RESEARCH ABSTRACT

ENVIRONMENT

Title: Removal of Volatile Organic Compounds from Swine Facilities via Adsorption: Technical and Economic Evaluation - **NPB #12-072**

Investigator: Praveen Kolar

Institution: North Carolina State University

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Scientific Abstract: The purpose of this research is to evaluate biochar as an inexpensive adsorbent for mitigation of odorous volatile organic compounds from swine lagoons. Biochar was synthesized from discarded pinewood, swine manure, and coconut shell via pyrolysis and gasification (two most popular) techniques, respectively. Briefly, pinewood was impregnated with K_2CO_3 (impregnation ratio: 2) and pyrolyzed at 266 °C for 2 h to obtain pinewood biochar. Surface characterization of pinewood biochar indicated that the acid value increased from 5.01 to 9.29 as a result of K_2CO_3 and pyrolysis. Batch experiments were performed in which, 1g of pinewood biochar was mixed with 100 mL of *p*-cresol solution (50- 1000 mg/L) at 15-45 °C. Samples were drawn periodically and analyzed via gas chromatograph equipped with a mass selective detector. The data indicated that a theoretical maximum adsorption capacity of 6.97 mg/g was possible at 25 °C for *p*-cresol). The thermodynamic analysis revealed that adsorption of p-cresol was exothermic ($\Delta H° = -2.11$ kJ/ mol) suggesting that lower temperatures favor higher adsorption capacities possibly due to p-cresol-char bond disruption at higher temperature. In addition presence of another VOC, 2 methylbutyraldehyde did not reduce or inhibit adsorption of either p-cresol or 2 methylbutyraldehyde, suggesting that pinewood biochar may adsorb VOC mixture simultaneously. In the second part of the research swine manure was used as raw material for preparation of biochar via gasification. Dried swine manure (40% moisture) obtained from NC State swine farm was gasified at 704 °C for 15 min using a mixture of nitrogen (25 parts) and air (1 part) to obtain swine manure biochar. Boehm titration analysis indicated that the biochar consisted predominantly of basic surface functional groups perhaps due to presence of ammonia in the manure. The swine manure biochar was tested for mitigation of *p*-cresol in batch experiments that were performed at 25, 35, and 45 °C to determine the kinetic, isotherm, and thermodynamic parameters. The data indicated that swine manure biochar may adsorb up to 14 mg/g of *p*-cresol irreversibly. Unlike pinewood biochar, the adsorption process of p-cresol on manure char seemed to be endothermic ($\Delta H° = 6.3$ kJ/ mol) suggesting that higher temperatures favor higher adsorption capacities, perhaps due to availability of higher pore volume and chemisorption rates at elevated temperatures. As the concentrations of *p*-cresol and other odorous VOCs are usually less than 5 mg/L, adsorption capacities obtained in our research are considered adequate for optimum mitigation of these aforementioned pollutants. But the biochar obtained from these thermochemical processes (pyrolysis and gasification) possess low structural integrity. Hence to be able to apply in lagoons, the biochar needs to be structurally stable. Hence we prepared biochar from coconut shell and tested its efficacy extensively. Our results indicate that coconut shell biochar can remove up to 30 mg of p-cresol per gram of biochar. In addition the biochar derived from coconut shell was extremely stable and was able to maintain its form even after several experiments. Our research is expected to have significant positive implications on air and water quality in and around swine facilities