Spectrum

Methane gas from meatworks waste

Meatworks, like many other industrial complexes, are faced with an increasing problem of waste disposal. Stricter legislation and rising public opinion against discharging untreated effluents into waterways are forcing the industry to look at new disposal methods.

Meatworks waste contains much higher concentrations of organic matter—as well as nitrogen, phosphorus, and grease—than normal household sewage. This opens up possibilities of using the waste to produce energy in the form of methane gas, a practice carried out by some municipal sewage works. The gas could then be used to provide power for running engines, heating, or generating electricity.

Mr Chris Mardon of the CSIRO Division of Chemical Technology has looked at the possibility of overcoming a meatworks' effluent disposal problem in this way. He estimates that the use of two digesters—one for treating liquid effluent and another for treating solid wastes—could supply enough methane gas to meet between one-quarter and one-third of a works' total fuel consumption. Whether such an installation would be an economic proposition would depend on, among other things, the penalties against the disposal of partly treated effluents.

At present meatworks carry out some primary treatment to remove grease and solids from their waste water. After the larger solids are screened out, the effluent goes to a settling tank, where fat floats to the top and is skimmed off and rendered down. The sludge that settles at the bottom of the tank is usually dumped.

This sludge and the other major wastes—paunch solids and manure from the holding yards—have a high organic matter content and are a valuable potential source of methane gas.

From an analysis of the wastes at a large Melbourne abattoir, Mr Mardon has come up with figures for a hypothetical meatworks slaughtering 400 cattle and 2000 sheep a day—typical of a moderately large urban works.

He estimates that sludge, paunch wastes, and manure would amount to 46 tonnes of wet solids a day, including 41 tonnes of water. The remaining 5 tonnes would be mainly organic material with the potential for energy production; but the problem would be to separate this from the water. Evaporation would be prohibitively expensive.

Mr Mardon has looked particularly at anaerobic methods of treating the wastes. These involve mixing them with large quantities of microorganisms in closed airless tanks. The bacteria convert the organic waste to carbon dioxide and methane gas, which can then be collected and used as a fuel.

The organisms grow only slowly because of the lack of oxygen. By contrast, in the usual aerobic process in open lagoons they react rapidly with the oxygen in the air to produce carbon dioxide and water, leaving large quantities of unusable biological sludge.

Mr Mardon estimates that anaerobic treatment could convert 80–90% of the organic wastes to a usable form. But he admits that it has some disadvantages. High temperatures are needed for optimum operation. And the growth rate of the methane-producing bacteria is slow, although new research may overcome this in the near future.

The two anaerobic processes involve the contact and conventional digester systems. Both use large enclosed airless tanks known as digesters, in combination with settling tanks. They operate at either of two optimal temperature ranges—30–35°C or 60–65°C.

Meatworks wastes are usually warm to start with, and some of the methane gas produced (or heat from other meatworks operations) can be used to heat them still further.

The contact digester is useful for treating dilute liquid wastes. Several meatworks in the United States used this type during the 1950s and 1960s. It handles liquid material with organic matter contents of between 500 and 2000 mg per litre.

The conventional digester works well on raw solid and semi-solid wastes, introduced at intervals to the digester and mixed with large quantities of microorganisms. The greater concentration of the waste results in much higher potential methane production.

In considering the production rates and economics of the two processes, Mr Mardon worked on figures for the same hypothetical meatworks—slaughtering 400 cattle and 2000 sheep a day. A contact digester—handling liquid effluent containing only 1300 p.p.m. of solids, entering the digester at 28°C—would produce about 13 800 megajoules of potential energy a day.

The conventional digester would produce much greater quantities of methane, probably giving a daily output of about 33 300 megajoules. This would be enough gas to raise its own temperature to 32–34°C, dry its sludge to 12% moisture content, and still provide a surplus energy supply of about 3500 megajoules a day.

Both types produce a liquid end product. However, the conventional digester would produce one that was still rich in nutrients such as nitrogen and phosphorus—and probably about 32 000 litres of it a day, as well as 2·8 tonnes of dry residue that could be used as a soil conditioner.

Mr Mardon points out that the contact digester would only become economically worth while where penalties for discharging organic matter into the general sewage system are quite high. It can remove about 90% of the organic matter and 80% of the suspended solids from liquid wastes. After final treatment in a trickling filter or aerobic lagoon, the waste could be discharged quite safely into a river.

A contact system would need a 100 000-gallon digester, a 7500-gallon settling tank, and auxiliary equipment, costing $80–$100 000 to install.

If penalties for discharging untreated wastes into the watercourse were $100 a day, and fuel oil cost 32 cents a gallon, the plant would provide our 'typical' meatworks with an annual net saving of $23 000.

A solid-waste treatment system would need a 25 000-gallon mixing tank plus a 125 000-gallon digester and a 12 000-gallon settling tank, which would cost slightly more than the contact system. In this case its output of an extra 3200 megajoules of gas energy per day would save only $980 per year, after allowing for heating the system to the operating temperature. But if waste heat from other meatworks processes could be used to heat the digester, the annual saving would be $9200 if it replaced natural gas at 8 cents a therm and $23 050 if it replaced fuel oil.

If both a contact digester and a conventional one were installed, the gas produced would probably supply between one-quarter and one-third of the total fuel consumption of the works. So if the works used three boilers, one of them could be converted to run on the gas from the two digesters.

Mr Mardon believes that selecting the right digester for a particular meatworks is a complex decision. It is not just a matter of balancing the capital and running costs of the treatment against the cost of producing the methane gas. It also involves the question of present waste-disposal costs and possible increased penalties in the future.

Other factors to be considered are the possibility of using heat from other meatworks processes to warm the digester, the difficulty of converting existing plant, and the likelihood of producing new by-products—such as feed additives, fertilizers, and soil conditioners—from the waste.

Methane energy production from meatworks wastes. C. J. Mardon. *CSIRO Meat Research Laboratory Resources and Waste Management Seminar*, 1976.

Helping abattoirs come clean. *Ecos* No. 6, 1976, 13–14.