MARTIN SCHWALBE

by TREENA HEIN

manure

Researching how to reduce odours from hog operations is important in building good community relationships between producers and their neighbours.

Manure odour is caused by anaerobic bacteria, which are found in the oxygen-free environments of the pig gut and the liquid manure tank. These produce smelly organic compounds that contain sulphur and nitrogen. Reducing the number of these bacteria reduces the odour, but which method of killing bacteria is most effective?

Nigel J. Bunce, Professor of Chemistry, Research Associate Dorin Bejan and Lisa Rabson, who will shortly start her M. Sc. in the Department of Chemistry at the University of Guelph, have previously shown that flowing an electric current through liquid hog manure, using a process known as electrolysis, can kill bacteria effectively on a small scale.

Even though there are challenges, using electrolysis is advantageous to chemical treatment of manure because it requires less complicated equipment and can be accomplished at ordinary temperature and pressure. Additionally, Bunce says, "reducing odour with electricity costs less than using chemicals."

Electrolysis involves electric current being applied between two inert electrodes (an anode and a cathode) immersed in a liquid and driven by an electrical power supply. Electrolysis in liquid hog manure kills anaerobic bacteria in several ways. Hydroxyl radicals formed at certain types of electrodes are highly destructive to bacteria and all other living cells. Additionally, the anodes of the circuit generate oxygen, which is toxic to anaerobic bacteria. Bacterial death also results from the formation of toxic hypochlorite ions, created through electric oxidation of the chloride already present in the manure.

In addition to obtaining data on the effectiveness of electrolysis in reducing bacteria in manure, the scientists have demonstrated that electric current does not affect the amount of fertilizer nitrogen, potassium and phosphorus in manure. However, the small scale of these experiments, which involved small electrochemical reactors, left the research team wondering whether odour reduction could be achieved using a similar process, but on a larger scale.

In experiments carried out during 2006, Bunce and his associates constructed a one-litre and a 27-litre model, of which the latter was used in an on-farm demonstration. Raw manure samples were collected from the swine research unit of the Arkell Research Station at University of Guelph. Most samples were collected from deep in the lagoon by means of a sewage pump. Samples were returned to the lab and stored at 37 C to maintain bacterial populations.

The team then studied the effect on manure odour of running constant current through the samples at different current levels for varying treatment times. Notes Bunce: "In order to determine if the current is a major factor contributing to the bactericidal effects of the electrolytic treatment, the current was varied from 25 milliamperes (mA) to 150 mA, but the total charge passed through the manure was kept constant."

Bacterial populations were typically reduced by an impressive two orders of magnitude, with electrolysis at 50 mA for six hours, reducing counts by three orders of magnitude. Electrolysis at the low current of 25 mA was unsuccessful in these experiments, Bunce says. "Our results suggest bactericidal effects of electrolysis depend on the amount of charge passed rather than applied current or length of treatment."

The scientists also experimented with using several types of anode materials with different electrochemical properties, and measured which materials killed the most bacteria. These materials included Ti/IrO2, an anode material used in the industrial production of chlorine, as well as boron-doped diamond, a recently developed material which is too expensive to be used on a large scale at present. The cathodes were composed of stainless steel.

In small-scale tests, the team found that killing efficiency was not greatly dependent on which anode material was used. "Reductions in bacterial count of one to two orders of magnitude were consistently achievable," says Bunce. Boron-doped diamond, an anode material which generates hydroxyl radicals, performed somewhat better than the other electrode materials.

However, the efficiency of electrolysis in killing bacteria and reducing odour was influenced by the solids content of the manure. Bunce says that small manure samples treated in the lab to break up solids showed a better odour rating after electrolysis than normal samples. This result was surprising in view of the successful operation of the 27-litre reactor in the on-farm demonstration, which involved whole manure.

Bunce says that this set of experiments allows his team to conclude that constant current electrolysis is successful in reducing both odour and bacterial counts. "These results generate optimism that a technology can be developed in which the control of the population of (especially) anaerobic bacteria through continuous or semi-continuous moderate current electrolysis will succeed in controlling the production of odour-causing substances."

The team is planning further studies involving more field treatments at a scale of 1,500 litres, which will identify the lower limit of applied current needed and the optimum treatment period required to reduce bacterial populations and odour in manure on a large scale.

Funding for this research was provided by Ontario Pork and the Natural Sciences and Engineering Research Council of Canada (Collaborative Research and Development Program).