NOMOGRAMS [1] FOR THE GRAPHIC DETERMINATION OF THE HORIZONTAL VELOCITY OF SOUND (V m/sec) FROM THE SALINITY (S‰) AND TEMPERATURE (t° C) OF THE SEA-WATER

by

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(Extract from " *Annalen der Hydrographie* ", Pamphlet IV of 15 April 1941, p. 105).

For the determination of the horizontal velocity of sound the principle here employed corresponds to that which was used in former years for establishing the group of curves for the graphic determination of the oxygen content [2] and the density of sea-water [3]. The basis of this diagram was the corresponding table, published by the British Admiralty, giving the horizontal velocity of sound in sea-water [4], which may be justly considered as the most accurate of its kind in this field.

Since, in the above cited article [2], we have already given the principle of construction of these diagrams, we shall give here only a few indications as to the method of using these nomograms. The essential feature is that every straight line drawn on the nomograms joins the three values of salinity (S ‰), temperature (t° C) and velocity (V m/sec) which can exist simultaneously. Therefore, there is given the possibility, if we know two of these values of determing the third. If we place a straight edge (if possible one that is transparent) to join two of the known values S ‰ and t° C, we may then read off on the scale of value of V m/sec. which is the velocity of sound sought [5].

In order to obtain a sufficiently large scale, the region to be represented is divided amongst two diagrams; one ranging from o to 20 ‰ S, and the other from 20 to 40 ‰ S. Further, on each diagram is a triple temperature scale with graduations from — 2° to 30° C. The scales which correspond are distinguished by special frames surrounding the figures. Still another peculiarity of Fig. 1 should be noted. The figures furnished by the English Tables show, for fresh water and for the range of temperature below 18° C, a deviation, increasing with the temperature, from the function which is used as a basis for the diagram.

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(1) *For the theory of these Nomograms see* " Traité de Nomographie" by Maurice d'Ocagne, 2nd edition — Gauthier-Villars, Paris 1921 (Note of I.H.B.).

(2) Kalle K., 1939. — *Some improvements on the determination of dissolved oxygen in sea-water.* — " Annalen der Hydrographie ", 1939 — 267-269.

(3) Kalle K. and Thorade H., 1940. — *Tables and Diagrams for the density of* sea-water. — Archives of the Deutsche Seewarte and Marine Observatorium — Vol. 60, N° 2.

(4) *Tables of the velocity of sound in pure water and sea water for use in echo-sounding and sound ranging.* — Hydrographic Department, Admiralty London, 1927, 21/22.
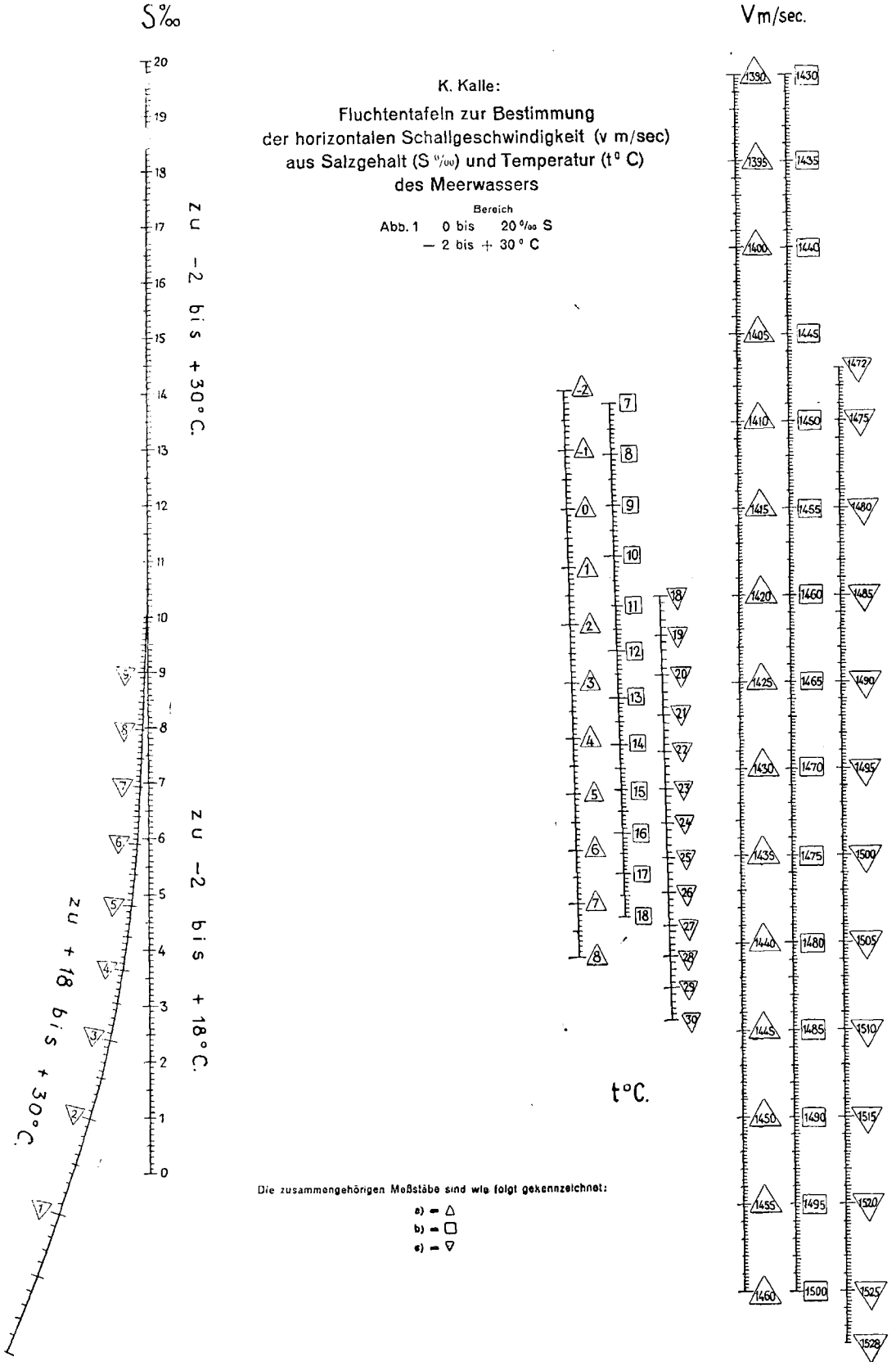
(5) *For greater ease in manipulation it is recommended to secure the end of a black thread by means of a thumb-tack to the lower left hand corner of the nomogram. If we then move this thread, which is manipulated with the right hand to pass it over a needle lightly pricked on the value of the salinity. (S ‰) in question, it is easy to read off the corresponding velocity of sound, after having moved the thread to make it pass over the point giving the corresponding value of the temperature.*

K. Kalle:

Fluchtentafeln zur Bestimmung
der horizontalen Schallgeschwindigkeit (v m/sec)
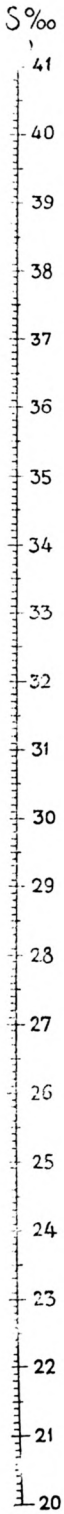aus Salzgehalt (S ‰) und Temperatur (t° C)
des Meerwassers

Bereich
Abb. 1   0 bis   20 ‰ S
          − 2 bis + 30 ° C

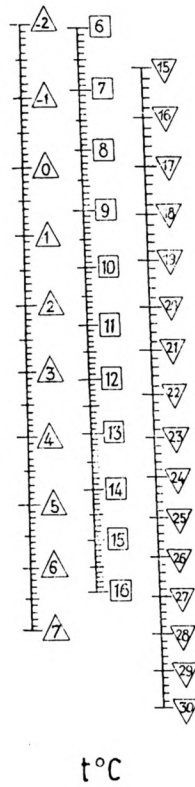Die zusammengehörigen Meßstäbe sind wie folgt gekennzeichnet:

a) = △
b) = ☐
c) = ▽

FIG. I.

S‰

41
40
39
38
37
36
35
34
33
32
31
30
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28
27
26
25
24
23
22
21
20

K. Kalle:

Fluchtentafeln zur Bestimmung
der horizontalen Schallgeschwindigkeit (v m/sec)
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des Meerwassers

Bereich
Abb 2   20 bis   41 ‰ S
          − 2 bis + 30 ° C

V m/sec.

t°C

Die zusammengehörigen Meßstäbe sind wie folgt gekennzeichnet:
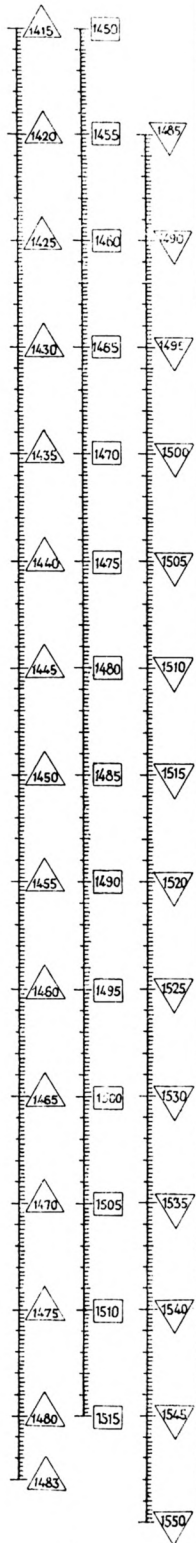
a) = △
b) = ☐
c) = ▽

FIG. 2.

It was therefore necessary to find a solution to make possible a graphic adaptation of the diagram to this peculiarity. The best solution of the difficulty seemed to be to reproduce on the left and below the curve branching off at 10 S ‰ on the salinity scale, carrying corresponding graduations of the S values. In practice, it is essential to remember that the normal S ‰ curve (straight line) should be employed for the range of temperatures from — 2° to 18° C and the curving branch of the scale S ‰ for the range from 18° to 30° C. We obtain, for instance, the following values :

S ‰	t° C	v m/sec.	S ‰	t° C	v m/sec.
1.00	25.00	1494.4	21.17	14.50	1486.2
2.00	16.00	1492.7	29.87	+ 2.00	1447.8
17.43	4.00	1440.7	39.79	27.00	1541.4

Nomogram for determining the horizontal velocity of sound (v m/sec) *from the salinity* (S ‰) *and the temperature* (t° C) *of sea water.*

from 0 to 20 ‰ S
from — 2° to 30° C

Indication of the corresponding scales

a) = △

b) = ☐

c) = ▽

from 20 to 40 ‰ S
from — 2° to 30° C

(6) *The figures have been reduced to one half size for reproduction in this Review.*