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UNCERTAIN PHYSICAL PARAMETERS OF PEAT

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SUMMARY

Conventional methods to determine density and bulk density of peat do not account for physical characteristics of plant residues like inherent liquid and gas. Enlarging the density models by all phasing fractions of plants residues shows that in textbooks reported porosities, field capacities and out of it derived data are wrong. Even for strongly decomposed peat the electric charge of the solids are as high that the decision whether the water of the electric double layer belongs to the solid or to the free water.

KEY WORDS: peat, density, porosity, field capacity

INTRODUCTION

Important physical parameters of peat are

the density $\rho_s = \frac{m_s}{V_s} / \text{Mg} \cdot \text{m}^{-3}$ (1),

(dried material at 50 to 105 °C and $1.5 \pm 0.1 \text{ Mg} \cdot \text{m}^{-3}$)

the bulk density $\rho_b = \frac{m_s}{V_b} / \text{Mg} \cdot \text{m}^{-3}$ (2),

the volume of substance per unit volume of peat V_b $V_{bs} = \frac{\rho_b}{\rho_s} / \text{m}^3 \cdot \text{m}^{-3}$ and

the volume of pores per unit volume of peat V_p $V_p = V_b - V_{bs}$ with $V_b = 1$ or 100 %

with m = mass/Mg, V = volume/ m^3 , s = solid, b = peat and p = pores (DIN 19683, 1973; Schweikle, 1990; AG Boden, 1994; Zeitz, 2001).

ρ_s is useful to calculate the amount of mineral material in the peat.

ρ_b is an excellent reference of the density distribution of elements and compounds in a unit volume of peat.

But ρ_s and ρ_b don't explain, why peat swims or floats and why water doesn't flow through peat despite extremely high porosity of 90 % and higher. Therefore textbooks have been looked up for physical characteristics of plant residues, resp. organic matter.

METHODS

Evaluation of textbooks for physical characteristics showed, that

- low decomposed organic matter contains solids, liquids and gases (Sitte *et al.*, 2002) and
- high decomposed organic matter has a very high electric surface charge (cation exchange capacity = CEC), which interacts with the water dipoles (l.c. Hillel, 1980).

RESULTS AND DISCUSSION

Introducing the nature of plants like mass and volume fractions of liquids and gases in equations (1) and (2) results in

$$\text{the density of organics} \quad \rho_o = \frac{m_s + m_l + m_g}{V_s + V_l + V_g} / \text{Mg} \cdot \text{m}^{-3} \quad (3) \quad \text{and}$$

$$\text{the bulk density of organics} \quad \rho_{bo} = \frac{m_s + m_l + m_g}{V_b} / \text{Mg} \cdot \text{m}^{-3},$$

with o = organic matter, l = liquid and b = gas.

The high porosities of peat of > 90 % of V_b result from adding volumes of liquid and gas in the plants to the pores outside the plants, due to inappropriate methods in soil physics, neglecting physical characteristics of plants. This is true also for the field capacity. Reported porosities in textbooks should be reduced by a factor of 0.5 and smaller. But the volumes of equivalent pore size diameters at potentials between 0 and – 0.5 MPa are measurable with ceramic plates. They are not measurable at potentials < – 0.5 MPa.

The density of organic matter depends on the volumes of liquids and gases. If $\rho_o < 1$ peat swims (like floating mire), if $\rho_o = 1$ it floats and if $\rho_o > 1$ it goes down. Submarines follow the same principle (Marconi, 1969).

Even the load of peat on the underground is not known, due to unknown ρ_o as a consequence of not determined V_l and V_g (with negligible m_g).

Highly decomposed peat does not have intracellular volumes of liquids and gases, but it has a very high electric surface charge interacting with water dipoles and forming an electrostatic double layer on the solid surface of the organic solid matter (Hillel, 1980). The electrostatic double layer reduces the flux of water at low pressure gradients in loamy soils by 75 % and in clayey soils by 97 % compared with nonpolar fluids (Schweikle, 1982). Introducing this linkage force in ρ_o gives

$$\rho_o = \frac{m_o + m_{lex}}{V_o + V_{lex}} / \text{Mg} \cdot \text{m}^{-3},$$

with lex = attached liquids on the surface of solids. The thickness of the electrostatic double layer, especially the diffuse fraction, depends on a potential gradient parallel to the surface of the solid matter; ρ_{lex} is not constant.

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