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Modeling Soil Repellency

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It is a common opinion that the wettability or repellency of soils depends on the surface properties of soil particles, type of organic matter and associated contact angle. Among the others the wetting front displacement during infiltration and the capillary rise experiments are applied to determine the contact angle. In principle these methods are valid for cylindrical capillaries, while the real pores in soils have at least three different features: they are not either cylindrical or straight and they are interconnected. The consequences of non-cylindrical shape of pores on capillary rise are examined in this paper. Axis symmetrical, sinusoidal shaped capillary model has been applied to calculate the kinetics of capillary rise. Analytical formula for the capillary pressure and the meniscus rate as a function of rising height in such capillary has been found what provided the determination of rising kinetics for the variety of pore shapes and the assumed true contact angles.

Application of Washburn equation to the model output data gave possible to calculate the apparent contact angle, the apparent pore radius and to compare them with the assumed values. It was found that the capillary shape highly influences the value of apparent contact angle. It is strongly increasing function of the capillary wall waveness d– parameter describing the wall slope related to the meniscus movement direction.

Analysis of the capillary pressure formula shows that the water repellency in such a capillary should occur at the contact angle much lower than 90^0. The critical contact angle θ_c value, showing the limit between repellency and wettability, depends on the shape of the pores

$$ctg(\theta_c) = \pi * d$$

The experiments carried out with glass beds qualitatively confirm the theoretical pre-

dictions. Contact angle of water drop on a flat clean glass was found to be equal 27.4^0, while the value calculated from the capillary rise experiments on the powdered glass was almost 3 times higher. Surprisingly the apparent contact angle determined by the same method for sand and peat soils have the close values.

The above results can be summarized as fallow: the pore topology is an important factor determining the wettability and the repellency of soils.