Technical Brief
December 2002

Practical Salinity of Seawater

Since it is not possible to directly measure the absolute salinity of seawater (the ratio of the mass of dissolved material to the mass of seawater), it is necessary to work in terms of practical salinity, which can be determined from measurable properties of seawater.

> "The practical salinity, symbol S, of a sample of sea water, is defined in terms of the ratio K of the electrical conductivity of a sea water sample of 15°C and the pressure of one standard atmosphere, to that of a potassium chloride (KCl) solution, in which the mass fraction of KCl is 0.0324356, at the same temperature and pressure. The K value exactly equal to one corresponds, by definition, to a practical salinity equal to 35."[1]

The practical salinity of seawater can be calculated from three measurable parameters: electrical conductivity, temperature, and pressure. Each of the three parameters is necessary for the salinity calculation since the electrical conductivity of seawater changes with temperature and pressure. Electrical conductivity of seawater is dependant upon the number of dissolved ions per volume (salinity), as well as the mobility of those ions (affected by temperature and pressure). The accuracy of the salinity "measurement" depends on the accuracy to which the three principal parameters can be measured.

The Practical Salinity Scale of 1978, endorsed by UNESCO/IAPSO, is currently the world standard for salinity calculation. It is used by all RBR CTD instruments for the calculation of seawater salinity. The salinity calculation is performed automatically in the RBR Windows® software using the equations on the following page.

[1] 'Algorithms for computation of fundamental properties of seawater', N.P.Fotonoff and R.C.Millard Jr., Unesco technical papers in marine science, Unesco 1983.

27 Monk Street • Ottawa, Ontario • Canada K1S 3Y7
(613) 233-1621 • fax (613) 233-4100 • info@brancker.com
www.brancker.com

Practical salinity, S, is calculated using the following equation(s) (IEEE Journal of Oceanic Engineering, Vol. OE-5, No. 1, January 1980, page 14):

$$S = a_0 + a_1 R_T^{1/2} + a_2 R_T + a_3 R_T^{3/2} + a_4 R_T^{2} + a_5 R_T^{5/2} + \Delta S$$

where

$$\Delta S = \frac{(T-15)}{1+0.0162(T-15)} * (b_0 + b_1 R_T^{1/2} + b_2 R_T + b_3 R_T^{3/2} + b_4 R_T^{2} + b_5 R_T^{5/2})$$

T is the in-situ temperature (International Temperature Scale 1968 or ITS-68). Since RBR loggers are calibrated to the more recent ITS-90 scale, the conversion to ITS-68 for salinity calculation is performed automatically in the RBR Windows® software.

$$R_T = \frac{R}{R_p r_T}$$

RBR Conductivity sensors measure R, which is the ratio of the conductivity of the sample of seawater, to the conductivity of standard seawater at S = 35, T = 15ºC, and p = 0. Conductivity(35,15,0) = 42.914mS/cm.

$$R = \frac{Conductivity(S,T,P)}{Conductivity(35,15,0)} = R_T R_p r_T$$

R_P and r_T are calculated to adjust for in-situ temperature and pressure:

$$R_P = 1 + \frac{p(e_1 + e_2 p + e_3 p^2)}{1 + d_1 T + d_2 T^2 + (d_3 + d_4 T)R}$$

$$r_T = c_0 + c_1 T + c_2 T^2 + c_3 T^3 + c_4 T^4$$

p is the in-situ pressure measured in bars.

Coefficients

	a	b	c	d	e
0	0.0080	0.0005	0.6766097		
1	-0.1692	-0.0056	$2.00564e^{-2}$	$3.426e^{-2}$	$2.070e^{-4}$
2	25.3851	-0.0066	$1.104259e^{-4}$	$4.464e^{-4}$	$-6.370e^{-8}$
3	14.0941	-0.0375	$-6.9698e^{-7}$	0.4215	$3.989e^{-12}$
4	-7.0261	0.0636	$1.0031e^{-9}$	$-3.107e^{-3}$	
5	2.7081	-0.0144			

27 Monk Street • Ottawa, Ontario • Canada K1S 3Y7
(613) 233-1621 • fax (613) 233-4100 • info@brancker.com
www.brancker.com