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Thermal diffusivity of peat, sand and their mixtures at different water contents

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Thermal diffusivity of peat, sand and their mixtures at different water contents was studied using the unsteady-state method described in (Parikh et al., 1979). Volume sand content in studied samples was 0 % (pure peat), 5, 10, 15, 20, 30, 40, 50, 55 and 62 % (pure sand).

Thermal diffusivity of air-dry samples varied from $0.6\times10^{-7}m^2s^{-1}$ for pure peat to $7.0\times10^{-7}m^2s^{-1}$ for pure sand. Adding 5 and 10 vol. % of sand didn't change the thermal diffusivity of studied mixture as compared with that of the pure air-dry peat. Adding 15 % of sand resulted in significant increase of thermal diffusivity by approximately 1.5 times: from $0.6\times10^{-7}m^2s^{-1}$ to $0.9\times10^{-7}m^2s^{-1}$. It means that small amounts of sand with separate sand particles distributed within the peat don't contribute much to the heat transfer through the studied media. And there is a kind of threshold between the 10 and 15 vol. % of sand, after which the continuous sandy chains are formed within the peat, which can serve as preferential paths of heat transport. Adding 20 and 30 % of sand resulted in further increase of thermal diffusivity to $1.3\times10^{-7}m^2s^{-1}$ and $1.7\times10^{-7}m^2s^{-1}$, which is more than two and three times greater than the initial value for pure peat.

Thermal diffusivity vs. moisture content dependencies had different shapes. For sand contents of 0 to 40 vol. % the thermal diffusivity increased with water content in the whole studied range from air-dry samples to the capillary moistened ones. For pure peat the experimental curves were almost linear; the more sand was added the more pronounced became the S-shape of the curves. For sand contents of 50 % and more the curves had a pronounced maximum within the range of water contents between 0.10 and 0.25 m^3m^{-3} and then decreased.

The experimental $k(\theta)$ curves, where k is soil thermal diffusivity, θ is water content, were parameterized with a 4-parameter approximating function (Arkhangelskaya, 2009, 2014). The suggested approximation has an advantage of clear physical interpretation: the parameters are (1) the thermal diffusivity of the dry sample; (2) the difference between the highest thermal diffusivity at some optional water content and that of the dry sample; (3) the optional water content at which the thermal diffusivity reaches its maximum; (4) half-width of the peak of the $k(\theta)$ curve. The increase of sand contents in studied mixtures was accompanied by the increase of the parameters (1), (2) and (4) and the decrease of the parameter (3).

References

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