NATIONAL INSTITUTE OF OCEANOGRAPHY

WORMLEY, GODALMING, SURREY

The Plessey Velocimeter

REPORT OF TESTS IN THE R. R. S. "DISCOVERY"

MAY 1965

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by

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The purpose of the trials described here was to test the velocimeter in the sea at greater pressures than had previously been tried, down to the recommended safe working depth limit of 5000 ft., and to compare its readings with sound velocities deduced from temperature, salinity and pressure observations.

One instrument, model MO 30, reading in ft/sec, worked satisfactorily throughout the trials and gave results in good agreement with calculated velocities, down to the maximum pressure of 1475 decibars (equivalent to 4800 ft. depth, approximately). A second instrument, type MO 31, reading in metres/sec, failed on the first deep lowering at about 1100 decibars pressure, and after repair still showed an intermittent fault. Such readings as were obtained from it, however, varied with pressure in the expected manner.

Method

The velocimeter was lowered on a 1600 metre length of 4-core armoured cable on the midships winch of the R.R.S. "Discovery". Its output signal was brought up the cable and fed via slip rings to a display unit in the electronics laboratory. Power was supplied to the instrument via the same cable.

It would have been a simple matter to make a profile of velocimeter readings versus wire out, and compare them to velocities calculated from a water-sampling station done immediately afterwards, but this would have left too much uncertainty in picking corresponding depths on the two profiles. Without some means of measuring pressure, or depth, on the velocimeter cable, one might well make errors of 20 - 30 metres in estimating its depth from wire out and near surface wire angle, with 1500 metres of wire out. Besides that, internal waves or patchiness of water properties could cause real changes between the two velocity profiles. A more stringent test could be made by measuring temperature, salinity and pressure at the same place and time as the velocimeter was being read.

The armoured cable was too large in diameter (0.270") to allow a water bottle to be clamped on in the ordinary way, and ordinary messengers would not slide down it. However, it was possible to tie a water bottle by its lower end to the cable, with a short piece of cord, about 2 metres above the velocimeter, and then to support the upper end of the water bottle in a TYF net-release which was clamped to the armoured cable. The net-release could be actuated by a large heavy messenger.

The bottle, carrying protected and unprotected reversing thermometers, could then be sent down with the thermometers in the upright "measuring" position, and the whole bottle reversed when the messenger was sent and the top end of the bottle released. In this way, the temperature and pressure could be observed at the same time and place as the velocimeter was being read. It was not possible to make the bottle collect a water sample for salinity determination when used in this way, but that was not a serious drawback since salinity need not be known with very high accuracy for this purpose, and it was sufficient to estimate it from the known temperature and the T-S relationship found at a subsequent water-sampling station.

Results

With the first instrument, model MO 30, dips were made to 50 metres wire out (twice), 200 m, 500 m, 1000 m and 1500 m. The 1000 m dip had to be repeated because the bottle did not trip first time. The results are given in the table below:

Wire out (metres)	Pressure (decibars)	Temp. °C	Sal. (‰)	Calculated Velocity (ft/sec)	Observed Velocity (ft/sec)	Observed minus Calculated Velocity
50	47	11.37	35.54	4910.7	4910.6	-0.1
50	50	11.38	35.54	4910.7	4910.7	0.0
200	193	10.96	35.57	4913.7	4912.9	-0.8
500	493	10.80	35.59	4928.1	4926.7	-1.4
1000	990	9.27	35.69	4936.0	4936.4	0.4
1500	1475	5.72	35.25	4916.3	4916.4 -4915.7	-0.3

The "calculated velocities" were obtained from the observed temperatures, salinities and pressures using the tables produced by the A.D. Little Co. Inc. from the measurements of W.D. Wilson. They have an inherent uncertainty of approximately 1 ft/sec, quite apart from any errors in measurement of pressure, temperature and salinity. These latter are believed to be no more than ±5 dbar, ±0.02°C, and ±0.01‰, equivalent to uncertainties in sound velocity of 0.25, 0.26 and 0.04 ft/sec respectively. In the worst case these would not amount to 0.6 ft/sec. The overall uncertainty in the calculated values is therefore probably a little over 1 ft/sec, and the differences between observed and calculated velocities seem negligible. Their r.m.s. value is 0.7 ft/sec, and there is no significant relationship with pressure.

Three dips were made with the second instrument (MO 31), after it had failed and been repaired, to 100, 200 and 500 metres wire out. It had not been adjusted as carefully as the other one, into agreement with the tabulated values at atmospheric pressure, but this zero error was found to be constant, within the accuracy of the observations, as the following results show:

Wire out (metres)	Pressure (decibars)	Temp. °C	Sal. (‰)	Calculated Velocity (m/sec)	Observed Velocity (m/sec)	Observed minus Calculated Velocity
100	102	11.76	35.58	1499.0	1492.9	-6.1
200	195	11.22	35.58	1498.6	1492.6	-6.0
500	491	10.94	35.58	1502.5	1496.8	-5.7

As before, the estimated uncertainty of the calculated velocities is about 0.4 m/sec, most of which is inherent in Wilson's original observations, and the range of variation of the discrepancy is not significant.

Comments

So far as they go, these tests show that the Plessey Velocimeter can give results in good agreement with calculated velocities, without any signs of systematic error dependent on pressure. Only a limited range of temperatures and salinities were experienced, but that was inevitable in the limited choice of area and time when the tests could be made. The range of velocities measured was not large, even in going from 50 metres to 1500 metres. This is of course due to the opposing effects of temperature decrease and pressure increase. The performance of the meter seems a little more impressive, perhaps, when it is remembered that 1500 decibars of pressure alone would cause a velocity increase of 80 ft/sec.

Readings were taken with the velocimeter every 50 or 100 metres, during lowering, and these have been compared with the vertical profiles of velocity calculated from temperature and salinity observations at the same station. These are in fairly good agreement (within 1 or 2 ft/sec) where the temperature does not change rapidly with depth, but on the deepest lowering, to 1500 metres, discrepancies amounting to 9 ft/sec occur in the lower part of the profile. These are mainly due to real changes of temperature. On the deepest velocimeter lowering, a temperature of 5.72°C was found at 1475 decibars. Three hours later, during the water-sampling station, 5.26°C was observed at 1463 decibars - a change of about ½°C, equivalent to 6 ft/sec velocity change. Such large fluctuations make it clear that, for a critical test of the velocimeter, only the temp rature and pressure observations made at the same time and place as the velocimeter readings can be used

When Matthews' tables are used for calculating sound velocities, there are discrepancies between calculated and observed values, consistent with the observation made by Hays, that the pressure correction given by Matthews is too great. For example, the change in sound velocity predicted by Matthews is going from 47 to 1475 dbar, with the temperatures and salinities observed when the first instrument was used, is 13 ft/sec, while the change predicted by Wilson is 5.6 ft/sec and the observed change is 5.7 ft/sec.

References

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