Water-Air Partitioning of ^{222}Rn and its Dependence on Water Salinity

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Radon is well established as natural tracer for both the localization and the quantitative assessment of submarine groundwater discharge into the coastal ocean. Radon-in-water on-site detection (mainly as time series) is usually carried out by means of a mobile radon-in-air detector after radon gas extraction from a water pump stream into a re-circulating closed air loop. The approach relies upon the establishment of a concentration equilibrium of radon between the water pump stream and re-circulating air.

For converting the detected radon-in-air concentrations into the corresponding radon-in-water concentrations the water/air partition coefficient of radon ($K_{w/air}$) needs to be known. In natural waters $K_{w/air}$ can cover a range of one magnitude between ≈ 0.05 (hot saline water) and ≈ 0.5 (cold freshwater). While the temperature dependence of $K_{w/air}$ is generally allowed for, the influence of the water salinity on the radon solubility is often neglected. This is acceptable in freshwaters since here the salinity impact is rather insignificant. However, in salt-water environments, i.e. in the coastal sea, the salinity dependence of $K_{w/air}$ has significant impact on $K_{w/air}$. This, in turn, affects the quantification of radon-in-water concentrations if detection is based on the air-water equilibrium approach.

As a result of theoretical considderations and extensive laboratory experiments an equation was set up that allows quantifying the dependence of $K_{w/air}$ on salinity (S) and temperature (T; [K])[1]. In the equation β is the Bunsen coefficient and a1 to b3 refer to six adjustable parameters.

$$\ln \beta = a_1 + a_2\left(\frac{100}{T}\right) + a_3 \ln\left(\frac{T}{100}\right) + S\left\{b_1 + b_2\left(\frac{T}{100}\right) + b_3\left(\frac{T}{100}\right)^2\right\}$$

with $K_{w/air} = \beta \cdot T / 273.15$ and

a1 *(±)*	a2 *(±)*	a3 *(±)*	b1 *(±)*	b2 *(±)*	b3 *(±)*
-76.14 *(21.43)*	120.36 *(30.34)*	31.26 *(10.29)*	-0.2631 *(0.0345)*	0.1673 *(0.0230)*	-0.0270 *(0.0038)*

[1] SCHUBERT M., PASCHKE A., LIEBERMAN E., BURNETT W.C. (2012): Air-Water Partitioning of ^{222}Rn and its Dependence on Water Salinity. ***Environmental Science & Technology***, 46: 3905−3911.