International Council for

the Exploration of the Sea

Hydrography Committee

A FORMULA FOR THE DENSITY OF SEA-WATER. II

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In 1971 the present author submitted a formula for the density of sea-water (C.M. 1971/C:30) to this committee. The formula was founded on the observations published by R. A. Cox (the late), M. J. McCartney and F. Culkin (1970), and it was given such a form that at $S = 0$ it was identical with the expression for the density of distilled water given by L. W. Tilton and J. K. Taylor (1937).

The sum of the squared residuals for the 86 observations was 0.01079. We shall estimate how much this sum can possible be reduced by using some better formula. The majority of the observations occur in groups of two, or more observations with closely spaced salinity values. There are 26 such groups. For each group the sum of the squared residuals cannot be reduced below the value resulting if the mean of the residuals in the group is zero. The corresponding minimum sum of the squared residuals for the 63 observations occurring in groups amounts to 0.00439. There are 26 isolated observations and these can be expected to contribute to the sum of the squared residuals in proportion to their number. This will increase the total minimum sum to 0.00599 corresponding to a mean square deviation of 0.0084. Of course it is not possible that any formula with a reasonable number of coefficients will be able to reproduce the centres of the groups exactly, and therefore even the best possible formula will give a sum of squared residuals larger than 0.006. It appears probable that only a minor part of this sum is due to experimental errors. It follows that the mean square deviation caused by variations in the composition of sea-water can be estimated at 0.008.

An attempt has been made to improve the formula submitted to this Committee in 1971 by giving it a form copied on the expression for the density of distilled water. The attempt has not been

successful, because the formula required thirteen coefficients, besides those determined by distilled water, to reduce the sum of the squared residuals to 0.00837, or by 22.4%, and the mean square deviation from 0.0113 to 0.0099, which does not justify such a large number of coefficients. Therefore, the formula shall not be submitted to the Committee.

REFERENCES

Tilton, L. W. and J. K. Tayler (1937), Accurate representation of the refractivity and density of distilled water as a function of temperature. J. Res. natn. Bur. Stand., 18, 205 - 214.

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