CHANGING MODE OF FEEDING FOR IMPROVING THE KVIC DIGESTER

Viral Dhanjee,
Technology for Development Division,
Ministry of National Development, PO Box 199, Victoria, Seychelles

ABSTRACT

The performance of batch biogas digester systems has been shown to improve substantially by innoculating fresh cow dung with 14-40 day old starter material. Experiments are reported here to investigate whether similar improvements can be achieved by allowing mixing of spent slurry and fresh material in continuous/semi continuous digester systems. A traditional KVIC digester and an improved design without a partition wall and incorporating a better stirring device are compared. The improved design has 10% higher biogas production. Addition of spent slurry at 2.5% volume does not appear to increase biogas production in semi continuous systems.

INTRODUCTION

Laboratory experiments within the African Energy Programme (AEP) have revealed that using spent slurry would considerably improve batch digester performance by reducing the latent phase period of anaerobic fermentation (Baguant et al 1984; Dhanjee 1984). Starter material 14-40 days old, added at a level of 2.5% by weight to fresh dung feed has been show to be sufficient to provide the required level of bacterial population for satisfactory biogas production in batch system.

The efficiency of continuous/semi continuous digesters may also be improved by changing the mode of feeding to recirculate spent slurry (starter material). The traditional vertical KVIC model of continuous/semi continuous digester has a partition wall to prevent the short circuiting of fresh material added to the digester, thus ensuring that the retention time chosen for the raw material is achieved. The partition wall prevents the mixing of the fresh material and spent slurry. The initial lag phase in biogas may thus be lengthened while the appropriate bacterial population becomes established within the fresh material.

It is believed that the inlet chamber of the conventional KVIC model digester (Fig. 1) may therefore be acting more or less like a dead space - no allowance being made for any resettling/refloatation: phase separation of materials.

A modified KVIC model digester has been designed to improve its performance. The partition wall has been removed to allow the mixing of the fresh material and the baterical rich spent slurry. To eliminate short circuiting of fresh material the outlet pipe has been redesigned and the stirrer has been improved.

This paper reports the findings of various experiments to evaluate the performance of this improved digester in comparison with the conventional KVIC model.

LABORATORY EVALUATION

The conventional KVIC digester (Figure 1) has been compared with the performance of an improved biogas digester (Figure 2). The former, digester 1, has an active volume of 206 litres and the latter, digester 2, of 210 litres. In all test runs, biogas production in digester 1 was corrected to an active volume of 210 litres.

In all cases, the raw material was cow dung fed at a dilution of 1:1 with water. Digesters were operated at room temperature. At the beginning 25% starter material was included. The feeding rate was calculated as follows:

$$\text{Feeding rate} = \frac{\text{Active volume (AV) x 7 days/week}}{\text{Retention time x 5 working days/week}}$$

The gas composition was analysed by flamability tests and gas volume measured in litres by a gas flowmeter.

Two test runs are reported. In the first a retention time of 30 days was used, in the second a retention time of 21.4 days. The first run was forced to end after 8 days because of serious scum formation in the KVIC Digester Design. The layer of scum was 21 cm deep. No scum was formed in the 8 days. The scum breaker/stirrer of both gas holders were improved and utilised in the second run.

In the second run, scumming problems were eliminated. The activities undertaken during the test run can be summarised as follows:

1. 0 - 675.5 (hours since initiating digestion)
   - NO RECYCLING
   - PERIODIC LARGE LOAD (to create gas pressure for burner utilisation)
   - DAILY STIRRING
2. 675.5 - 963.5
   - NO RECYCLING
   - NO LARGE LOAD (GAS FLOW METER in constant operation)
   - DAILY STIRRING
3. 963.5 - 1515.5 (continuation)
   - NO RECYCLING
   - NO LARGE LOAD
   - DAILY STIRRING
   - INTER CHANGE OF GAS FLOW METER to verify results of 1 and 2.
4. 1179.5 - 1515.5 (continuation)
   - As 3 but RECYCLING of 2.5% Starter Material to KVIC Digester Design (MODE OF FEEDING CHANGED)

- IMPROVED DIGESTER DESIGN AS in 3 (MODE OF FEEDING NOT CHANGED)

5. 1419.5 - 1515.5 (continuation)

   - KVIC as in 4
   - IMPROVED Digester Design - MODE OF FEEDING changed - Recirculation of 2.5% Starter Material

6. 771.5 - 795.5 and 1155.5 - 1299.5

   - 24 hour break in monitoring (due to gas leakage)
   - 6 days break in monitoring (due to gas leakage)

Results

The daily average biogas production for the two designs of semi continuous biogas digester is shown in Figure 3. Biogas production in the improved design is presented as percentage increase or decrease over that of the conventional KVIC design.

Except with large loads, where there was loss of gas from the improved digester, this digester performed better than the KVIC design. Even with interchange of gas flow metres, the improved design performed better.

The digesters are still running, but at time of the last measurements reported here, recirculation of starter material at the level of 2.5% of volume did not appear to change the rate of gas production in the improved design.

The stirring mechanism of the KVIC design was difficult to use owing to scum formation. That of the improved digester, operated very easily.

DISCUSSION AND CONCLUSIONS

1. Recirculation of starter material to a quantity of 2.5% of weight of the fresh cow dung does not seem to affect the performance of the two semi-continuous digesters tested. A longer operating time is necessary to confirm this. It may be that the rate of sedimentation of the slurry is sufficient to innoculate the fresh feed with enough bacteria to start immediate biogas production. In batch system there is no endogenous colony of methanogens.

2. It is not possible to explain the better performance of the improved digester design compared to the conventional KVIC design. However, there may be a more concentrated population of methanogens, since the improved Digester design is an upflow digester with a greater sludge bed volume.

3. No value can yet be given to the efficiency of the improved digester design compared to the conventional KVIC until the systems have been operating for a longer period. However, this will be in the order of a 10% increase in performance under the same conditions. The improved digester design would require a lower initial investment for a given

volume of biogas required, thus bringing the biogas technology within the grasp of even more people.

4. The improved digester design accomodates a high solids concentration and high loading rate without any scum formation problem. Since a lower dilution of the feed is required the design may be of interest since (a) it will require less water and (b) it could treat a large waste volume without requiring a proportionate increase in its sizes, again helping to keep the initial investment cost at a minimum.

5. The design of the improved digester permits the use of a better scum breaker/stirring mechanism. The extra cost of this unit would easily be offset by the saving of not having to build a partition wall as in the KVIC design. A proper comparative economic evaluation may need to be carried out.

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FIGURE 1: KVIC design digester

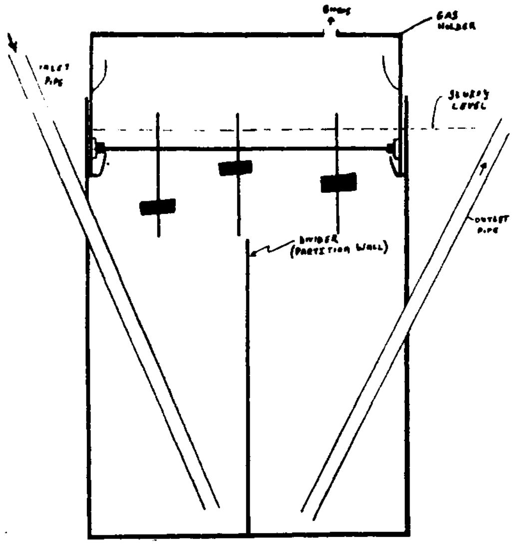

FIGURE 2: Improved biogas digester

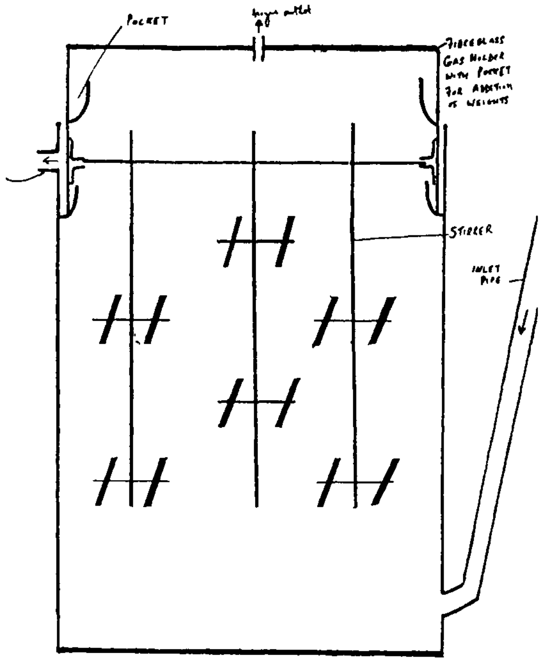

FIGURE 3: Average daily biogas production (I/A x 24) in litres

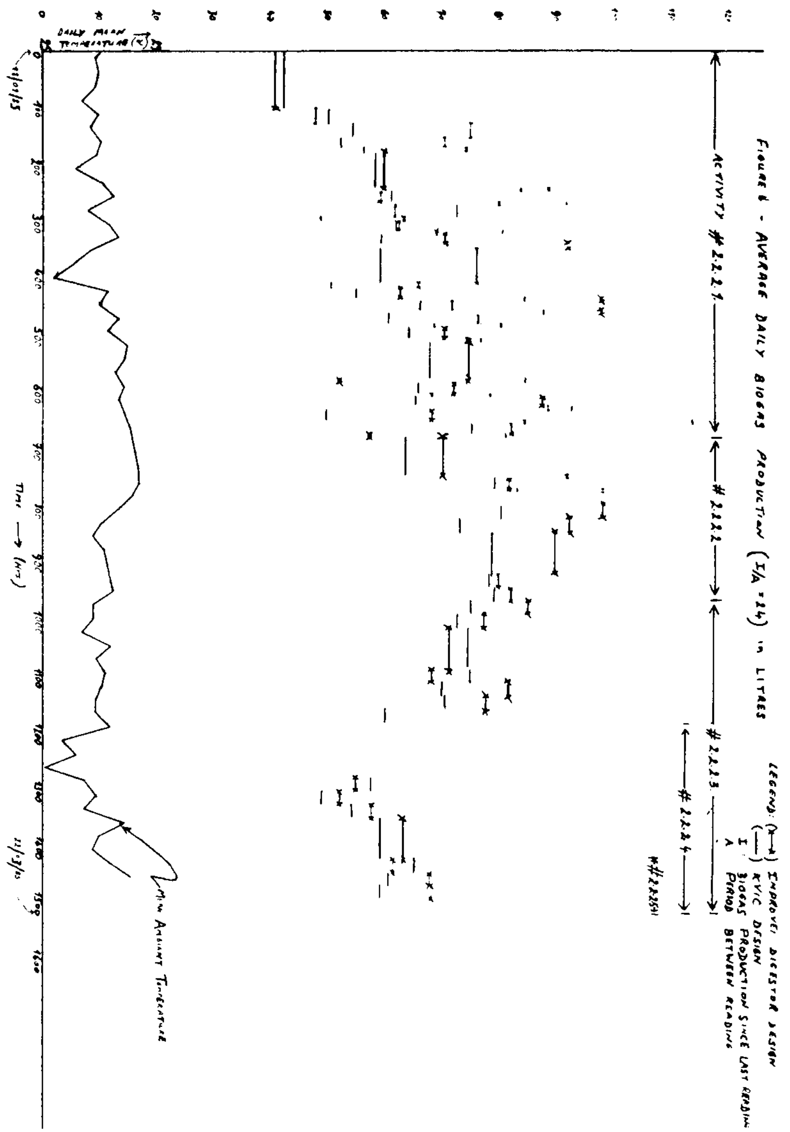

FIGURE 4: Percentage increase/decrease of biogas production from improved biogas digester compared to biogas production from KVIC design