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Punched-card Treatment of Hydrographic Observations on the Electronic Computer IBM 650

By

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1) Computation of σ_t.

This is done by means of the formulae given in Knudsen's Tables. However, the formulae for σ_0 is rearranged to give σ_0 as a function of (S-35):

$$\sigma_0 = 28.1263 + 0.8060\ (S-35) + 0.00023\ (S-35)^2 + 0.0000068\ (S-35)^3$$

If S is between 34 and 36, as is the case with the majority of oceanic observations, σ_0 is given with sufficient accuracy by the simplified formula $\sigma_0 = 28.1263 + 0.8060\ (S-35)$, and accordingly, that formula is used when S is between 34 and 36. Otherwise, the complete formula is used. The expression $0.1\ (\sigma_0-28)$ is formed and stored for later use (in the program for $\Delta\alpha$).

2) Computation of $\Delta\alpha$ (anomaly of specific volume).

Is computed by means of a reduced form of Ekman's formula (the complete form of this formula for $\alpha_{S,t,p}$ is reproduced in Bjerknes: Dynamic Meteorology and Hydrography, 1910 x)). In similar manner as by Sverdrup (1933) advantage is taken of the fact that σ_t has been computed beforehand. The reduced formula reads:

$$10^6\Delta\alpha = 10^6\Delta_{St}(1-4.66 \times 10^{-6}p) + \alpha_{S,t,0} \times 10^{-3}p\left[G(t,p) + \frac{\sigma_0-28}{10}H(t,p) - 1.85+0.4 \times 10^{-4}p\right]$$

Δ_{St} is Sverdrups anomaly $= \alpha_{S,t,0} - \alpha_{35,0,0}$, and $\alpha_{S,t,0} = \dfrac{1}{1 + 10^{-3}\sigma_t}$. The functions G(t,p) and H(t,p) are given by

$$G(t,p) = t(28.33 - 0.551t + 0.004t^2 - 10^{-4}p(9.50 - 0.158t) + 1.5 \times 10^{-8}p^2)$$

$$H(t,p) = 147.3 - 2.72t + 0.04t^2 - 10^{-4}p(32.4-0.87t + 0.02t^2)$$

3) Oxygen percentage.

The saturation value of oxygen is computed by means of Truesdale's formula (see, e.g., Truesdale and Gameson, 1957), rearranged to give the result in ml/l. Division of observed oxygen in ml/l by the saturation value gives the oxygen percentage. (The formula reads:

$$O_{2sat.} = 9.909-0.2759t+0.005398t^2-0.0000452t^3-S(0.0588-0.00179t+0.0000262t^2)\ ).$$

4) Tests for correct card sequence.

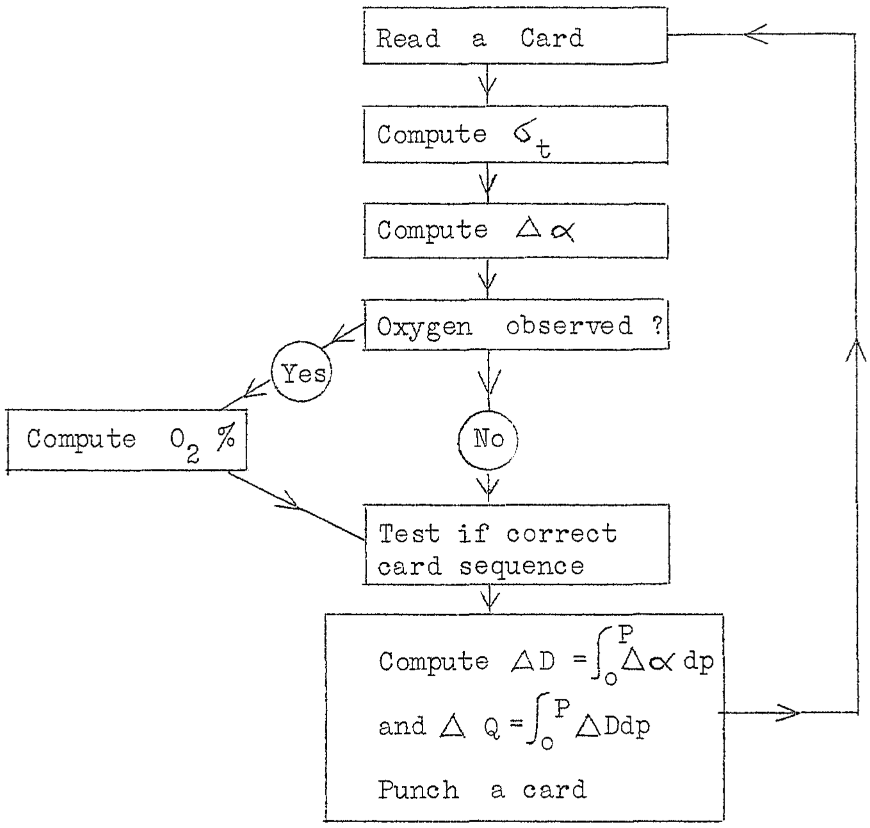
In order to give dynamic depths, the cards must, before they are fed into the machine, be sorted on ascending values of pressure (depth) within each station. Tests are made to ascertain that these conditions are fulfilled. Otherwise, the machine is programmed to stop. If the first card of a station has not zero pressure, the machine will also stop.

5) Dynamic depth and integral of dynamic depth.

The dynamic depth is accumulated progressively from zero pressure and downward. Simple linear interpolation is used. The integral of dynamic depth (Jakhelln's Δ Q, used for transport calculations), is computed in the same manner. Before punching out the results, the relevant quantities are transferred from the positions of "actual" values to the positions of values from "last" or preceding" card.

x) It should be noted that there are 2 printing errors in that formula, luckily in terms of minor importance: 1) in the third line of the formula (p. 31), the term $0.002\ t^2$ should be $0.02t^2$, and 2) in the fourth line, the sign before the term 0.1 t should be minus instead of plus.

Outline Block Diagram



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