Air pollution from animal and municipal wastewater: assessment of production and release of noxious gases

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Airborne contaminants and odor from animal manure and municipal wastewater can affect human physical and psychological health, and the environment. The estimation of gas emission rates and development of technologies to reduce the release of noxious gases from wastewater is limited by current knowledge on the production pathways of gases and the release mechanisms from various sources. The objectives of the present PhD were: (i) to study the effects of waste management (such as, surface disturbances during storage, acidification and aeration) on gaseous emissions from wastes, (ii) to study the hydrolysis of urea by bacteria in the slurry and identify important factors effect NH3 production, and (iii) to study gaseous emissions from various types of animal manure and municipal wastewater in relation to the wastes physicochemical characteristics.

First, the effect of slurry surface disturbance caused by animal excretion on emission of ammonia, carbon dioxide, and hydrogen sulfide was studied. A second investigation was carried to measure gas pollutants from four animal manure (swine manure, dairy manure, beef manure and layer hen manure) and municipal wastewater. To further understand the production of ammonia from animal manure, a determination of urease activity in faeces and fresh manure was conducted. Finally, we investigated the emission of ammonia, carbon dioxide and hydrogen sulfide during and after slurry acidification treatment, and evaluated the effect of pH, mixing and aeration on gas release.

The results of this PhD study suggest that future estimation of gases emission should consider transient-state conditions, especially in the case of H_2S, as occupational exposures and the associated health risks will be highly underestimated if the evaluation of exposures to H_2S is based on emissions from slurries stored under undisturbed conditions. The convective mass transfer governed NH_3 release, while bubble-release was dominant in the releases of CO_2, H_2S, and SO_2. The physicochemical characteristics of different types of wastes (e.g., the total nitrogen, total ammoniacal nitrogen, dry matter, and pH) had great influence on the releases of NH_3, CO_2, H_2S, and SO_2. The investigation of enzyme-kinetic parameters contributes to a better understanding of the urea hydrolysis process in manure, provides the basis for further studies of enzymatic degradation process in manure, and the obtained enzyme-kinetic parameters (V_{max} and K'_m) can be utilized in prediction modeling of ammonia production rates and thus ammonia volatilization from animal productions. The results of the acidification study showed that slurry acidification can reduce ammonia emissions by 50-77% and has no significant effect on CO_2 and H_2S emissions during treatment and subsequent storage.