Pig Manure and Odour

Dorin Bejan and Nigel J. Bunce
Department of Chemistry, University of Guelph,
Guelph, Ontario N1G 2W1, Canada
e-mail: dbejan@uoguelph.ca/nbunce@uoguelph.ca

Offensive odours from large-scale hog operations are the subject of increasingly adverse public attention due to the land disposal of liquid manure. Odour components are formed by anaerobic bacteria reducing organo-nitrogen and –sulfur compounds in the anoxic environments of the porcine gut and liquid manure tank. Purging the liquid manure tank with air is insufficient to achieve and maintain oxygenated conditions because of the high bacterial load and biological oxygen demand. This research involves electrochemical oxidation in reactors with different anodes to "neutralize" the odour of hog manure immediately prior to land disposal.

Odour nuisance is poorly defined, both scientifically and in the regulatory framework. We defined the ***quality*** of smell as follows: **A** = extremely unpleasant (raw hog manure smell); **B** = moderately unpleasant; **C** = slightly unpleasant; **D** = neither pleasant nor unpleasant. The ***intensity*** of smell was defined in terms of "Threshold Odour Number" (TON), where TON = mL of odour-free water that must be added to 1 mL of sample so that the odour of the solution is just detectable.

Both odour intensity and TOC, along with a lightening of the color of the solution, fell progressively with the increased current and/or increased electrolysis time at Ti/SnO_2 and BDD in a plug-flow reactor operated in recirculation mode (Figure. 1). Odour removal proceeded more rapidly than loss of TOC, as a result of Kolbe decarboxylation of aliphatic carboxylic acids, yielding hydrocarbons.

Figure 2 (BDD anode) presents the progress of electrolysis when a plug-flow reactor was operated in simulated cascade mode. At all values of the applied current there was progressive loss of both TC/TOC and smell with a D quality after 3 passes.

The intensity of odour was determined following changes in TON values (Figure 3) using a plug-flow reactor in simulated cascade mode. These values fell faster using the BDD anode than at Ti/IrO_2. In chemical terms the difference between the two types of anode can be rationalized in terms of the oxidation mechanism. It is not possible to notice any change in colour during electrolysis of whole manure, due to the presence of solids, but electrolysis of centrifuged samples caused a progressive change in color that correlated with the decrease of odour. In an experiment at BDD at 600 mA, the initial dark green colour of the solution gradually faded, and became completely clear after three passes through the reactor.

Electrolysis also had a pronounced bactericidal effect, with anaerobic bacteria, in particular, reduced almost to zero after only one pass at both anodes (Figure 4), a result that is explicable by the evolution of molecular oxygen during electrolysis. The rationale for making this determination was our earlier observation that solutions electrolyzed to a near-odourless state could be stored for several weeks without redeveloping an off-odour, even though the solutions still contained a substantial residual TOC.

The foregoing results were reproduced with whole (uncentrifuged) manure on a larger scale using both the 1 L and 27 L reactors, the latter being used for an on-farm demonstration, in which the smell of freshly collected manure was **A** and the smell of treated manure was **C** in continuous operation.

This technology does not require ancillary chemicals and the resulting solutions could be stored without developing any off odor. Retention of total nitrogen in the solution showed that its nitrogen content is preserved. The research is presently being developed to a pilot plant scale.

Symbols used: TC-total carbon; TOC-total organic carbon; IC-inorganic carbon; TN-total nitrogen; BDD-boron doped diamond electrode.

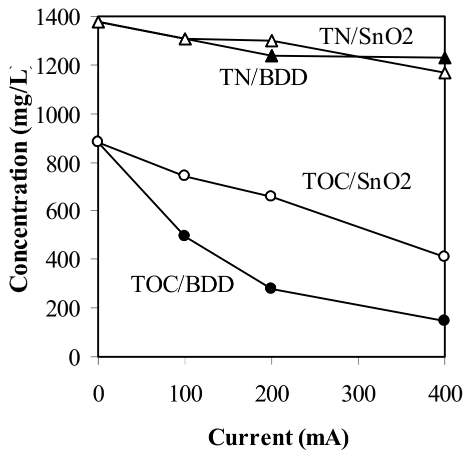

Fig. 1. Electrolysis of hog manure liquid in the plug flow reactor in recirculation mode (four equivalent passes).

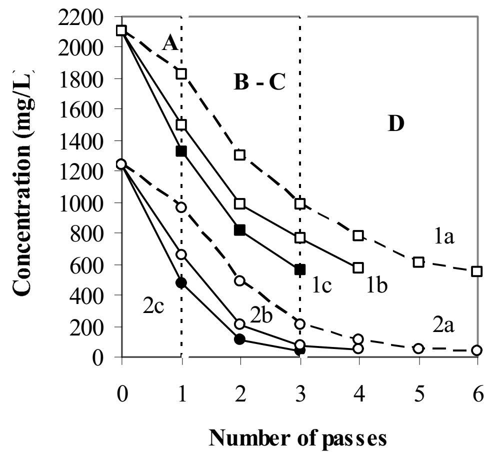

Fig. 2. Variation of TC (curves 1) and TOC (curves 2) at the BDD anode in a cascade of plug flow reactors; 400 mA (a), 600 mA (b) and 800 mA (c).

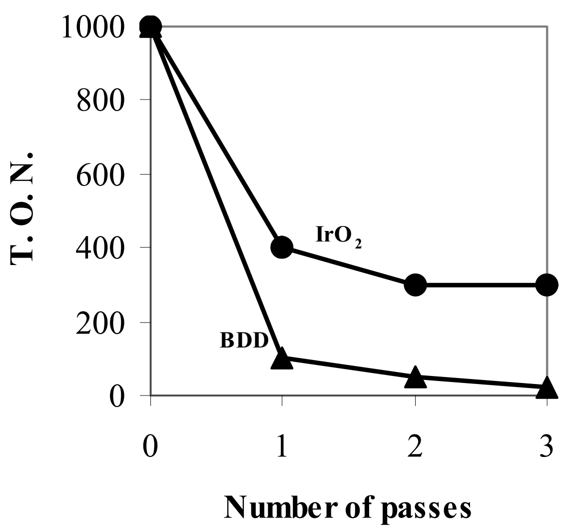

Fig. 3. Variation of TON using the plug flow reactor in simulated cascade mode at 600 mA.

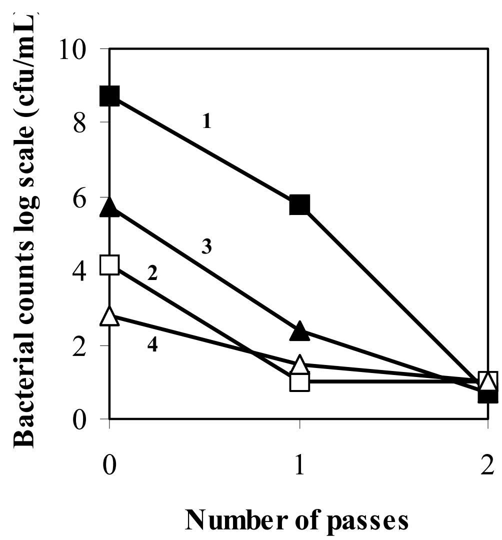

Fig. 4. Total Bacterial Count for Anaerobic (AN) and Aerobic bacteria (AER) for BDD and Ti/IrO_2 anodes, using the plug flow reactor in simulated cascade mode at 600 mA; 1 - BDD/AER; 2 - BDD/AN; 3 - IrO_2/AER; 4- IrO_2/AN.