## THE CAUSES AND REMEDIES OF CORROSION IN MARINE BOILERS.*

Marine engineers are all striving in various ways to attain increased economy of fuel in steamers. Among other means of doing so, triple-expansion engines of high initial pressure are being introduced, which appear to be gaining much favor, and will no doubt in time supersede the ordinary two-cylinder type. The increased pressure of steam evidently renders it necessary to be still more guarded than hitherto as to the deterioration of boilers. Steel boilers are now in very general use, and there can be no doubt as to their efficiency; but the writer's experience is that they are equally liable with iron boilers to corrosive influences. On careful scrutiny he has found in steel plates severe corrosions concealed by a very slight scale, upon the removal of which the plate has proved to be covered with a black substance, probably a black oxide of iron. In many cases a casual inspection may fail to detect this. Internal corrosion is well known to be most erratic in its action; it attacks the metal in different parts of a boiler, in different ways, and from various causes. The principal sources of corrosion, however, may be discussed under the two heads of defective design and defective management; which is equivalent to saying that an ordinary marine boiler will hardly be subject to corrosion at all, if well designed and well managed.

*Design.*—The most frequent fault of design which bears upon corrosion is the want of sufficient space for allowing a thorough examination to be made of every part of a boiler. The tubes are often placed so far out in the wings that it is impossible to get down to look at the sides of the furnaces, or so close to the furnace crowns that there is no room to get over these. It would be preferable to allow at least nine inches between each furnace crown and the bottom row of tubes, especially as this row is not useful as heating surface when placed so close down to the crown. The manholes are often inconveniently placed and made too small, which always affords an excuse for a want of proper attention on the part of the men in charge. Manholes should always be fitted in the wings if the size of boiler will allow. There can be no doubt that the best way to prolong the life of a boiler is to watch it carefully and constantly, so as to note the commencement of deterioration and take steps to check it. In any part which cannot be seen, it is impossible to know what is going on. Another fault of design, which easily escapes notice until too late, is the pitching of the steam-space stays, so that one or perhaps several of them come over a space, instead of over a tube, thus rendering the effective use of the scaling tool very difficult, or even impossible in that particular vertical space. With the object of securing the conventional 20 square feet of hearing surface per horse-power, the tubes are sometimes too closely pitched, which causes bad circulation, besides rendering the spaces liable to become soon choked with scale. The tubes should never be less than 1¼ inch apart, both vertically and horizontally.

*Management.*—The first point to be looked to in the management of a boiler is the circulation. In an ordinary multibular marine boiler the circulation takes place by the water ascending from the furnace crowns, and from the sides, backs, and fronts of the combustion chambers, and descending at the wings; the tubes do of course somewhat obstruct the upward current. There can be no doubt that the coolest places in the boiler are those where the circulation is most defective, as is naturally the case below the level of the fire-bars. The water in this part of the boiler always contains the greatest percentage of solid matter, and here the greatest deterioration may, therefore, be expected to be found. Double-ended boilers are not only subject to the same corrosive action as single-ended ones, but being longer they are also more prone to suffer from racking strains, due to the difference of temperature between their upper and lower parts. One method of reducing this difference as far as possible, is to fit the internal feed-pipe so that it is led along on a level with the upper tubes, so as first to warm the water inside it, and is thence carried down so as to discharge the warmed water in a horizontal direction at the bottom of the boiler. The scum pipe should be fitted with a pan, shaped like on inverted saucer, and placed just above the level of the water for the scum to collect under it; and it should always be blown off upon raising steam, and also about once a day when under weigh. The blow-off cock should either be attached at the bottom of the boiler, or else an internal pipe should be fitted to it, reaching down to the very bottom. Salt is not deposited until the density of the water exceeds 4–32nds by the salinometer, that is, until there is no more pounds of salt in 32 pounds of water; beyond this proportion the deposition of salt then begins upon the furnace crowns, etc. It is recommended that the opportunities occurring from time to time by the engines being stopped should be taken advantage of for pumping up the boiler to the top of the gauge glass, and then blowing it down to the bottom of the glass. This, repeated about twice or thrice on each occasion, will work wonders. The great usefulness of this plan arises from the fact that while the engines are stopped there is little or no steam being made, and therefore no solid matter is being deposited from the water; so that the extra feed-water pumped in at that time does much more to freshen the boiler than it would if the engines were at work. When in charge of the engines of a steamer on a voyage from England to Rangoon, calling at several ports on the way, and thence to Venice, the writer kept water in the boilers continuously during the whole round, that is to say the boilers were never entirely run out and refilled, but were blown down from time to time as above described. They were under steam about seventy-two days and upon being opened out at the end of that time had only a slight scale upon them of uniform thickness, and no indication of pitting or corrosion.

The mode of treatment adopted by the writer for new boilers is to have them well washed out before filling, then to run them up, and when they are filled with water up to the normal height, to throw into each through the top manhole about a bucketful of common soda. When steam is raised to about 30 pounds per square inch, blow out a little through the scum cock. Before adding any more water, start the feed donkey, and let it deliver for some time over the side of the ship, so as to get rid of any dirt, etc., in the pump; this is a very useful precaution to observe whenever the feed donkey is employed. After starting the main engines, let them run at first with the feed-water overflowing from the hot-well into the bilges; this will clear the condenser. When under weigh, it is advisable to use the blow-down cocks sparingly. The appearance of the water in the gauge-glass shows at a glance the state of the water in the boiler; if the glass is at all dirty inside, that is proof positive of the water not being clean enough; and this can be cured by the use of scum cock. In a double-ended boiler a scum pipe should be fitted at each end. The scum pipes are sometimes so fitted that their position can be altered to suit the trim of the ship, which is a point of far more importance than is generally imagined. After a run, when steam is finished with, the water should be blown out from the bottom, and the boilers then kept thoroughly dry. B fore refilling they should be carefully swept down inside, and washed out.

There is no doubt that one of the most active causes of deterioration in boilers is the want of proper care in their treatment. Cases have come under the author's notice of boilers being blown down as far only as the level of the bottom manholes, and refilled, without care being taken to draw the water out of the bottoms. This process having been frequently repeated, the waters at the bottoms became so impregnated that the heads of the rivets and the lower half of the compensating rings round the manholes were corroded away, while the other parts of the boiler were in good condition. Many good boilers are ruined through careless management and the makers are wrongly charged with allowing their work to come from the shop not properly finished. Another example, out of numerous cases met with, is that of a pair of boilers which were fitted some little time ago with hydro-kineters, or internal steam jet nozzles for stimulating the circulation of the water in the cooler spaces below the surface flues. Upon a recent examination the valves of these appliances were found to be hard and raising steam too quickly, and blowing out under too great a pressure, which cannot be too strongly condemned. Corrosion in the upper parts of the boiler is principally caused by the introduction of oil, tallow, and other greasy substances from the engines. In all the steamers with which the writer is connected he has discarded the use of all oil or other lubricant in the cylinders, with the most satisfactory results.

Various remedies have been suggested for preventing corrosion: among other, air extractors and circulating tubes. Zinc has been tried, both cast and rolled, and some engineers report favourably on its use; but to make it effective, very large

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