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Mass and Heat Transport Characteristics in Differently-Decomposed Peaty Soils at Variably-Saturated Conditions

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Peaty soils in wetlands are known as one of the major sources and sinks of global C and it is escaped as greenhouse gases to the atmosphere (e.g., Alm et al., 1999; Pilegaard et al., 2003). Knowledge of mass and heat transport characteristics in differently-decomposed and variably textured peaty soils at different moisture contents is important for simulating the emissions of the greenhouse gases, especially methane, from the wetlands (e.g., Alm et al., 1999; Pilegaard et al., 2003). Unique physical Characteristics of peaty soils such as high organic matter content, high total porosity and volume shrinkage may influence various transport properties of peaty soils. In this study, the analogies and differences between the soil transport parameters were investigated for differently-textured and variably-saturated soils and unified models were developed based on modified Archie s laws.

The study site was Bibai marsh, Hokkaido in Japan. Undisturbed peat samples were taken from three different sites in Bibai marsh at different depths using 100cm3 cylindrical cores. Peat 1 samples were sampled inside the marsh area, while Peat 2 samples were sampled from the area nearby a drainage ditch surrounding the marsh. Peat 3 samples were obtained from forested area located outside the wetland. Fiber contents showed that Peat 3 samples were the most decomposed followed by Peat 2 and Peat 1 samples. The peat samples were initially saturated and subsequently drained using two different methods corresponding to the matric suction ranges. The thermal conductivity (TC), gas diffusivity (Dp), air permeability (Ka) and unsaturated hydraulic conductivity (Kunsat) were measured at different soil moisture suction levels.

A percolation threshold was introduced for each heat and mass transport parameter and the normalized TC, Dp, Ka and Kunsat as a function of normalized fluid content suggested a strong analogy between these parameters. This analogy was well represented by an excluded volume expansion of Archie s second law. It showed a clear two-region behavior suggesting the applicability of the new two-region model concept for bimodal porous materials. However, each parameter showed its own characteristic behavior with different fluid contents. Model curves for the each transport parameter by using Archie s law with reference point (EXAR) were fitted well to the measured data for all transport parameters for both pore regions. And the consistent parameter values of the Archie saturation exponents (n) in two regions were obtained for three peaty soils. Thus, the EXAR models seem useful for describing the two-region behaviors of heat and mass transport parameters for peaty soils. In perspective further studies will be conducted to obtain all four parameters across same soil moisture conditions.

キーワード: Mass and heat transport, Peaty soil, Differently decomposed, Differently saturated
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