made for destructive wear-and-waste testing at major refits, and renewal if the

estimated durability then is less than six years. With the equipment currently available it is not possible confidently to estimate the durability of these tubes by non-destructive methods.

A modification action has been initiated to change to a castable material the insulation behind these studded wall-tubes and thus eliminate the voids in which the corrosive materials can accumulate. The insulation arrangements will then be similar to those fitted in boilers with 'tangential' wall-tubes as in boilers in G.M. destroyers, G.P. frigates and assault ships.

Since about 1969 the frequency of failures of economizer elements has been sharply reduced. It is rare now for a manufacturing weld to fail and the procedure for on-board welding of the elements to bends and headers (which had previously been the most frequent to fail) has been greatly improved. Failure due to either external or internal corrosion is now very rare and gauging of elements removed from ships for renewal at the currently prescribed six-year interval suggests that renewal intervals may well be extended to coincide with major refits.

Most reports from sea attributed economizer failures to corrosion pits. These pits were usually close enough to butt welds to throw doubt on the diagnosis and it must be acknowledged that due to difficulty of access it was rarely possible to view the failure point very closely. Subsequent workshop or laboratory examination of the failure however usually showed that the reported large 'corrosion' pit was in fact the erosion consequences of a pinhole in the adjacent weld. The weld failure had generally been the result of bad alignment of the adjoining tubes. The subsequent high-pressure water jet through the pinhole frequently also eroded several tubes in the same element or in adjacent elements.

There have been no undesirable consequences of the extension of the life of the superheaters in Babcock & Wilcox boilers permitting renewal at major refits, and a life of ten years is now normal. Individual predictable tube failures continue to occur in tubes where low steam speeds coincide with gas lanes between the passes leading to high rates of heat transfer in those tubes which are least well fed with steam. No one has yet produced an acceptable design change to eliminate the cause of these failures.

Since the publication of the article 'Internal Corrosion of Boiler Tubes' in the *Journal of Naval Engineering,* Volume 19, No. 3, no further cases of serious internal corrosion of boiler tubes have occurred. Reports of unacceptable contamination of boiler feed water by sea-water continue to be received from sea. Where this contamination has occurred, it is essential that the full remedial routine specified in B.R. 3000 is carried out. As is made clear in B.R. 1335, *Boiler Corrosion and Water Treatment,* hard scab-pitting is frequently associated with the use of feed water containing dissolved salts in comparatively small concentrations and whenever the chloride concentrations specified in B.R. 3000, Article 1233(5) have been exceeded the contamination is considered to be within the definition 'severe'.