OFEG-TECH

Improving uncertainty of CTD measurements by making them traceable to SI units

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• The Practical Salinity Scale PSS 78
• The Traceability Chain
• Absolute Conductivity
• TEOS – 10
• Way Forward
Practical Salinity (PSS78)

A seawater of practical salinity 35 has a conductivity ratio of unity at 15°C with a KCl solution containing a mass of 32.4356g KCl in a mass of 1 kg of solution.

IAPSO Standard Seawater is available in sealed glass bottles, each containing ca.200ml of natural seawater. The bottle label carries information on its conductivity ratio (K15) and salinity according to the Practical Salinity Scale 1978 (PSS78).
The Practical Salinity Scale

- Practical Salinity is calculated from this scale which is based on a series of laboratory controlled determinations.
- It has no units or dimension. The algorithms in PSS78 were adjusted to eliminate…
  
**ppt, parts per thousand, */₀ₒ, p.s.u.**

- IAPSO Standard Seawater is the only internationally accepted transfer standard.
- Chlorinity is an independent chemical parameter not linked with salinity.

PRACTICAL SALINITY IS NOT TRACEABLE TO SI UNITS!
(i) **metrological reference**: definition of conductivity ratio of unit one according to PSS-78 (documentation)

(ii) primary measurement procedure: preparation of KCl-solutions and IAPSO-SSW; $G_{KCl}$ and $G_{SSW}$ measurements

(iii) \[ K_{15} = 0.99986 \]

(iv) measurement procedure for $R$; (vi) for CTD calibration: preparation of seawater bath, measurement procedure for $R$

not assigned

(v) \[ R = 0.999110 \]

(vi) CTD: sea-water bath

seawater sample

assign

(vii) conductance-meter, (typically a salinometer)

assign

(viii) measurement procedure for $S_{P,CTD}$

salinometer, conductivity meter

(v) \[ S_{p}(R) = 34.9650 \]

assign

(vi) CTD: sea-water bath

(vii) conductance-meter, (typically a salinometer)

assign

(ix) \[ S_{p,CTD}(t, p, G_{CTD}) = 34.8856 \]

assign

seawater sample

(viii) measurement procedure for $S_{P,CTD}$

conductivity, temperature-depth probe (CTD)

measurement system

uncertainty

quantity value

action

measurement result

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conductivity, temperature-depth probe (CTD)
Metrology of Ocean Salinity and Acidity

JRP 07e
Ocean Metrology

Limitation of the current state-of-the-art

Practical Salinity
Not SI traceable
Long-term data comparability not guaranteed

Scientific work packages

WP1 Traceability of Practical Salinity based on density standards
Up to high pressure (100 MPa)
89 PM

Impact

SI traceability for Standard Seawater
Transfer standard for CTD sensor calibration
precision positioning system

sample

movable piston

temperature sensor

Pt-electrodes

\[ K = \frac{\Delta l}{A \cdot \Delta R} \]
TEOS-10

• Salinity is connected to thermodynamic properties
• A reference composition for salinity measurements have to be defined
• Difference in compositions in different parts of the world’s ocean is accounted for by correction tables
Way Forward

• Absolute Conductivity Method has to be established (still work in progress)
• Alternatives have to be found like speed of sound and refractive index
• The relation between the measurement proxies and salinity/density will always stay ambiguous