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Antibiotic Sorption Using the Clay from Wushanding Mud Volcano, Taiwan

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In this study, we investigated the sorption of tetracycline, a common antibiotic, using the clay from Wushanding Mud Volcano, which is near the village of Yanchiao, about twenty kilometers northeast of Kaohsiung City in Taiwan.
Antibiotics are microbial metabolites or synthetic analogs, which can inhibit microbial growth or kill them, and there are not serious side effects when people take them. Long-term and widespread use of antibiotics for the treatment of disease, prevention of disease, and promotion of animal growth lead to a big issue of environmental contamination. It is because that the antibiotics can not be completely absorbed by the organisms. There are about 90% of the antibiotics that will be in the form of a prototype or metabolites by patients and animals. They have been discharged into the environment and would consequently cause strong effects on natural water, soil and microbial ecosystem through the sportive behavior by soil minerals and humid materials. Long-term use of antibiotics to humans and animals has been resulted in the generation of resistant strains, which make the treatment very difficult for the increase of incidence diseases. Therefore, the detection and recovery of the presence of antibiotics in the environment is very important.
Clay minerals have the basic building units of the two major compositions, the Si-O tetrahedron and Al-O-H octahedron. They are divided into seven major groups including kaolinite group, clay mica, illite group, smectite group, chlorite group, mixed-layer group and the other, which is based on the chemical composition and atomic structure. In this study, the clay from Wushanding Mud Volcano contains 67.6 $\sim$ 71.5% illite, 7.6 $\sim$ 9.9% chlorite, 12.8 $\sim$ 14.2% kaolinite, 1.2 $\sim$ 1.4% smectite (Shih et al., 1967 and Chan, 2001). The Scanning electron microscope (SEM) images show a sheet structure.

The results showed that adsorption kinetic is consistent with pseudo second-order kinetic model. The figure is fitted to H-type adsorption curve. The sorption has already be over 50% of max sorption equilibrium amount in 15 minute. XRD analysis is mainly to investigate the variations of interlayer spacing of clays when tetracycline has been absorbed by the clay minerals. The variations of the d-spacing cannot be found in different pH values with the initial concentration of 200ppm tetracycline. Those results showed no shift in d-spacing and confirmed the clay adsorption with tetracycline is the surface adsorption. It might be because that the clay from mud volcano consists 67.6 $\sim$ 71.5% of non-expanded form of illite.

Fourier Transform Infrared Spectroscopy (FTIR) has also been used for the characteristics of the functional groups absorbed on clay by the wavelength position. TG analyses for the clay minerals before and after adsorption of the tetracycline were carried out for the investigation of adsorption machismo, either surface adsorption or intercalation between layers. The experimental conditions were heated to 600 degrees, 10 degrees per minute. In the study, the temperature to remove water from the clay is 215 degree. This temperature peak decreased when the tetracycline was absorbed. This result is quite different with rectorite. It suggested that tetracycline has been adsorbed on the surface of the clay with low thermal stability. This also proved that with 67 $\sim$ 71% illite of the clay from mud volcano, the adsorption of tetracycline mainly occurs on the surface.