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# Modelling of the radon exhalation from water to air by a hybrid electrical circuit for earthquake prediction

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To better understand the mechanism of Radon exhalation from liquid to air, a hybrid electrical circuit model has been introduced. Differential equations expressing changes in radon concentration in the gas and liquid phases can be written as

$$V_g \frac{dC_g}{dt} = -\lambda V_g C_g + F \tag{1}$$

$$V_l \frac{dC_l}{dt} = -\lambda V_l C_l + Q(C_0 - C_l) - F \tag{2}$$

Where $V_g$ and $C_g$ are volume and radon concentration in the gas phase, $V_l$ and $C_l$ are those in the liquid phase, $C_0$ is the original radon concentration in the groundwater before degassing, $\lambda$ is the decay constant of Radon, F is the degassing flux of radon from liquid phase to gas phase and Q is the flow rate of the groundwater.

The degassing flux of radon from liquid phase to gas phase can be written as

$$F = K_{tot}(C_l - \frac{C_g}{H})S$$

(3)
Where $K_{tot}$ is the total gas transfer velocity (m/s), S is the area of the boundary between liquid and gas phase and H is the Henry's law constant (H = $C_g$/ $C_l$ in an equilibrium state).

The component of $K_{tot}$ are the overall diffusive gas transfer velocity, $K_{ol,}$ and the bubble mediated gas transfer velocity , $K_{b,}$.

$K_{tot} = K_{ol+}K_b$ (4)

Where

$$\frac{1}{K_{ol}} = \frac{1}{K_w} + \frac{1}{K_a H} \tag{3}$$

Where $K_w$ is the transfer velocity in the water(m/s) and $K_a$ is the transfer velocity in the air (m/s)

$$K_w = \frac{D_w}{Z_w} \tag{4}$$

Where $D_w$ is the chemical molecular diffusion coefficient in water (at temperature of the water)($m^2$/s) and $Z_w$ is the thickness of the stagnant water film (m) .

$$K_a = \frac{D_a}{Z_a} \tag{5}$$

Where $D_a$ is the chemical molecular diffusion coefficient in air (at temperature of the air)($m^2$/s) and $Z_a$ is the thickness of the stagnant air film (m). We solved these coupled equations (1 and 2), using the finite element method for an actual system. Elaborating an active radon detector (RAD7), we measured the radon exhalation from liquid to a closed loop of air.

With comparing the results of the introduced model with the actual data for a proposed setup in the ICST lab, our model demonstrates the variation of the radon concentration efficiently. This model has significant applications in monitoring radon behavior in different geohazard disciplines including earthquake prediction and human health.