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Effect of Acid and Alkali Treatment on Physical and Surface Charge Properties of Clayey Soils

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Abstract : Most of the surface related phenomena in the case of fine-grained soil are attributed to their unique surface charge properties and specific surface area. The temporal variations in soil behavior, to some extent, can be credited to the changes in these properties. Among the multitude of factors that affect the charge and surface area of clay minerals, the inherent system chemistry occupies the cardinal position. The impact is more profound when the chemistry change is manifested in terms of the system pH. pH plays a significant role by modifying the edge charges of clay minerals and facilitating mineral dissolution. Hence there is a need to address the variations in physical and charge properties of fine-grained soils treated over a range of acidic as well as alkaline conditions. In the present study, three soils (two soils commercially procured and one natural soil) exhibiting distinct mineralogical compositions are subjected to different pH environment over a range of 2 to 13. The soil-solutions prepared at a definite liquid to solid ratio are adjusted to the required pH value by adding measured quantities of 0.1M HCl/0.1M NaOH. The studies are conducted over a range of interaction time, varying from 1 to 96 hours. The treated soils are then analyzed for their physical properties in terms of specific surface area and particle size characteristics. Further, modifications in surface morphology are evaluated from scanning electron microscope (SEM) imaging. Changes in the surface charge properties are assessed in terms of zeta potential measurements. Studies show significant variations in total surface area, probably because of the dissolution of clay minerals. This observation is further substantiated by the morphological analysis with SEM imaging. The zeta potential measurements on soils indicate noticeable variation upon pH treatment, which is partially ascribed to the modifications in the pH-dependant edge charges and partially due to the clay mineral dissolution. The results provide valuable insight into the role of pH in a clay-electrolyte system upon surface related phenomena such as species adsorption, fabric modification etc.

Keywords : acid and alkali treatment, mineral dissolution , specific surface area, zeta potential
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