Method of Chemically Testing Boiler Water for Corrosiveness

With the Apparatus used and supplied by Babcock & Wilcox, Ltd.

(Kindly presented to the Institute by the Firm.)

The first thing in testing, as is well known, is to see that the colour of the sediment of the water, as shown in the gauge glass, is neither black nor red. The only colour admissible is slightly dirty grey or straw colour. So long as the sediment of the water is red or black, corrosion is going on, and it must immediately be neutralized by the intelligent use of lime or soda, and frequently scumming or blowing off, the make-up being provided by evaporators.

The ordinary salinometer is an instrument for determining the total quantity of solid matter in the boiler water. The apparatus here described gives a convenient and correct method of ascertaining the exact number of grains of chlorine in the water tested. It consists of one graduated bottle, one bottle of silver solution containing 4·738 grains of silver nitrate to 1,000 grains of distilled water, and one bottle of chromate indicator, which is a 10 per cent. solution of pure neutral potassium chromate.

It must be clearly understood, however, that this apparatus merely determines the amount of chlorine which the boiler water contains per gallon. The solid matter per gallon corresponding to the chlorine is given in the table on page 72.

To Make Test.—Fill the graduated bottle to the zero mark with the water to be tested; add one drop of the chromate indicator and shake the bottle; then slowly add the silver solution; keep shaking the bottle. On nearing the full amount of silver solution required, the water will turn red for a moment, and then back to yellow again when shaken. The moment it turns red and *remains red*, stop adding the silver. The reading on the graduated bottle at the level of the liquid will then show the amount of chlorine in grains per gallon. For example, if a permanent red colour is shown when the level is midway between 150 and 200, there are 175 grains of chlorine per gallon.

The principle of the process depends upon the fact that if some of this silver solution be dropped into water containing a chloride, a curdy white precipitate of chloride of silver will be formed. If there is also present in the water enough potassium chromate to give a yellow colour, the white precipitate will continue to form as before, owing to the silver having a greater affinity for chlorine than for the chromic acid in the chromate. But, at the moment when all the chlorine in the sample has been converted, the silver will attack the yellow potassium chromate, and chromate of silver will be formed, which is red in colour. The amount of chlorine present is, therefore, shown by the amount of silver solution required to convert it all to silver chloride, and the exact point when the chloride precipitate ceases to form is shown when the chromate indicator turns from yellow to red.

It is not necessary to add the silver solution until the colour becomes very red, as the delicacy of the reaction would be destroyed; but the change from yellow to yellowish red must be distinct, and must not change on shaking. The sample of water to be tested should be neutral, as free acids dissolve the silver chromate. If it should be acid, neutralize by adding sodium carbonate. Slight alkalinity does not interfere with the reaction, but should the sample be very alkaline, it may be neutralized by nitric acid.

Should it happen that the colour does not change within the limits of the graduations, the sample may be tested by diluting with distilled water. For example, add three parts of distilled water to one part of the sample. If, then, on testing the mixture, the colour changes at 200, the number of grains per gallon in the original sample will be four times this reading, or 800 grains.

The chlorine should be kept down to the least possible amount—say below 100 *grains per gallon*—as the nearer the boiler water is to fresh water the safer the boilers will be against corrosion.

A testing outfit consisting of the graduated bottle and the solutions referred to, neatly packed in a padded box, is supplied by Babcock & Wilcox, Limited, with all boiler installations intended for sea service.

TABLE showing the amount in pounds of lime or soda required to counteract the corrosive effect which various admixtures of sea water would have in 500 gallons (5,000 lbs.) of boiler water.

Lime in lbs. for every 500 gallons boiler water.	Chlorine Tests in grains per gallon,	Soda Crystals in lbs. for every 500 gallons boiler water.	Lime in lbs. for every 500 gallons boiler water.	Chlorine Tests in grains per gallon.	Soda Crystals in lbs. for every 500 gallons boiler water.
18·48	1,400	104·16	9·24	700	52·08
17·82	1,350	100·44	8·58	650	48·36
17·16	1,300	96 72	7·92	600	44 64
16·50	1,250	93·00	7·26	550	40·92
15·84	**1,200**	**89·28**	**6·60**	**500**	**37·20**
15·18	1,150	85·56	5·94	450	33·48
14·52	1,100	81·84	5·28	400	29.76
13·86	1,050	78·12	4·62	350	26·04
13·20	1,000	74·40	3·96	300	22·32
12·54	**950**	**70·68**	**3·30**	**250**	**18·60**
11·88	900	66·96	2·64	200	14·88
11·22	850	63·24	1·98	150	11·16
10·56	800	59·52	1·32	100	7·44
9·90	750	55·80	·66	50	3·72

A boiler containing 500 gallons of water of which one-fifth is sea water and four-fifths fresh water (and the chlorine test of which indicates about 266 grs. per gallon), would, according to the above table, require little more than 3·3 lbs. of lime, or 18·6 lbs. of soda, in order to make it neutral, and therefore non-corrosive. (The exact figures would be: lime 3·5 lbs., soda 19·6 lbs.) Whereas, a boiler containing 500 gallons of water taken direct from the sea, would require 17·5 lbs. of lime or 98 lbs. of soda, in order to bring about the same result.

It is considered, therefore, that while the amounts of lime or soda in the first case are well within practical limits, and may be used in the boiler with advantage, those given for pure sea water might cause serious trouble. The amount of scale that would be deposited by the use of 17·5 lbs. of lime, would, in itself, be a sufficient objection, and the trouble that might arise from the introduction of 98 lbs. of soda into a boiler containing only 500 gallons of water, is well known to every engineer.

It must be clearly understood, therefore, that the table is given merely for the engineer's information. It should not be taken as an instruction to be implicitly followed for the amount of soda or lime to be used with various densities of sea water. This the engineer can only estimate himself by carefully recording the amounts of soda or lime he is putting in from time to time and the amount of make-up feed that is being introduced into the boiler, and by carefully following out the instructions given in the article entitled "Notes on Corrosion."