# Influence of Phosphate Sorption on Dispersion of Ferralsol Soils
## Ferralsol 土壌の分散に及ぼすリン酸収着の影響

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***Abstract***

Dispersion is an important issue in evaluation of stability of soil. Phosphate (P) is sorbed strongly in Ferralsols. Therefore, crops cannot easily absorb it. The influence of P sorption on the soil structure, specifically on soil dispersion and flocculation (soil D/F) has not been studied well until now. In this study, the effect of P on Ferralsol soil D/F was studied at different pHs in batch method. The zeta potential of the soil was measured to evaluate the effect of electrical properties of the charged soil particles on soil D/F. P sorption increases with the decrease of pH and the increase of added P concentration. At higher pH, the soil disperses well except higher electrolyte concentration. At lower pH, the soil flocculates well at lower electrolyte concentration. However, it tends to disperse with the increase of P sorption. The soil becomes flocculative at higher P sorption due to higher electrolyte concentration. The zeta potential depends on pH and P sorption. Absolute value of zeta potential gradually becomes larger with the increase of P sorption amount until around 10 mg P/kg. After that, it decreases with the increase of P sorption amount due to higher electrolyte concentration. The soil suspension condition at larger absolute zeta potential corresponds with the well dispersion condition. As the zeta potential relates to the repulsive electrostatic force between soil particles, the soil D/F condition can be evaluated with the zeta potential.

**1. Introduction**

In Ferralsols, the major clay minerals are kaolinite, aluminum and iron oxides. These charged particles can sorb P. Crops cannot easily absorb the sorbed P. When the phosphate fertilizer in the soil flows down to water environment by erosion, water is contaminated. The impact is more drastic if the soil becomes dispersive. On the other hand, the multiple ions phosphate adsorbed and changed the colloidal clay materials.[1] And zeta potential is an important parameter of the electrical double layer of clay particles in soil solution. Zeta potential is the electrical potential near the solid-liquid interface obtained by using electrophoretic mobility. Zeta potential represents a characteristic of electrical properties of solid/liquid interface.[2] The addition of phosphate to soil samples with a net charge of zero lowered the zero point of charge producing particles with a net negative charge.[3] Thus, it can make zeta potential vary. For the good water resources management and soil conservation, the research was conducted to evaluate the influence of phosphate sorption on dispersion of Ferralsol soil.

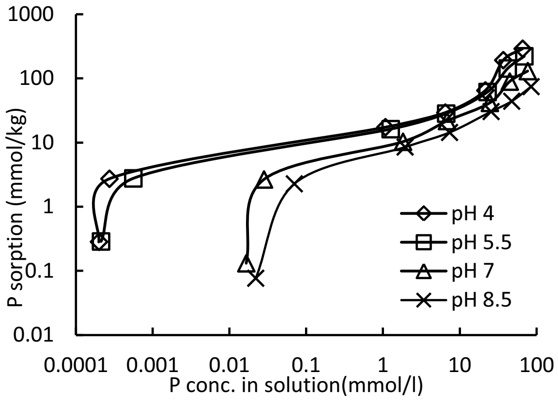


***Fig. 1. P sorption and P concentration***

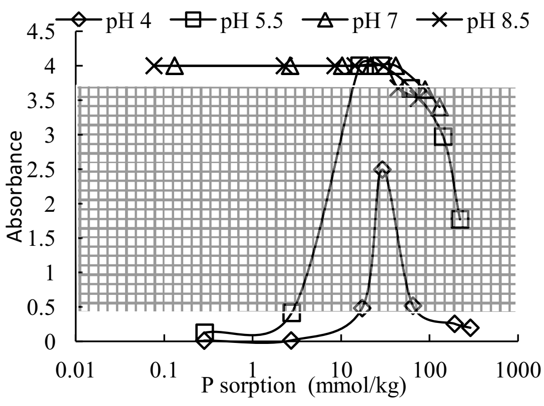


***Fig. 2. P sorption and Absorbance***

**2. Material and Methods**

***2.1. Materials.***

Ferralsol soil sampled at 10cm depth in central Vietnam was used. Soil texture is light clay; sand (29.39%), silt (29.35%) and clay (41.26%). The minerals present in the clay fraction (<2μm) were quartz (61%), kaolinite (34.4%) and goethite (4.6%). Soil samples were air-dried and sieved <2mm size before doing experiment.

***2.2. Methods***

- *Adsorption experiments*. P sorption at different pH (pH = 4, 5.5, 7, 8.5) and at different input P concentration (0.03, 0.3, 3 10, 30, 60,100 mmol$_c$ P/L) by using $NaH_2PO_4$ was determined by using a batch method. The electrolyte concentration was controlled at 10 $mmol_c$ /L. HCl and NaOH were used to adjust prescribed pHs. The sorption amount was calculated by subtracting the P amount remaining in the solution in the soil suspension from the input P amount.

- *Dispersion flocculation (D/F) experiments.* The same soil solution as those in adsorption experiment was prepared. That was shaken well and stood still for 3 hours, and 4 $cm^3$ of the supernatant was taken from 2 cm below the water surface. Its absorbance was measured with 660 nm wavelength using 10mm cell.

- *Zeta potential.* The same soil solution as those in adsorption experiment was prepared. That was shaken well and soon 4 $cm^3$ of the suspension was taken from 2 cm below the water surface. It was mixed with the same electrolyte concentration solution to dilute the proper suspension density for the zeta potential measurement. Its zeta potential was measured.

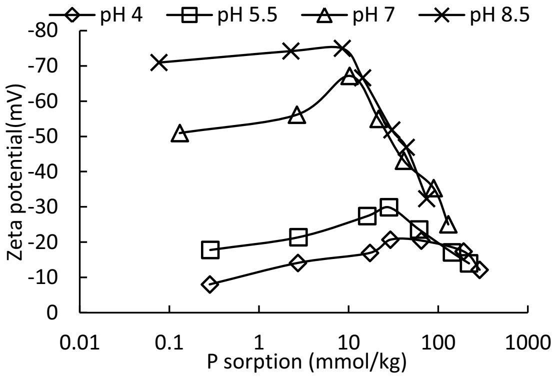


***Fig. 3. Zeta potential and P sorption***

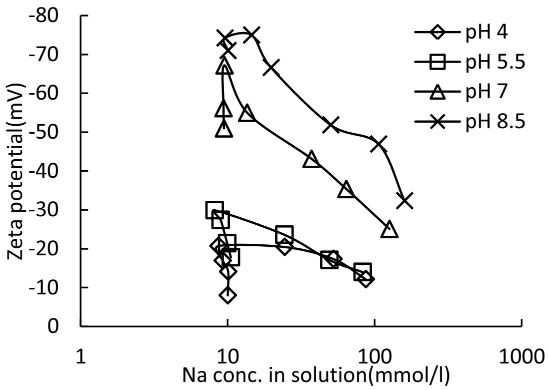


***Fig. 4. Zeta potential and Na concentration in solution***

**3. Results and Discussion**

Fig. 1 indicates that the P sorption increases with the increase of P concentration. The P sorption increases with the decrease of pH (Fig 1).

The result of dispersion flocculation experiment is shown in Fig. 2. When the absorbance is more than 3.7, the soil suspension is well dispersed. When the absorbance is lower than 0.4, the soil suspension is well flocculated. When the absorbance is between them, the soil suspension is partly dispersed. At pH 4, the soil suspension is well flocculated at the lower and higher P sorption, while it is partly dispersed at the middle. At pH 5.5, it is well flocculated at the lower P sorption, partly dispersed at the higher P sorption, while it is well dispersed at the middle P sorption amount. Meanwhile, at pH 7&8.5, the soil suspension is dispersed well both of lower and middle P sorption but it becomes partly dispersed at the higher P sorption.

Fig. 3 indicates that zeta potential varies with an effect of both pH of soil solution and P sorption. At low P sorption amount absolute value of zeta potential increases to highest value with increasing until about 30 $mmol.kg^{-1}$ P sorption (pH 4&5.5) and about 10mmol/kg (pH 7&8.5). When P sorption exceeds these amounts, zeta potential is less negative. When absolute value of zeta potential is larger, soil becomes more dispersive because larger electric potential near the soil surface generates electric repulsive force among soil particles. Thus, the interparticle forces between soil particles predominating is repulsive forces. Moreover, the variation of zeta potential relates to electrolyte concentration of solution (Fig. 4). At low Na concentration (about 10 $mmol_c$ Na/L), zeta potential becomes more negative when P sorption amount increases. Absolute zeta potential value decreases, however, with the increment of Na concentration in solution (>10 $mmol_c$ Na/L) due to the shielding effect of the electric field.

**4. Conclusion**

It is obvious that P sorption affects zeta potential and dispersion of soil. When P sorption increases, soil becomes more dispersive. Soil is less dispersive at high electrolyte concentration of solution. Zeta potential is more negative when soil is dispersed and more positive if soil is flocculated.

**5. Reference**

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