RESEARCH ABSTRACT
ENVIRONMENT

Title: Recovery of phosphorus and fine particles as fertilizer from swine manure by electrocoagulation – **NPB #15-037**

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Scientific Abstract

Swine manure typically contains total solids between 1% and 5%, and approximately half of the solids has particle sizes equal to or less than 45 microns. The fine particles poses challenges to solid-liquid separation, so that a substantial amount of solids still remains in the separated liquid layer after natural sedimentation, centrifugation or drum screen. The issue is further worsened by the fact that an appreciable amount of phosphorus exists in the fine particles. Anode oxidation of certain metal electrodes releases metal ions that can work as coagulants, binding phosphate and neutralizing fine particles which form larger ones to precipitate or to be flocculated. This study proposed to adopt electrocoagulation (EC) technology to recover phosphorus and fine particles from swine manure to increase its fertilizer value. The objectives of this study include: 1) optimization of electrocoagulation for phosphorus and fine particles recovery from swine manure; 2) pilot scale demonstration and techno-economic analysis of the process; 3) integration of the new electrocoagulation process with current manure management practice. The study found that EC using low carbon steel effectively removed P and fine particles from the liquid manure collected from the two manure management systems of lagoon storage and deep-pit storage. Although particle size change was not obvious, settling ability of swine manure particles were improved so that natural sedimentation is effectively to separate the liquid and solids phase after EC treatment. More costly separation methods, e.g., centrifuge and filtration, were not necessary in S/L separation process. The achieved results are promising since 79.5% and 91.6% of P was recovered from flushed manure, while 73.0% and 83.1% of P from deep-pit manure, resulting in concentrated P contents (5.83% to 9.24% of P_2O_5 in dry matter) in sludge in our pilot study. The resulting sludge had small N:P ratios of 0.52-0.53 and 0.67-0.78 for each manure types in respective. The process also substantially increased N:P ratios in supernatant. For example, the untreated flushed manure had a N:P ratio of 1.72, and deep-pit manure of 2.45. After EC treatment and sedimentation, the supernatant was more N concentrated, with N:P ratios of 17.2-38.7 and 10.7-13.3 for each manure type. The changes of nutrients proportion makes the manure more suitable to be applied in nearby croplands with reduced P loading, indicated an environmental benefit of less P runoff going to nearby receiving water bodies. The pilot-scale EC skid installed on campus swine barn had a capacity of treating 100 L/day (or 8 hrs). The total cost of setting up this skid was $3539. Manure production capacity in a typical 2400-head barn was estimated to process 20.79 thousand m^3/yr of flushed manure, or 2.175 thousand m^3/yr of deep-pit manure. Cost analysis for a scale that treats all the generated manure plus operating costs showed a net present value of the investment would be $447,647 for flush system, and $148,082 for deep-pit system. The present analysis did not take into account of the environmental benefits of P removal, the benefits of more nutrient-balanced manure, and the value of the P-enriched sludge as a potential fertilizer. A full techno-economic analysis, or cost-benefit analysis will better elucidate the entire social-economical value of the technology.