Ammonia Interactions with Soil Minerals

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Ammonia may be adsorbed on soil minerals by a variety of reactions. These reactions are extremely important from the standpoint of fertilizer usage for two reasons: First, the adsorption itself prevents loss of ammonia to the atmosphere and so preserves it in the soil for plant and microbiological use; second, some of the adsorption mechanisms convert the ammonia gas, which is toxic to living matter, to ammonium ion, which can be utilized by microorganisms and by plants for their metabolism.

The mechanisms of adsorption of ammonia on minerals range from chemical reactions which bind the ammonia very strongly to physical adsorption where it is bound very weakly, with a complete gradation of adsorption energies within these extremes (18, 19). The chemical reactions require specific adsorption sites on the mineral surface with which the ammonia can react. The bond formed by the reaction is very strong and a great deal of energy is required to reconvert the compound back to ammonia. Consequently, these sites are very important in retaining the ammonia so that it does not desorb from the mineral surface into the gas phase and be subsequently lost to the atmosphere. On the other hand, physical adsorption on mineral surfaces takes place only when there is a positive pressure of ammonia in the soil as for example on injection of the material into the soil. As soon as the pressure of ammonia in the gaseous phase becomes low, the physically adsorbed ammonia will go back into the gaseous form and diffuse through the soil until it can react chemically with a mineral or organic matter surface or is possibly lost to the atmosphere.

The size and kind of minerals in soils affect the amounts of ammonia which may be adsorbed. Generally, the amount of adsorption is proportional to the surface area of the adsorbent. Thus, a sandy soil has a lower specific surface (surface area per unit weight) than a clay soil and its capacity for adsorption of ammonia is consequently lower. A general observation has been that losses of ammonia after application of anhydrous ammonia are more likely on the sandy than the heavy soils. Even in sandy soils, the clay fraction is usually the most important mineral portion with respect to the adsorbing properties. A relatively