ON BOILER INCRUSTATION AND CORROSION

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PREFACE.

THERE is perhaps no subject connected with Engineering Science which at the present time commands more attention or causes more perplexity than does the compound subject of this paper. In Marine Engine practice its difficulties are most keenly felt; and of itself that is a field of operation large enough, as it involves interests sufficiently extensive, to give great importance to the subject, and to demand the utmost exertions of engineers towards the solution of its problems, and the providing of remedies or preventive measures against the ravages of what is an active and powerful agent in the destruction of their works. But the range of action which this destructive agent has is bounded only by that which puts a limit to the use of

steam, and hence many other interests besides those of engineers are involved in the matter.

The state of general information about this subject is very unsatisfactory, because it amounts only to the fact that obscurity, or at least uncertainty, prevails. Yet many facts of the greatest interest and importance have been observed and noted, and, as is usual in such cases, there are some men who have considered these in the light of their own experience with the intelligence which is needed in order to turn all to good account. As the subject is partly a chemical and partly a mechanical one, it demands, in order that it may be successfully grappled with, a combination of scientific and practical information which, in consequence of defective educational methods, has not frequently been found among engineers.

I propose to myself in this paper the simple task of bringing together these scattered facts and observations, adding to them in whatever measure I am able,

in order to elucidate if possible the full truth of the matter. The course of investigation and inquiry which have been called forth has been marked by the suggestion of various remedies. The earlier stages have produced the recommendation of a variety of empyrical remedies or nostrums—substances which have been proposed apparently for every conceivable reason except an intelligent perception of the nature of the action to be counteracted, and consequently of the qualities requisite in the remedy. A list of these applying to Incrustation is given in a paper by Mr. Jas Napier, published in the *Proc. of the Phil. Soc. of Glasgow* (vol. iv., 1855-58), who gives also some account of the more rational methods proposed in his day. For Corrosion a similar list has in recent times appeared—too large, however, to quote at length; and some methods of working have been proposed which have been more or less successful under special circumstances, but all partial in their application. Of these comes the endeavor to

form a scale of salt by the use of a proportion of sea water, the use of zinc in the boilers, filtering the feed water, &c.

There seems to be in some quarters the idea that Incrustation and Corrosion of Boilers, inasmuch as in general they both result in the destruction of the boilers, are one and the same action. But although this is an error, and the two actions are very dissimilar, yet they are so often united in effecting the destruction of boilers (and almost all crusts contain iron), and are so often present successively in the same boiler (*i.e.*, a crust being formed and then decomposed or partially decomposed, with injury to the boiler), that an examination which did not include a notice of both could not lay claim to any degree of completeness.

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INCRUSTATION.

A FEW years ago the attention of all concerned was exclusively directed to Incrustation, its evils and prevention. The evils produced by it are numerous, for boilers when coated with crust quickly accumulate layers of this material, which is a bad conductor of heat, and thus are not only hard to steam, requiring a large excess of coal, but are more quickly worn out and sometimes suddenly oxydized or "burned" in consequence of the increased temperature rendered necessary in the furnaces. Dr. J. G. Rogers, of Madison, United States, in a paper published some years ago, estimated the conducting power of crusts as compared with that of iron as 1 is to 37.5. A scale

1-16 inch thick, he says, requires an extra expenditure of fifteen per cent. more fuel, and this ratio increases as the scale is thicker. Thus, when it is ¼ inch, sixty per cent. more fuel is needed; ½ inch, 150 per cent., &c. The temperature of the heating surface of the boiler must be raised in proportion to the thickness of scale. Thus, while to produce steam of a pressure of 90 lbs., water must be heated to about 320° Fah., and this can be done in a clean boiler with ¼-inch plates by heating the boiler surface to about 325°; if ¼-inch of scale intervenes between the shell and the water, it will be necessary to raise the temperature of the heating surface to about 700°—almost low red heat. Iron oxydizes the more rapidly the higher the temperature at which it is kept, and at any heat above 600° it very soon becomes granular and brittle, and is liable to give way under pressure. This condition predisposes the boiler to explosion, and makes expensive repairs necessary, and the presence of scale also renders the raising and lowering of steam slower.