Biogas from fruit waste

About 750 000 tonnes of fruit and vegetable wastes are produced each year by Australian canneries and juice-processors. If you were manager of a cannery, what would you do with 20 000 tonnes (the yearly output of a typical cannery) of wet, ready to rot, peelings and offcuts?

Dr Alan Lane of the CSIRO Division of Food Research suggests you ferment the stuff in a suitable digester and produce biogas — energy to burn! At a pilot plant he designed at the Letona Co-operative Cannery, the digester is producing 30–40 cubic metres of gas per day.

Usually, waste is carted away and dumped, but this is an expensive and messy process. Heaps of rotting organic refuse encourage the breeding of flies and vermin, and run-off can pollute nearby streams.

Some cannery waste makes a passable cattle fodder, but there is a limit to how much can be consumed this way. While cattle find such fare appetizing, it is low in protein (3–4%) and at the peak of the canning season plenty of grazing is available anyway.

The cost of transport prevents the waste from being taken outside the local area, so mostly it's dumped nearby. Even so, this practice can generate a bill of $75 000 to $120 000 for the cannery to pay.

An anaerobic digester poses no problems with smells or flies because its working principle demands that it be sealed off from the air. Bacteria break down the waste, producing methane and carbon dioxide and very little else (some sludge).

The basic needs are a tank, pumps to circulate the brew, and a mill to chew up the waste for easier digestion. Also required is heat to keep the bacteria warm and active.

The principles of anaerobic digestion were discussed in *Ecos* 14. The digester acts like the rumen of a cow; indeed, the bacteria involved are very similar. They can break down any plant material fed in, except the lignin component. Straw and wood are difficult to digest because of their high lignin content, but most food wastes, even corn cobs and pineapple pressings, are quickly and almost totally devoured.

Most existing digesters operate on sewage, piggery waste, and even domestic garbage. Dr Lane's unit is unique in being 'tuned' specifically for food waste. Experience with this digester, and with smaller ones that Dr Lane operated earlier, is showing how to turn the waste into biogas with maximum efficiency.

While superficially simple, the biochemical workings of a digester are extremely complex. No one type of microbe can convert plant material directly into methane. A digester contains a whole population of different bacteria, each using the products of others to carry out successive steps in the conversion process.

Because the system is in complex equilibrium, the best conditions for operating it depend fairly heavily on the type of feed consumed. Dr Lane now believes that he knows how best to encourage the food-waste-into-methane process.

In his laboratory at North Ryde, Dr Lane's

Cooking with biogas.

experiments with small digesters showed that wastes from fruit and vegetable processing, being high in carbohydrate and low in lignin, could be converted almost completely to gas, leaving virtually no residue to dispose of.

The gas produced is a mixture of methane and carbon dioxide, their proportions depending upon the protein content of what is being digested. With cannery waste the two gases are produced in just about equal volumes. Despite the high content of carbon dioxide, the gas would burn well in a conventional gas ring.

It has a calorific value of 18–20 megajoules per cubic metre, which means that 1·4 cubic metres of biogas is about equivalent to 1 litre of petrol.

Dr Lane calculates that a processing plant with an annual output of 30 000 tonnes of waste (with 90% moisture content) could generate 1·5 million cubic metres of gas a year. Waste heat from processing operations could be used to keep the digester warm (about 40°C is ideal), so the power needed for other digester equipment, like pumps, grinders, stirrers, and so on, would probably consume only 20% of the gas.

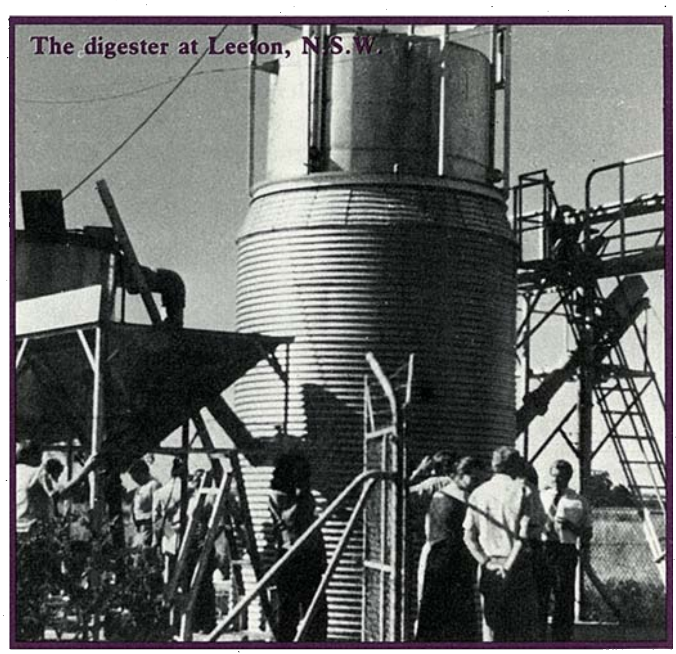
He therefore estimates a volume of surplus gas of around 1·2 million cubic metres — equivalent to 840 000 litres of petroleum valued at more than $200 000. A cannery could use this gas to replace a considerable portion of the fuel oil it uses for generating process heat. To the value of the gas should be added the saving on transporting and dumping the waste — which, at $4 per tonne, is $120 000.

Capital cost of a suitably sized digester may be $500 000, and running costs should be low, making the installation look like a very favourable investment all round.

Dr Lane's work with small digesters in the laboratory was followed by experiments at the Division with a 3700-L digester — a rain-water tank insulated with a 50-mm coating of urethane foam. Using pelletized orange peel as a convenient feedstock, he established optimum feed rate and other conditions.

He found that it is important not to give the digester any sudden shocks. This means the feed rate needs to be built up gradually to its working level and kept steady. For a cannery, this would mean buffering the day-to-day supply of waste with a small stock pile, or transporting waste from other nearby canneries or a similar source. The temperature needs to be kept constant at about 40°C.

The next step was the construction of a 23-cubic-metre digester at the Letona



The digester at Leeton, N.S.W.

Co-operative Cannery at Leeton, N.S.W. Built jointly by CSIRO and the cannery, this handles up to 1 tonne of wet waste a day, one-twentieth of the full waste output of the factory. It produces some 30–40 cubic metres of gas daily, although all of this is vented to the atmosphere at present.

The unit has been operating continuously and successfully for more than 2 years now. For the first 6 months, the operators used orange-peel pellets, to gain familiarity. Then they used 'apple press cake'. The cake — the residue left from pressing apples into juice — is generated almost all the year round at the Mountain Maid plant at Batlow (a subsidiary of Letona) and over a shorter season at Leeton. The two plants produce about 6–7000 tonnes of it a year.

The digester thrived on the cake. Extended trials, including 1 month at maximum loading, have produced thousands of cubic metres of gas and shown that all aspects of the digester's operation could be carried out by the cannery staff.

Last December the digester's diet was altered to pulped fresh apricot waste, and then, early this year, to pear and peach waste. Maximum loading rates have given no problems, and conversion of solid materials to gas continues to be around 95–100%. The small amount of indigestible sludge is easily disposed of: it is an inoffensive mud that makes a good soil-conditioner.

If everything goes according to plans, the digester should now be tackling de-oiled citrus peel.

Case study — Letona, New South Wales, Australia. A.G. Lane. Lecture 8b, 334–51. *Proceedings of the Workshop on Biogas Technology of the ASEAN Working Group on Utilization and Management of Food Waste Materials, ASEAN Seminar, Manila, March 1981.*

Methane from fruit and vegetable wastes. A.G. Lane. *Food Engineering International*, September 1979, 28–32.

How close is the methane alternative? *Ecos* No. 14, 1977, 14–20.