RESEARCH NOTE

Biogas Generators for Rural Southern Africa

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The techniques and the potential benefits of anaerobic digestion of organic 'wastes', particularly cattle manure, in underdeveloped regions of Southern Africa have been discussed previously [1-3]. New information on the performance of certain biogas generators (digesters) has since become available and this requires that some views expressed in the above studies be revised.

The generator design identified in the previous discussions [1,3] as the most promising for local rural implementation was the family-scale Chinese fixed dome digester. Such units (described in greater detail elsewhere [3,4] consist essentially of excavated cavities lined with masonry and sealed with locally manufactured mortars and cements. Inlet and outlet ducts or chambers are fitted in which the level of the manure/water slurry is typically 1 to 1,5 m higher than that in the cavity. Raw slurry is fed and spent slurry is removed intermittently, and the biogas (stored under the dome) is withdrawn as required. The structure is thus subjected to time-varying stresses.

This digester has been widely hailed as spectacularly successful largely because of the building, at very low capital cost, of 7 to 8 million units in China between 1970 and 1980. It now appears, however that as many as half of these have been abandoned owing to failure of the structure and attendant leakage [5-7]. Further, the fixed dome digester cannot benefit from solar heating and thus supports rather low gas generation rates, even in summer. The insulating effect of the surrounding soil, however, affords it a measure of protection from low ambient temperatures.

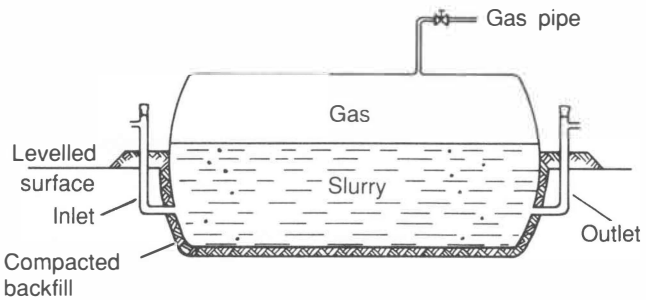

Figure 1 – Taiwanese Bag Digester, after [8].

A digester design finding favour as an alternative to the fixed dome (and the floating dome) type is the Taiwanese bag digester [8]. The unit (Figure 1) consists of a pliable polymer moulding in the shape of a giant sausage casing with an integral slurry inlet pipe at one end, an outlet at the other, and a gas pipe along its length. The bag is positioned horizontally, gas pipe uppermost, in an excavated trench of depth somewhat greater than half the bag diameter. The inlet and outlet systems are so arranged that the mass of the slurry within the bag is supported by the surrounding soil and that the pressure in the gas space does not exceed some 4 kPa. A very successful bag material appears to be a mineral-filled PVC called 'Red Mud Plastic', having a life expectancy of 20 years. Capital costs are low, namely $25 to $30 per cubic metres of bag volume, or some $400 for a 15 m³ digester. These figures are comparable with the cost of a masonry fixed dome digester, as built in Zimbabwe [9]. (The costs of the latter units were optimistically underestimated in previous reports [1,3].)

In temperate and warm climates bag digesters maintain higher mean temperatures than fixed dome units, and thus have greater specific gas generation rates. Gunnerson and Stuckey [8], reporting on studies conducted in China and Korea, quote production rates of 0,14 and 0,7 m³ of gas per day per m³ of digester volume for winter (digester temperature 8 °C) and summer (32 °C), respectively. The corresponding figures for fixed dome digesters are approximately 0,1 and 0,2.

The superior performance of bag digesters is largely due to solar heating. Being uninsulated, however, bag digesters are more sensitive to low night temperatures than the underground fixed dome units. Such heat loss problems could be alleviated by suspending a transparent plastic dome or tent over the bag. The covering could be retained for daytime use, thus forming a 'solar tent'. This holds the potential benefit of increased mean digester temperature and hence improved gas generation rate.

It would seem therefore, that the fixed dome underground digester cannot be confidently recommended at its present stage of development. The bag digester, being superior with regard to both structural integrity and gas generation rate, appears to warrant serious consideration for local rural application.

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