Pams

55

The surface sampler, an apparatus for the collection of samples from the sea surface from ships in motion.
With a note on surface temperature observations.

by J.R. Lumby.

Copenhagen, J. Cons. Perm. Int. Explor. Mer., 2, 1927, pp. 332-342.

Too small
Should be made of e.g. rubber

The Surface Sampler, an Apparatus for the Collection of Samples from the Sea Surface from Ships in Motion.

With a note on surface temperature observations.

By

J. R. Lumby.
Fisheries Laboratory, Lowestoft.

Copenhagen, J. Cons. Perm. Int. Explor. Mer., 2, 1927, pp. 332-342.

The apparatus here to be described was designed to facilitate the collection of surface water samples from ships in motion, the samples being obtained to provide material for salinity and temperature determination. The need for some such apparatus sprang from the realisation that the use of an ordinary iron bucket was not always a simple task, the difficulties attending on which being of such a nature that they might well militate against the efficiency of the bucket as a sampler. There are moreover objections against most types of draw buckets ordinarily in use on the grounds of cleanliness.

It is considered that the use of the surface sampler would materially improve the collection of samples for salinity determination and that so far as observation of temperature is concerned, given ordinarily advantageous conditions, with due precaution readings may be obtained with a fair degree of accuracy.

The apparatus, which is made in brass, consists essentially of two parts — head and body. The body is formed of a brass tube *A* (see Figure 1), having a base plate *B* to which is attached a cup *C* by means of a nut *H*. The sample bottle *G* (capacity about 150 cc.) is supported on the plate *D*, and when the apparatus is assembled maintains the spiral spring *E* in compression. The movement of plate *D* in the cup *C* is determined by the guide screws *FF'*. The base plate *B* carries an eyebolt *J* to which a preventer wire *K* may be fastened as an additional safeguard against loss should the spring catch *T* fail to prevent the head rotating and so coming apart from the body.

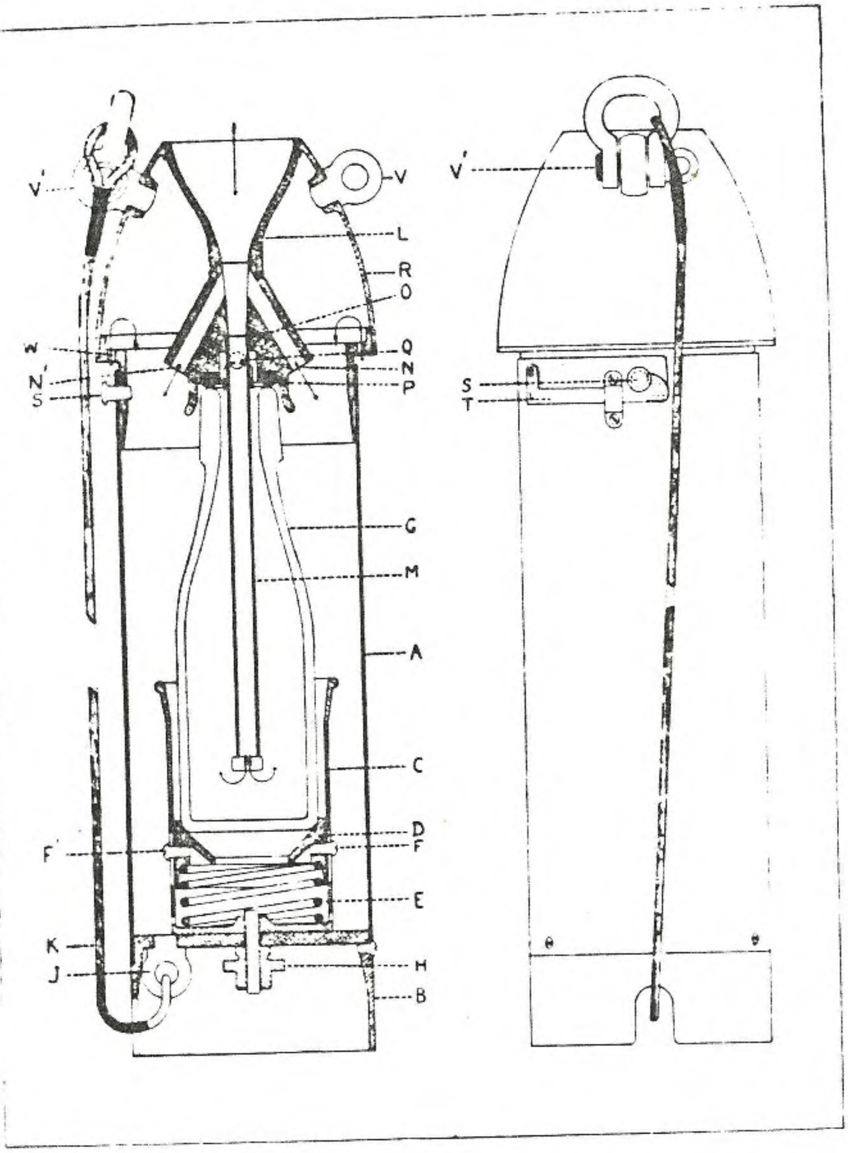

Fig. 1.

The outer shell R of the head carries at its upper end a funnel piece L which is continued in the tube M, passing well down into the sample bottle. A casting O, between the funnel piece L and the tube M, carries two side tubes NN', which assist in promoting the circulation of water within the cavity of the body. The casting O also furnishes a bed for the rubber washer P against which the head of the sample bottle G bears, and in this casting are the outlet ports Q from the sample bottle.

The lower end of the outer shell R is a loose fit in the body tube A. The head is held to the body by 3 lugs on the head fitting into grooves in the body tube, forming 3 bayonet joints. A spring catch T operates with one of the lugs to prevent the head rotating in the body, and so becoming free from it.

Towing bridles are shackled to the two eyebolts VV' screwed into the head of the apparatus. The towing line consists of a length of $1^1/_2$ inch circumference manila rope (usually of about 10 fathoms length), having an eye at one end, to which is shackled a swivel; to the other

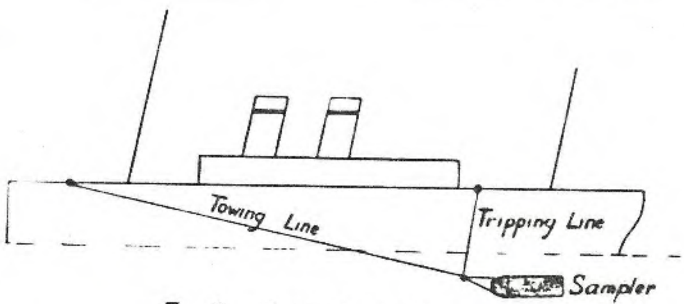

Fig 2 Method of Towing.

end of the swivel two bridles (each about 3 feet of $^1/_4$ inch circumference wire rope) are shackled and the other ends of these bridles are shackled to the eye bolts VV'.

Figure 2 illustrates a convenient method of towing.

When the apparatus is towed, water enters the apparatus through the funnel piece L; part of the water is diverted through the side tubes NN' into the body cavity, and part flows through the tube M into the sample bottle where it passes through the outlets Q into the body cavity of the apparatus. The water leaves the apparatus through a series of ports W on the under side of the head.

The spring cup C can be removed for cleaning etc. by unscrewing the nut H. Removal of the guide screws FF' gives access to the spring E. The tube M is also easily removable for cleaning. The weight of the apparatus assembled and filled, but excluding bridles and towing line is about 7 kilos.

In order to test the efficiency of rinsing, a sample bottle and the body cavity of the apparatus were filled with a coloured liquid and towed for various periods at speeds from about 8 to 25 knots. After towing for 5 minutes no trace of colour was visible in the sample brought in, and at high speeds this was also the case when crystals of potassium permanganate were placed in the sample bottle. The period for which it is necessary to tow the apparatus consistent with efficient washing must naturally vary with the speed of towing, and this period can readily be ascertained by making similar tests to that outlined above.

One of these samplers has now been in use for more than a year in s.s. "Dieppe" Southern and French State Railway Co., and, so far as its operation is concerned, has proved satisfactory.

When samples for salinity determination are collected in an ordinary bucket, attention must be paid to the cleanliness both of the draw bucket itself and of the bottle in which the sample is to be stored. Instructions are given to Observers in which they are asked to take 2 or 3 successive casts of the bucket well forward from any waste discharges before bringing on board a final sample. This procedure may sometimes be inadequate or neglected, since samples are ocassionally received which contain foreign matter of a nature suggesting a dirty bucket as origin. Moreover, though the sample bottles are, through the kindness of the Government Chemist, carefully cleaned and inspected at the Government Laboratory before being despatched to the various ships, it seems that it is possible for contamination to arise through salt dust particles entering the bottles after packing (*vide* J. R. Lumby, Fishery Investigations, Ser. II Vol. VII, No. 7. 1924 (1925), appendix p. 22). Rinsing the bottle with some of the sample should indeed be sufficient to remove contamination of this type, but neglect of this precaution might conceivably introduce errors larger than permissible.

The surface sampler was primarily designed to minimise such errors, and with this apparatus the salinity sample is collected in the bottle in which it is to be stored, and this bottle is washed automatically in the process of collection.

As regards the observation of temperature the surface sampler provides a sample for temperature determination separate from that destined for salinity determination. With the apparatus in its present form the volume of the sample available for temperature determination is approximately 1 litre.

Surface temperatures from light vessels and commercial ships are commonly given to the nearest 0.1° C., but it is questionable whether an accuracy of $\pm$ 0.05° C. is always obtained, in support of which the following observation may be cited from the Bulletin Trimestriel No. 1 1927:—

15/1/1927, 57° $49\frac{1}{2}$ N. 22°38′ E., — 2.0° C., 6.20 ‰; the freezing point of water of that salinity being —0.3° C.

In order to obtain the highest possible accuracy when no thermal insulation of the sample is provided, it is necessary that the bucket — or whatever may be used for drawing the sample — should remain submerged for a time sufficient to allow the bucket to reach the same temperature as the water. Then, to ensure that the temperature of the sample is observed as soon as possible after the sample is drawn, the draw bucket must be convenient to handle, while at the same time the volume of the sample must be large enough to preclude too rapid changes of temperature through exchange of heat with the atmosphere. Moreover, precaution must be taken against cooling through evaporation, either from the sample itself or from the surface of its container, and finally the thermometer used must be sensitive and of low thermal capacity. The thermometer moreover ought to be at the same temperature as the water sample, and to this end should be included in the apparatus, though provision for such an arrangement is not made in the present design of the surface sampler.

In order to furnish an idea of the relative efficiency of the various types of buckets commonly in use, in regard to the accuracy with which it is possible to obtain observations of surface temperature, iron, leather and canvas buckets were immersed, together with a surface sampler fully assembled, in the sea from the side of the ship at anchor away from direct sunlight for a period of at least ten minutes. Each draw-bucket was removed in turn, placed on a grating on deck out of direct sunlight and the temperature of the sample determined at successive intervals. From these observations the rate of change of temperature was estimated roughly by plotting temperature against time and drawing a freehand curve through the points. These results are shown in Table 1, series A. Series B and C relate to similar experiments made on shore, the samplers (without heads) being first immersed in a tank and then placed on a ledge before an open window, away from direct sunlight. In these two latter experiments the thermometer was placed in the sampler before immersion, so that it should not be necessary to wait until the thermometer had reached the temperature of the sample before a reading could be obtained. As an attempt to increase the insulating properties of the surface samplers a sheet of $^1/_{16}$″ rubber was bound round the body of sampler No. 3, but this device does not

Table I. Showing the rate of change of temperature of water samples under different conditions of collection.

(1) Series	(2) Apparatus	(3) Approx. Capacity	(4) Air Temp. Wet bulb.	(5) Air Temp. Dry bulb.	(6) Diff. (5—4)	(7) Water Temp. (estim.)	(8) Diff. (4—5)	(9) First obsn. of temp. of Sample	(10) Time of first obsn.	(11) Diff. (7—9)	(12) Average Rate of change of temp. (of sample) per min. over first 2 mins.
		litres	°C.	°C.	°C.	°C.	°C.	°C.	m. s.	°C.	°C./min.
A.	Iron bucket	8	13.79	15.23	+1.14	13.80[1]	−1.43[1]	13.82[1]	2.33[1]	−0.02[1]	+0.01[1]
						(14.03)	(−1.20)	(13.92)	(0.45)	(+0.11)	(−0.10)
	Canvas bucket......	1 1/2	..	..	..	13.80	−1.43	13.81	0.40	−0.01	+0.01
	Leather bucket.....	8	..	..	..	13.77	−1.46	13.78	0.50	−0.01	+0.00
	Sampler No. 2......	1	..	..	..	13.81	−1.42	13.83	0.55	−0.02	+0.02
						13.89	−1.34	13.90	0.20	−0.01	+0.02
B.	Sampler No. 3 (lagged)..............	1	17.65	19.91	+2.26	22.10	+2.19	21.99	0.25	+0.11	−0.13
	Sample No. 4 (no lagging)............	1	..	..	..	22.13	+2.22	22.10	0.15	+0.03	−0.16
	Canvas bucket	1 1/2	..	..	..	22.06	+2.15	22.01	0.18	+0.05	−0.07
C.	Sampler No. 3 (lagged)..............	1	17.24	19.51	+2.27	23.81	+4.30	23.70	0.32	+0.11	−0.21
			17.09	19.60	+2.51	23.58	+3.98	23.50	0.16	+0.08	−0.20
	Sampler No. 4 (no lagging)..............	1	17.10	19.51	+2.41	23.77	+4.26	23.69	0.18	+0.08	−0.21
			16.81	19.40	+2.59	23.50	+4.10	23.40	0.22	+0.10	−0.20
	Canvas bucket	1 1/2	17.10	19.85	+2.75	23.64	+3.79	23.60	0.15	+0.04	−0.12
			16.78	19.27	+2.49	23.39	+4.12	23.32	0.20	+0.07	−0.11

[1] Neglecting observations made in first 2 1/2 minutes, the figures in brackets below being the values obtained according to the normal procedure.

seem to have produced an appreciable improvement under the conditions then existing.

Columns 4 and 5 give the readings of wet and dry-bulb thermometers placed in the neighbourhood of the draw buckets during the time the observations were in progress. For series A and B are given averages of a number of readings taken during the course of the experiment.

Column 6 gives the differences between these readings, giving a measure of the rate of evaporation.

Column 7 gives the temperatures of the waters from which the samples were drawn, as extrapolated from the graphs mentioned above.

Column 8 gives the differences between air and water temperatures (estimated) at the times of the experiments.

Columns 9 and 10 give the first observations made of the temperature of the samples and the times at which they were made, times being reckoned from the withdrawal of the buckets from the sea or from the tank.

The differences between these first observations of temperature and the estimated water temperatures are given in Column 11.

Column 12 gives approximations to the average rates at which the temperatures of the samples changed in degrees centigrade per minute reckoned over the first 2 minutes. In the first place it is evident, as is to be expected, that, as regards the different series the rate of change of temperature increases as the difference between air and water temperature increases In series A the temperature of the samples in the canvas and leather buckets changed less rapidly than that of the samples in the iron bucket and in the surface sampler. With an air temperature 1.4° C. above water temperature, and a wet- and dry-bulb difference of 1.4° C., 5 minutes could have elapsed after drawing the sample before the temperature of the sample in surface sampler No. 2 would have changed by 0.1° C., a time limit which makes it reasonable to suppose that an accuracy of $\pm 0.05°$ C. could have been obtained under the conditions prevailing.

It was at first thought that the low rate in the case of the canvas bucket might be ascribed to the fact that loss of heat through evaporation from the wet surface of the bucket was almost balanced by the gain of heat from the air, but in series B and C when water temperature was higher than that of the air, and the loss of heat due to evaporation would tend to increase the cooling rate, this rate was, for the canvas bucket, again lower than that for the two samplers.

Returning to series A, at first the temperature readings for the sample in the iron bucket, the first to be drawn from the sea, fell from 13.92°

to 13.82° C., afterwards rising at the rate of ca. 0.01° C. per minute. It is thought that this initial fall may have appeared from the fact that the thermometer, which was at a temperature higher than that of the water, required from 2 to 2$^1/_2$ minutes in which to become adjusted to the water temperature. This time appears to be unduly long, but unfortunately the thermometer used, which was of a special type and of which no duplicate is at present available, has subsequently been broken, and the point cannot be checked.

In series B and C, with air-water temperature differences of about 2° and 4° C. respectively, the rates of temperature change were roughly 7 and 11 times the rates found for the sampler used at sea (series A). That is to say, in order that observed water temperatures should not differ by more than 0.1° C. from true temperatures, readings must be obtained under these conditions in less than $^3/_4$ min. and $^1/_2$ min. respectively after drawing the samples. Though it is possible to obtain an observation in less than 1 minute after collection, it would not be justifiable to expect an accuracy to the nearest 0.1° C. under the conditions of series C, and even under the conditions of series B this accuracy could not be assumed with certainty.

It therefore appears that as regards temperature observations, the surface sampler, though it may be modified with advantage, can be used with due precaution in ordinarily favourable circumstances so as to yield observations which may be relied upon to differ from the true temperatures by not more than $^1/_4$° C. Lagging with sheet rubber having so far proved ineffective, it is possible that improvement may be made by increasing the capacity of the apparatus and/or by fitting an insulation jacket, and further it is hoped that some method may be found for including the thermometer in the apparatus.

It has been suggested by Professor OTTO PETTERSSON that sea temperatures might be obtained from the inlet pipe to the condensers in commercial ships. While it is an advantage that in many ships observation of the inlet water temperature is a matter of routine, and that accurate readings would probably be readily obtainable, such observations are not necessarily comparable with surface samples taken from on deck, since the inlet pipe is necessarily below surface, and moreover its depth varies from ship to ship and in the same ship according to circumstances. Surface temperatures taken from on deck relate perhaps to the uppermost metre of water. In the southern part of the North Sea it is sometimes possible to obtain a value from 30 or 40 metres depth which would not differ appreciably from an observation taken at the surface of the same water column, though on a hot calm day a very thin layer might be formed having a very high temperature which would be rapidly dissipated with the advent of wind. Again a high degree of vertical homogeneity is attained in winter in the northern North Sea, such that in a vertical series down to 80 metres no differences greater than 0.01° C. might be found, but in summer near the coast an observation at 10 metres might differ from one at 0 metres by more than 1° C.

Through the courtesy of the Marine Superintendent of the Meteorological Office, London, data from R.M.S. "Majestic" (Commodore Sir Bertram Hayes) have been furnished relating to air and sea temperatures, the latter being taken (a) by using a draw bucket from on deck and (b) from the main injection pipe 30 feet (9 metres) below the surface, at 4-hourly intervals on passage from Southampton to New York and on the return voyage. These observations were made between 4 p.m. 15th/XI/1923 and 4 p.m. 29th/XI/1923. In addition, Captain S. Marmery, s.s. "Dieppe", Southern and French State Railway Co., has kindly furnished similar data, giving daily observations (at midnight?) during the month of November 1926 from the English Channel, at position (approx.) 50°23′ N. 1°29′ E. In this case the depth of the inlet pipe was 10 feet (3 metres) below the surface.

These observations which were recorded in degrees Fahrenheit, are summarised in Tables 2 and 3.

In regard to the observations from s.s. "Dieppe" in only one case is a difference of 2° F. recorded between two corresponding water temperature observations and the averages for the month differ by 0.1° F.,

Table II. Showing the Temperature of the Air and of the Sea (a) as observed by using a draw-bucket and (b) as taken from the inlet pipe.

Ship	Depth of Inlet pipe	No. of observations	Time	Averages		
				Air Temp.	Water Temp. by draw bucket	Water Temp. from inlet pipe
	m.			° Fahr.	° Fahr.	° Fahr.
S.S. "Dieppe".....	3	30	—	49.5	55.2	55.3
R.M.S. "Majestic".	9	60	All	54.9	56.1	55.9
			4 a.m.	53.9	54.5	55.5
			8 a.m.	55.6	58.7	58.8
			noon	56.8	56.7	56.5
			4 p.m.	54.2	55.9	56.3
			8 p.m.	54.2	56.0	55.4
			m'dn't	54.5	54.7	53.1

Table III. Showing the Number of Occurrences of Differences between Observations of Sea-temperature as made (a) by using a draw-bucket, and (b) from the inlet pipe.

Ship	Difference ° Fahr.	Number of Occurrences + ve[1])	− ve	Total
s.s. "Dieppe"	0	16		16
	1	6	7	13
	2	—	1	1
				30
R.M.S. "Majestic"	0	6		6
	1	2	5	7
	2	11	2	13
	3	3	1	4
	4	7	9	16
	5	—	2	2
	6	1	1	2
	7	1	2	3
	8	2	1	3
	9	1	2	3
	10	—	—	—
	11	—	—	—
	12	—	—	
	13	—		
	14	1		1
				60

so that in these circumstances one might be justified in regarding the inlet temperature observations as comparable with surface observations proper.

The two sets of observations from R.M.S. "Majestic", however, show considerably greater differences, the most frequent being 4° and 2° F. respectively, and though the averages for the whole period differ from one another by only 0.2° F., 57 per cent. of the observations exhibit differences of 3° F. and above. It may therefore be concluded that the method of observing the sea temperature at the inlet pipe cannot at present replace the existing procedure for surface observations, though the collection of inlet temperature observations as representative of sub-surface conditions might well prove a valuable addition to hydrographic work.

[1]) A + ve value indicates that the temperature observation made by using a draw-bucket was higher than that obtained from the inlet pipe.

In conclusion, I wish to offer my thanks to Mr. D. J. MATTHEWS, Hydrographic Department, the Admiralty, London, for giving me the benefit of his experiences with a similar type of apparatus; to Mr. HARRY J. GARROOD of Messrs. ELLIOTT & GARROOD, Ltd., Beccles, Suffolk, whose help in drawing up the technical details of the design has been invaluable; and to Captain S. MARMERY and Mr. SHAW, Chief Officer, s.s. "Dieppe" for their very kind assistance during tests of the apparatus. I am further indebted to Messrs ELLIOTT & GARROOD, who have constructed the surface samplers now in use, for the print from which Figure 1 was prepared; and to Mr. STOKES, of the Laboratory staff, for preparing the diagrams for publication.