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MEASUREMENT OF SALINITY.

Quantitative measurements of the salinity of feed water in H.M. Ships are of great value for two practical reasons. Firstly, so that the source of any slow and small contamination of the feed can be detected by recording the salinity of the various feed reservoirs, and secondly in order to determine whether the water in any particular reservoir is sufficiently good to allow of its use, subject to suitable dilution, or whether it should be pumped overboard or otherwise disposed of.

There are four general methods in use for the detection of salinity :—

(1) The sensitive hydrometer.
(2) The nitrate test.
(3) The electrical salinometer.
(4) A more elaborate nitrate test making use of potassium chromate as an indicator (Mohr's method).

(1) The first method measures directly the Specific Gravity of the water and is, of course, not a direct test of salinity, as other impurities will affect the results. Also the sensitive hydrometer is very sensitive to changes of temperature of the water, and it is therefore very difficult to obtain accurate results. Its use is almost confined to testing water from boilers ; it is insufficiently sensitive to detect the smaller quantities of salts which may be present in condensate water, etc.

(2) The ordinary nitrate test is a very sensitive qualitative one, but cannot be used as a quantitative test ; moreover, the presence of lime in the feed water causes a cloud which is difficult to distinguish from that caused by sodium chloride.

(3) Electrical salinometers are of great value as giving a continuous indication of the state of the water passing through them, and in modern instruments fitted with reliable devices for temperature compensation a sufficiently accurate indication of salinity is obtainable ; it is, however, desirable to check their accuracy from time to time as variations may occur in the condition of the electrodes and electrical circuits and, further, they are not conveniently adapted for testing water from sources other than those to which they are specifically connected. These instruments would, of course, be affected by large quantities of lime and other impurities in the water, but the quantities usual in the system in practice are insufficient to prejudice the accuracy.

(4) An outfit for carrying out the nitrate test by Mohr's method is carried in flagships for the use of the Fleet Engineer Officer.

The test is a very satisfactory and accurate one, the basis of the test being as follows :—

A measured sample of the water under test is made slightly alkaline (if not already so) and a few drops of potassium chromate are added as an indicator, turning the water yellow in colour. A standard solution of silver nitrate is then added slowly, the mixture being well stirred throughout the operation, till it changes colour to a reddish-yellow throughout. Observation of the amount of silver nitrate of known concentration necessary to effect this change enables the chlorine content of the water to be calculated.

The chemical reaction involved is the same as for the ordinary silver nitrate test, viz. :—

	$NaCl$	$+$	$AgNO_3$
	(Sodium Chloride)		(Silver Nitrate)
$=$	$AgCl$	$+$	$NaNO_3$
	(Silver Chloride)		(Sodium Nitrate)

and after the reaction is complete, the excess drop of silver nitrate which cannot be converted into silver chloride and sodium nitrate forms the reddish precipitate with the potassium indicator.

It is possible to carry out this test using improvised apparatus much less elaborate than that provided in the flagship's testing outfit and still obtain results which are sufficiently accurate for practical purposes.

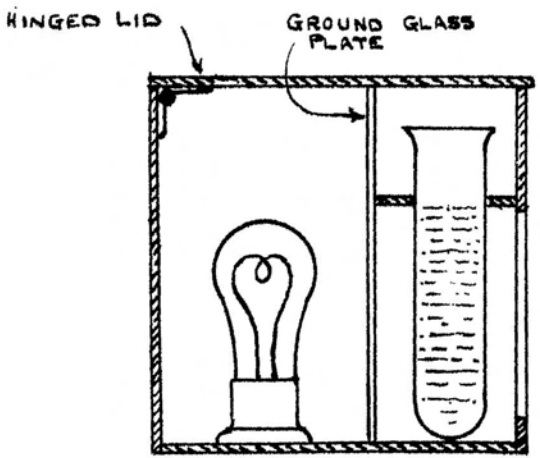
A standard solution of silver nitrate as supplied to the service contains 4·738 grams of silver nitrate per litre of water, or 332 grains per gallon of water.

If we take a test tube and fill it with $17\frac{1}{2}$ c.c. of water to be tested, then five drops of this standard solution from a drop bottle will be required to complete the reaction for each grain per gallon of chlorine in the water to be tested. (The figures are based on an average content of one-twentieth c.c. per drop.) A filling mark may be made on the test tube once it is calibrated so that the correct volume of test water is always used.

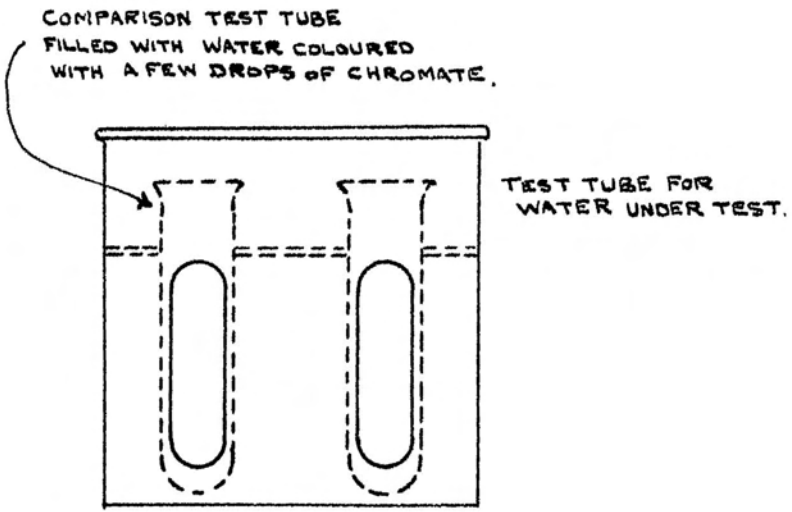
Silver Nitrate solution is apt to vary somewhat from its standard strength due to evaporation, and for this reason it is preferable to make up a solution from silver nitrate crystals when these are obtainable (silver nitrate in pellet form is usually obtainable from the sick bay).

It is convenient to make up two solutions, one for testing water which may have a high salinity, *i.e.*, from boilers, etc., and the other for feed and condensate. The weaker solution of silver nitrate might be one-tenth the standard strength, which gives five drops to 0·1 grains per gallon of chlorine in test water.

In order to test the strength of a nitrate solution, a standard salt solution may be made up if materials are obtainable, or alternatively, the solution may be obtained from a reputable analytical chemist. Messrs. Burroughs & Wellcome sell sodium chloride in tabloid form,



SECTIONAL ELEVATION



FRONT ELEVATION.

which may be used for making up the standard solution by adding pure distilled water.

Sodium Chloride contains 23 parts of sodium and 35·5 parts of chlorine by weight, so that each grain contains 0·6 grains of chlorine. Sodium chloride is very hygroscopic and great care is therefore necessary to see that it is dry when used.

Practical Points and Precautions.—A sample taken from the water to be tested should first be tested for alkalinity with methyl orange; if not alkaline, a few drops of sodium carbonate solution should be added and another sample tested and the process repeated until the water is just alkaline. The marked test tube should then be filled to the mark with the water and three or four drops of potassium chromate added to the solution, after which the silver nitrate should be added a drop at a time, and the solution stirred with a glass rod; each drop will cause a reddish precipitate for an instant, the yellow colour returning when stirred until the reaction is complete, when the reddish tint remains after stirring.

The use of a testing box, made up according to the accompanying diagram, will enable the operator to gauge the point of colour change more readily, whilst the standard illumination intensity is of advantage.

It is essential that the apparatus should be kept perfectly clean, and the test tubes and stirring rods should be well rinsed either with distilled water or with the water under test before use; care must be taken to avoid contamination from perspiration or from the fingers.

The drop bottle used for silver nitrate must be kept for this purpose and the grooves in the stopper must be kept free of dirt or crystalline deposits.

The silver nitrate solution should be kept in an amber coloured or painted stoppered bottle.

Potassium Chromate and Sodium Carbonate are rate book articles obtainable in pellet form with instructions for making up standard solutions.

It is of great importance that all water used for making up solutions should be pure distilled water and particularly should be free from chlorine.

The degree of salinity permissible is somewhat arbitrary, but the following figures are suggested as being generally suitable:—

Boiler water	20 grains/gall. Chlorine.
Main feed tanks and condensate generally	0·2 grains/gall. Chlorine.
Reserve and overflow feed tanks ..	1·0 grains/gall. Chlorine.

A chlorine content of 1·0 grains/gall. is appoximately equivalent to 1,000 parts of distilled water diluted with one part of sea water.