



## **Eco Process Assistance**

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# **MELISSA**

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## **TECHNICAL NOTE 43.2**

### **MELISSA DEMONSTRATION REACTORS**

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## **1. Introduction**

The MELISSA demonstration reactor is responsible for the degradation of faecal material. From previous experiments can be concluded that the overall conversion efficiency of the organic matter in the MELISSA reactor at a pH of around 7 and a temperature of 55°C was 40%. It appeared that protein were more easy to biodegrade (60%) than other components such as polycarbohydrates (20%). The fibrous fraction of the human faeces is the most resistant part to biodegrade. This fraction consists of cellulose, xylan and lignin components. Enzymes can benefit the biodegradation of those recalcitrant components (TN43.1).

The production of methane must be inhibited in the MELISSA- cycle, because it is of no use in the other compartments. Low pH values (6.5) in the demonstration reactor inactivated the methanogenic bacteria (TN41.2). Under these circumstances a conversion efficiency of only 30% could be achieved. Proteins were biodegraded for about 70% and non-protein material for only 10%.

This technical note represents the results of the MELISSA demonstration reactors. The parameters analysed on both effluents were dry matter, organic matter, ammonium-N, total-N and volatile fatty acids. Those analyses were frequently carried out.

The major difference between both reactors were: Reactor 1 was operated at a pH of 6.5 and Reactor 2 was fed with pretreated cake from Reactor 1. This concept should give better polycarbohydrates biodegradation and less methane production.

Conversion efficiencies were calculated during the operation of the demonstration reactors. Two different conversion efficiency can be distinguished. The total conversion efficiency encloses the production of VFA, carbondioxide and methane. Methane is of no use in the MELISSA-loop and therefore a second conversion efficiency is calculated. In the MELISSA conversion efficiency only the conversion of organic matter into volatile fatty acids and carbondioxide is taken into consideration.

Preliminary DGGE analyses and PCR were performed in order to identify the dominant species in the demonstration reactor.

## **2. Reactor 1**

### **2.1 Set-up**

The first demonstration reactor had a wet volume of 1.6 litre and a temperature of 55°C. The reactor was set at a pH of 6.5 in order to inhibit the methane production and was continuously stirred with a magnetic stirrer. The reactor was fed with faecal material collected from different persons. The characteristics of the faecal material are represented in Table 2-1. Every two days 150 ml of feed was fed into the reactor after sampling 150 ml from the reactor. The hydraulic retention time obtained in the reactor was about 21 days. The reactor was automatically flushed with N<sub>2</sub>-gas every six hours for 10 seconds. In this way the produced biogas and H<sub>2</sub> was removed from the reactor. The gas was trapped in a solution containing 1 N KOH in order to capture the produced carbondioxide. The amount of CO<sub>2</sub> was measured by titration. Gas was frequently measured with a gasanalyser.

Table 2-1 Reactor 1: Characteristics of the faecal material

Parameter	Unit	Mean value
pH		6.9
Dry matter	g/l	23
Ash	g/l	3.7
Total nitrogen	mg/l	1241
Ammonium nitrogen	mg/l	100
VFA	mg/l	868
Acetic acid		354
Propionic acid		218
Iso Butyric acid		29
Butyric acid		167
Iso valeric acid		46
Valeric acid		33
Caproic acid		20

## 2.2 Preliminary Characterisation of the microbial community

DGGE analyses and PCR were performed in order to identify the dominant bacterial species in the liquefying compartment of the MELISSA-cycle. It can be concluded from the results that three dominant bacteria species present in the reactor are related with:

F1: *Ruminococcus bromii* (99.7% identical DNA sequences)

F2: *Petrotoga mobilis* (92% identical DNA-sequences)

F3: CDC group DF-3 (81% identical DNA-sequences)



Figure 2-1 DGGE analysis of MELISSA- reactor. Each band corresponds with 1 bacterial species

### **2.2.1 Ruminococcus bromii**

Ruminococcus are present in rumen and are anaerobic, chemoorganoheterotrophic heterofermentative bacteria. These Gram-positive bacteria are able to form acetic and formic acids from carbohydrates. Many strains can use cellulose.

### **2.2.2 Petrotoga mobilis**

This thermophilic bacteria present in hot oilfield water is obligatory anaerobic. The fermentative sheathed Gram-negative bacterium is capable of reducing elemental sulphur to hydrogen sulfide and tolerates high salt concentrations. The optimum growth conditions are 58-60°C and pH 6.5-7.0 with 3-4% NaCl and 0.7% MgSO<sub>4</sub> · 7H<sub>2</sub>O in the medium. The cells vary in size from 1-2 to 40-50 µm in length and are motile. The cells grown on xylan have xylanase activity and glucose isomerase activity was detected in xylose-grown cells (Lien et al., 1998).

### **2.2.3 CDC group DF-3**

This bacteria is related but different with Capnocytophaga species and constitutes a separate genus that clusters together with *Bacteroides forsythus* and *Bacteroides distasonis* (Vandamme et al., 1996). It is a rare isolate from blood, stools and wounds.

## **2.3 Results**

### **2.3.1 pH and EC**

The pH was set at 6.5 at day 42.1 in order to inhibit the growth of methanogens and therefore to prevent methane production. The EC was stable during the period when a pH of 6.5 was obtained. The small fluctuations were due to measurement-errors.

### **2.3.2 Dry matter, organic matter and ashes**

The dry matter concentration decreased at day 36.9. This decrease is due to a dilution of the reactor content. To avoid the pH sensor of drying up and to make sure enough volume was going to be left after performing enzymatic tests, 700ml of water was added to the reactor. From day 44 the dry matter in the reactor increased due to the increase of dry matter in the feed. At day 98.1 a decrease in dry matter is noticed. This decrease occurred during the Christmas period, where instead of fresh faecal material, starch and gelatine were fed into the reactor. From day 100 the dry matter of the feed stabilised and therefore more stable values in the reactor were noticed. The small fluctuations noticed in Figure 2-3 arose due to measurements-errors.

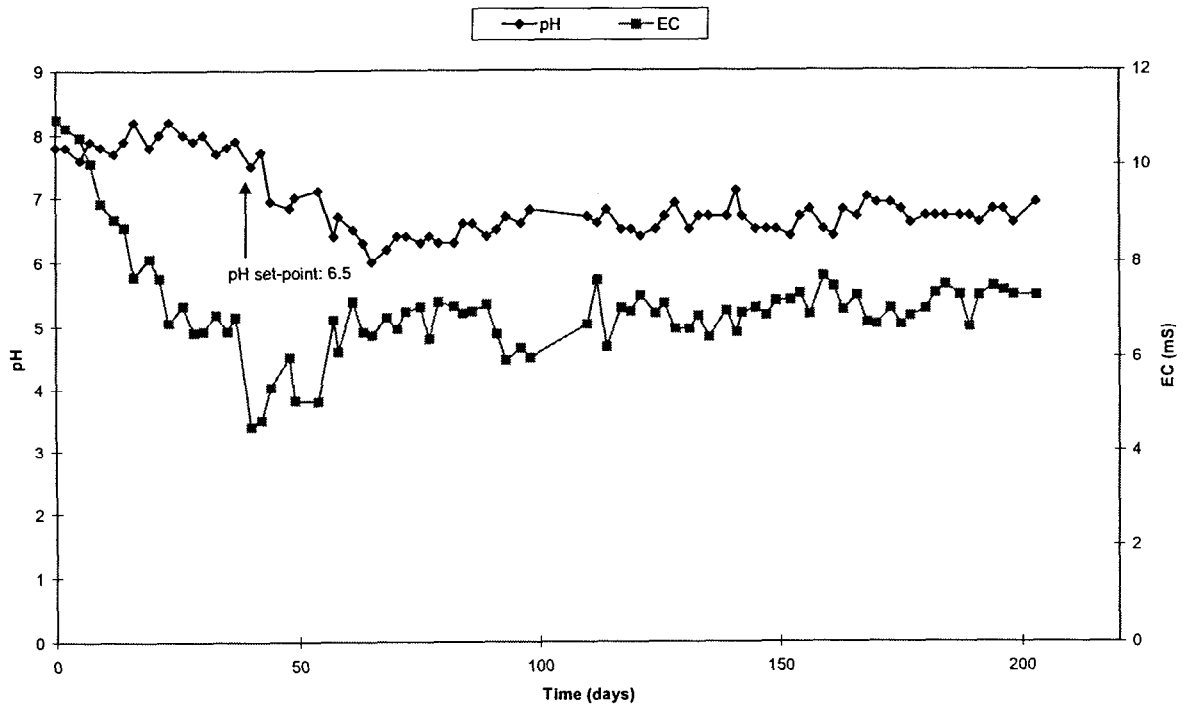


Figure 2-2 Reactor 1: pH and EC in reactor

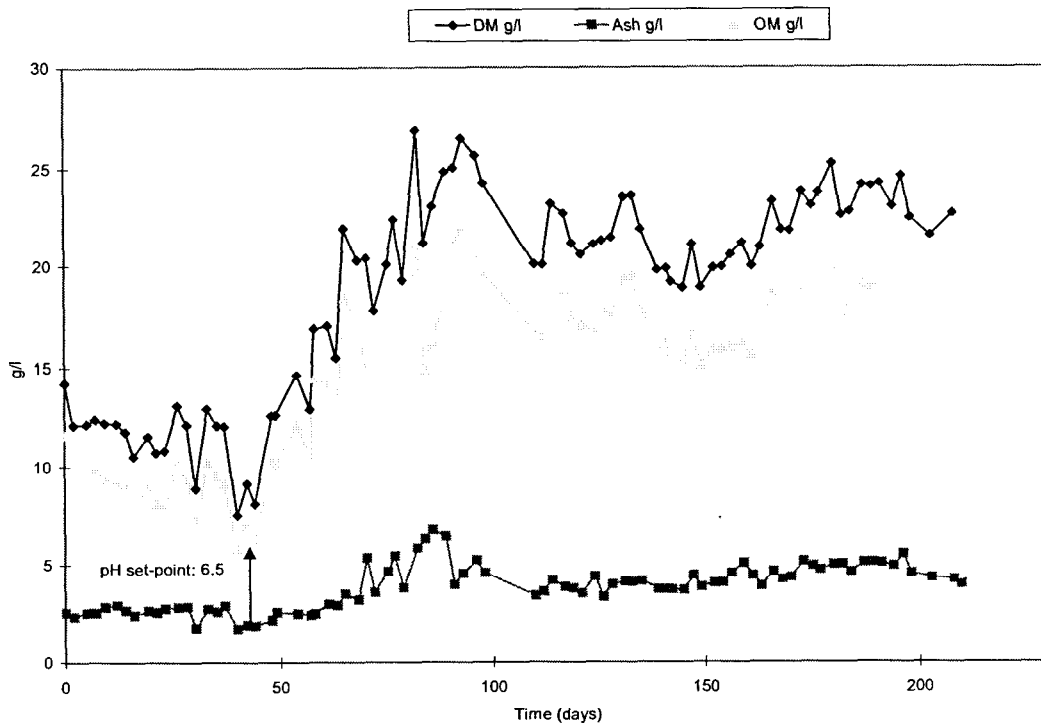


Figure 2-3 Reactor 1: Dry matter, organic matter and ash in reactor



### 2.3.3 NH<sub>4</sub>-N and N-org

The decrease in NH<sub>4</sub>-N and N-org points to a decrease in protein degradation. From day 80 the NH<sub>4</sub>-N and N-org concentration stabilised until an average value of 1400 mg/l NH<sub>4</sub>-N was reached. The dilution of the reactor content at day 36.9 is also noticed in Figure 2-4.

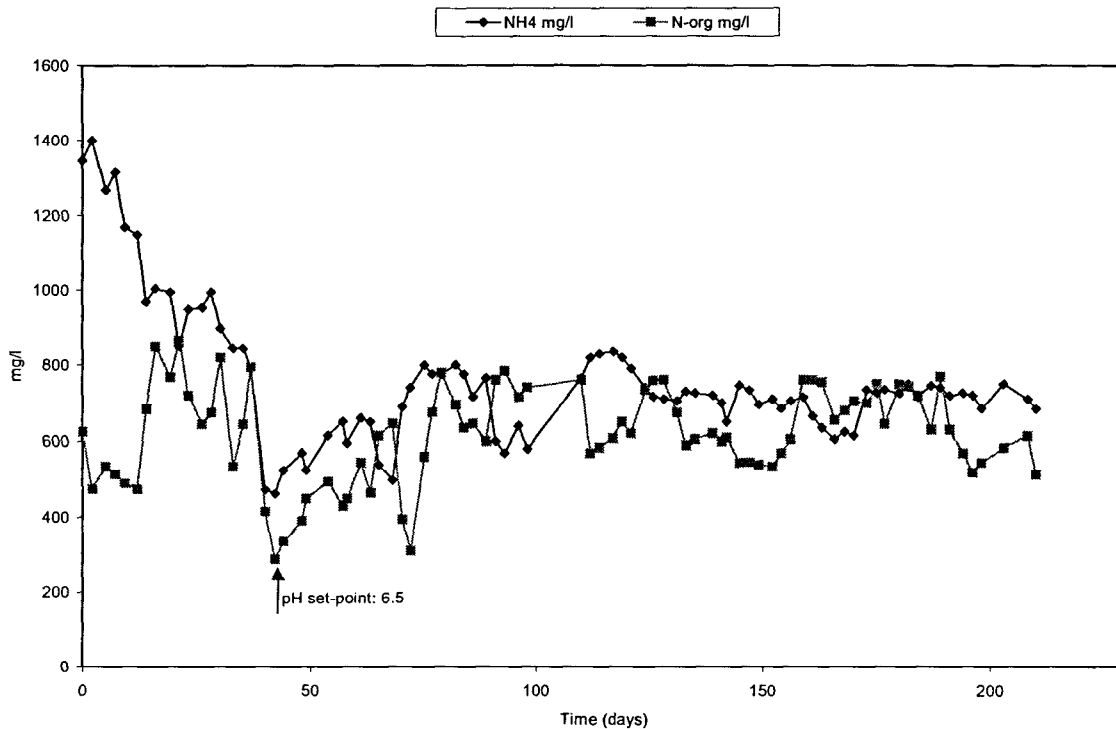


Figure 2-4 Reactor 1: NH<sub>4</sub> and N-org in reactor

### 2.3.4 Volatile fatty acids

The Volatile fatty acids concentration increased with high rates after the pH was set at 6.5 and this until day 75.2. At day 98.1 a small increase of VFA is noticed. This increase occurred during the Christmas period when instead of faecal material, starch was fed into the reactor. Starch is good biodegradable by the autochthonous bacteria. In Figure 2-6 the composition of the VFA is represented. Until day 88.9 the majority of the produced VFA was acetic acid, due to the inhibition of the methanogenesis. Afterwards most acetic acid was washed out and also the inhibition of acetogenesis occurred, what resulted in low acetic acid and high propionic acid concentrations.

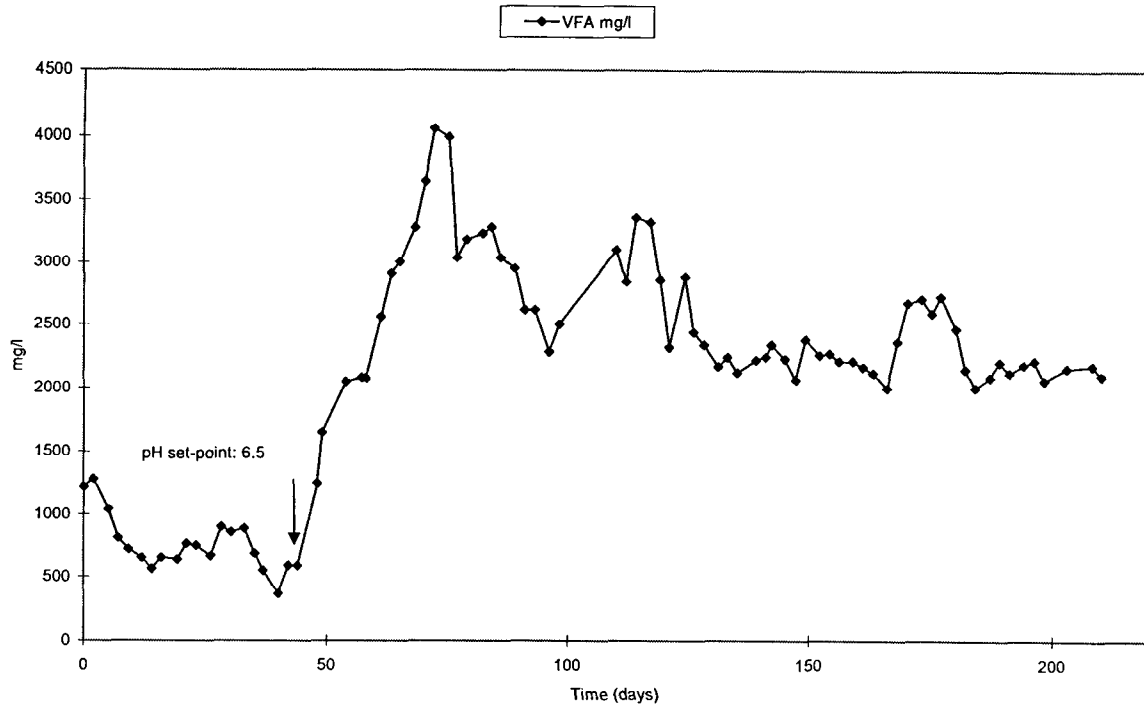


Figure 2-5 Reactor 1: Volatile fatty acids in reactor

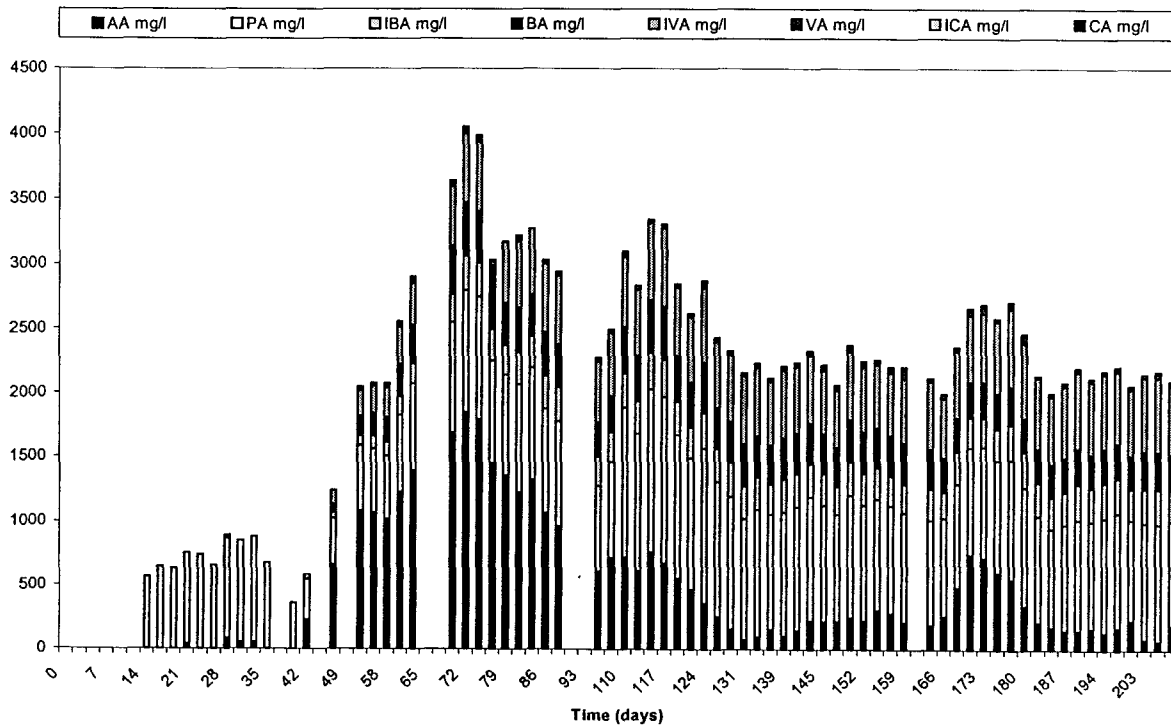


Figure 2-6 Reactor 1: VFA composition in reactor

### 2.3.5 Biogas production

The cumulative biogas production is represented in Figure 2-7. Before the pH was set at 6.5, the biogas consisted of methane and CO<sub>2</sub>. At low pH methane disappeared and only CO<sub>2</sub> was produced.

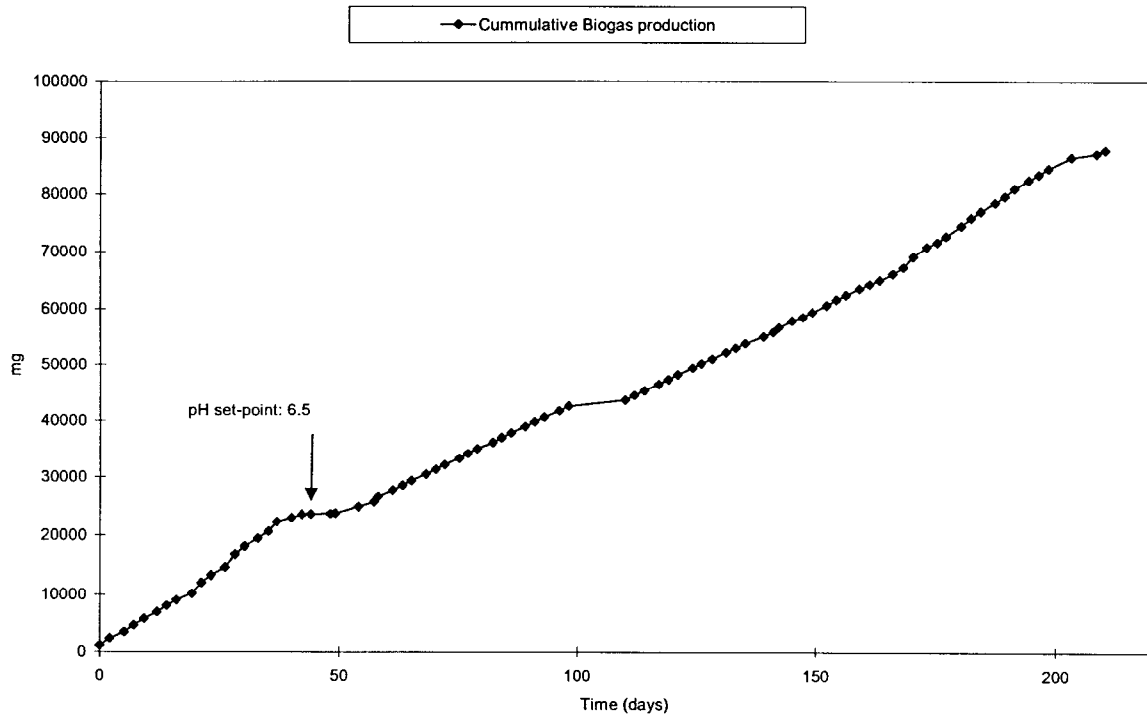


Figure 2-7 Reactor 1: Cumulative biogas production

### 2.3.6 Conversion efficiency

The total and MELISSA conversion efficiency of the demonstration reactor at pH 6.5 is represented in Figure 2-8. After the transition period, one HRT, representative conversion efficiency can be obtained. At pH 6.5 methanogenesis was inhibited and therefore the total conversion efficiency was equal to the MELISSA efficiency. Until day 65 the total conversion efficiency had higher values, due to small methane production. From day 53.9 the methanogens were completely inhibited. The conversion efficiency increased to 50%, due to high volatile fatty acid productions. From day 82.1 the conversion efficiency decreased until a stabilisation value of 40% was reached. The protein conversion efficiency stabilised at a value of 60%. The fibre conversion efficiency reached a value of 29%.

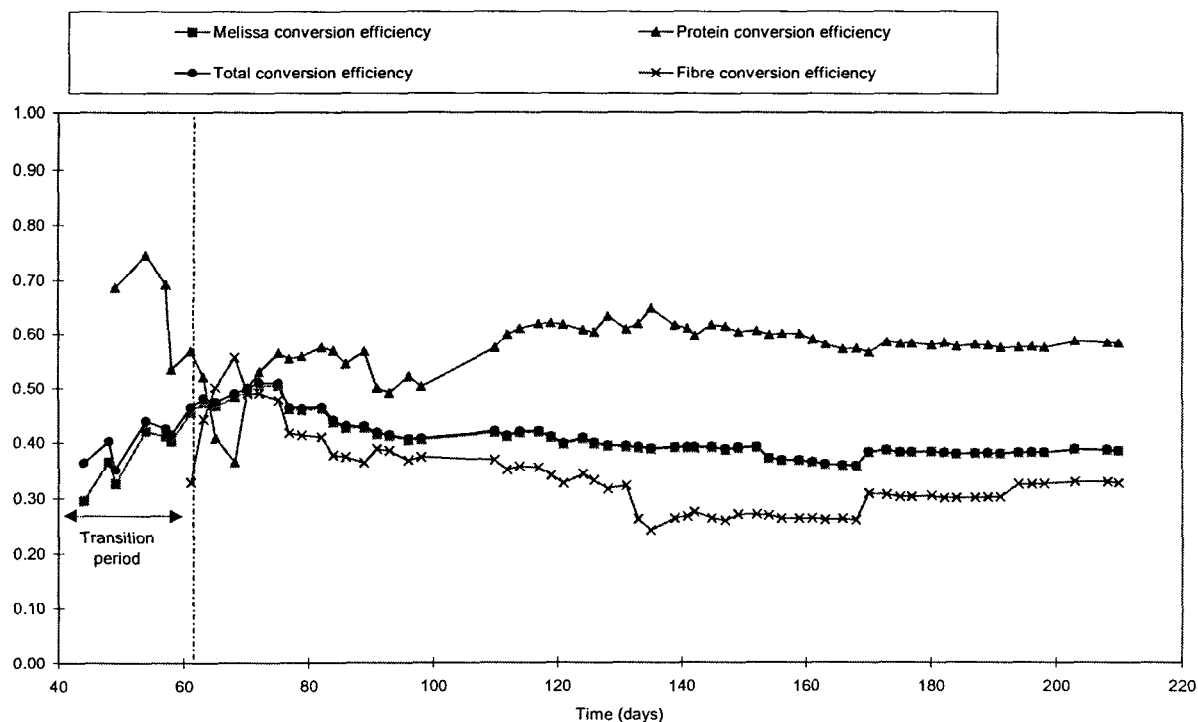


Figure 2-8 Reactor 1: Conversion efficiencies at pH 6.5

### 3. Reactor 2

#### 3.1 Set up

The addition of enzymes in order to increase the biodegradation of cellulose and xylan was tested in preliminary tests (TN43.1). After 2 months operation enzymes were added to reactor 2. The reactor had a wet volume of 0.9 litre and was kept at a temperature of 55°C and pH around 8. The hydraulic retention time was about 18 days. The effluent of reactor 1 was centrifuged and the cake was pretreated with cellulase and xylanase for 2 days at a temperature of 37°C and a pH of 5.1. After the incubation the pretreated cake was fed into the reactor. The preparation of the feed from reactor 2 is represented in Figure 3-1. The characteristics of the faecal material fed into the reactor are shown in Table 3-1. The configuration of the combination of both reactors is represented in Figure 3-3.

Table 3-1 Reactor 2: Characteristics of the faecal material

Parameter	Unit	Mean value
pH		6.8
Dry matter	g/l	5.99
Ash	g/l	0.76
Total nitrogen	mg/l	227
Ammonium nitrogen	mg/l	43
VFA	mg/l	210
Acetic acid		47
Propionic acid		66
Iso Butyric acid		24
Butyric acid		30
Iso valeric acid		43

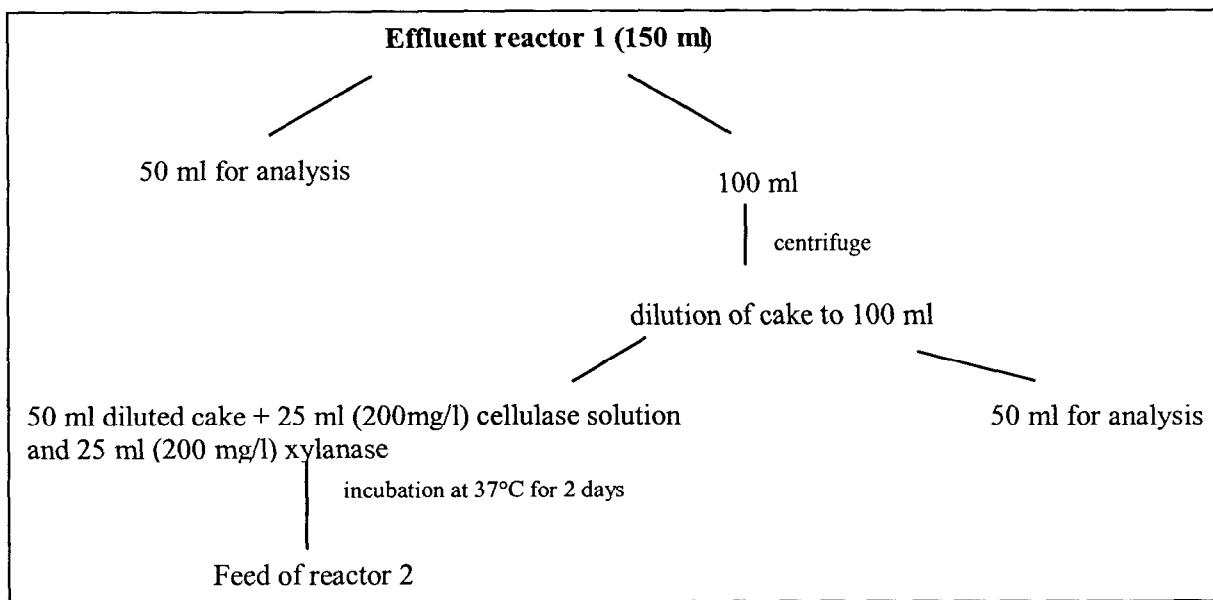


Figure 3-1 Feeding regime of reactor 2

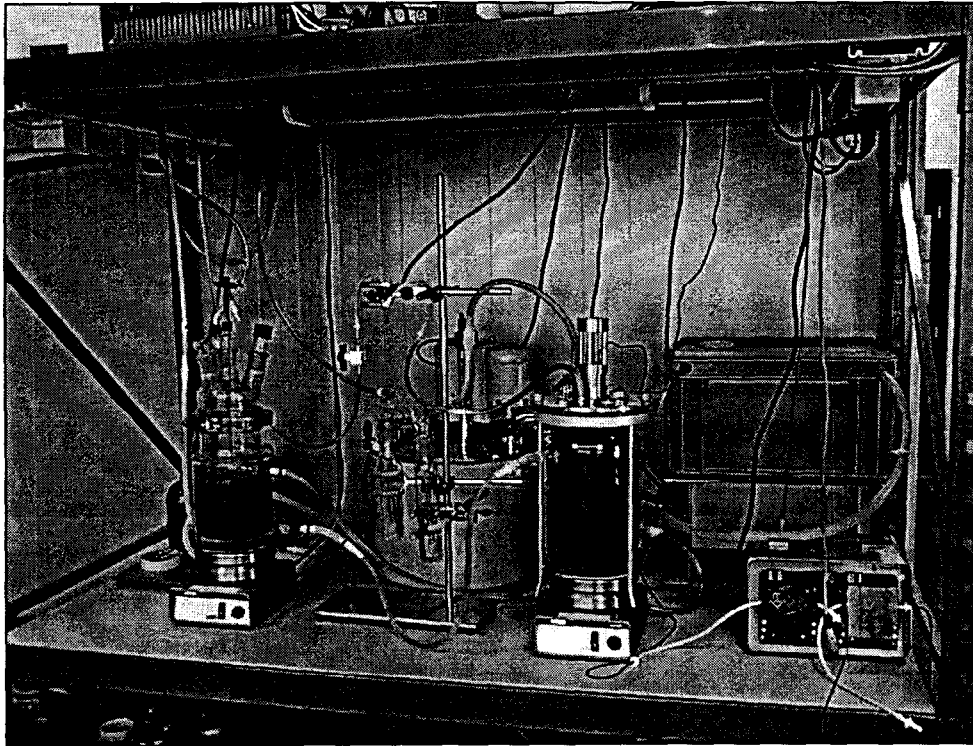


Figure 3-2 Presentation of the combination of the MELISSA demonstration reactors

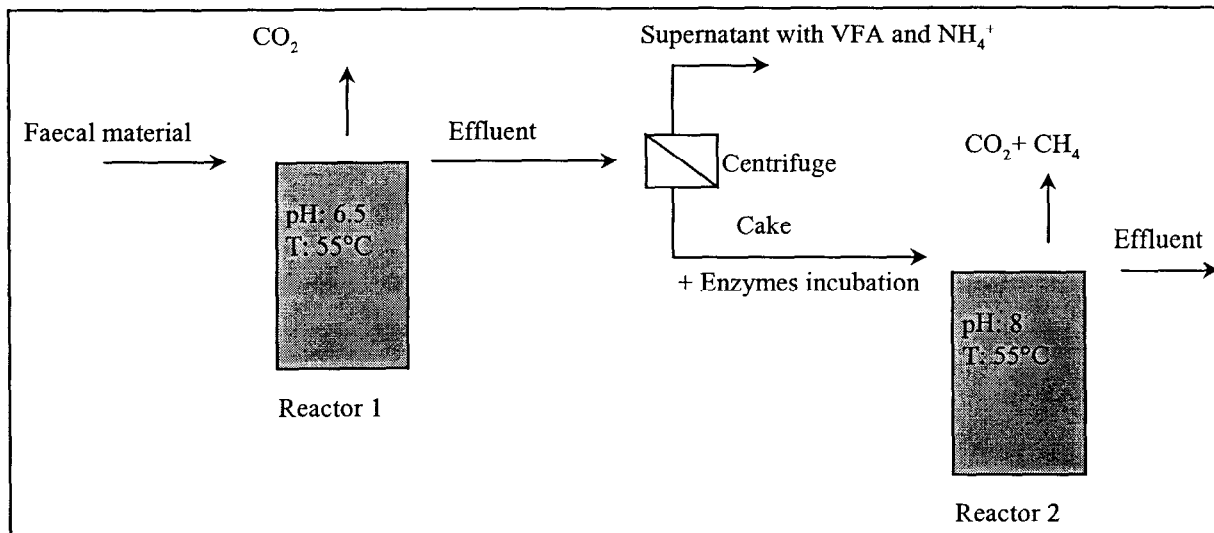


Figure 3-3 Schematic overview of the combination of reactor 1 and reactor 2

## 3.2 Results

### 3.2.1 pH and EC

The pH fluctuated around 8 during the entire period. From day 29.9 the EC decreased due to a dilution of the feed of reactor 2. At day 69 an increase of EC was noticed. During the Christmas period the reactor was fed with starch and gelatine instead of faecal material. After this period a stabilisation value of 2 mS was reached.

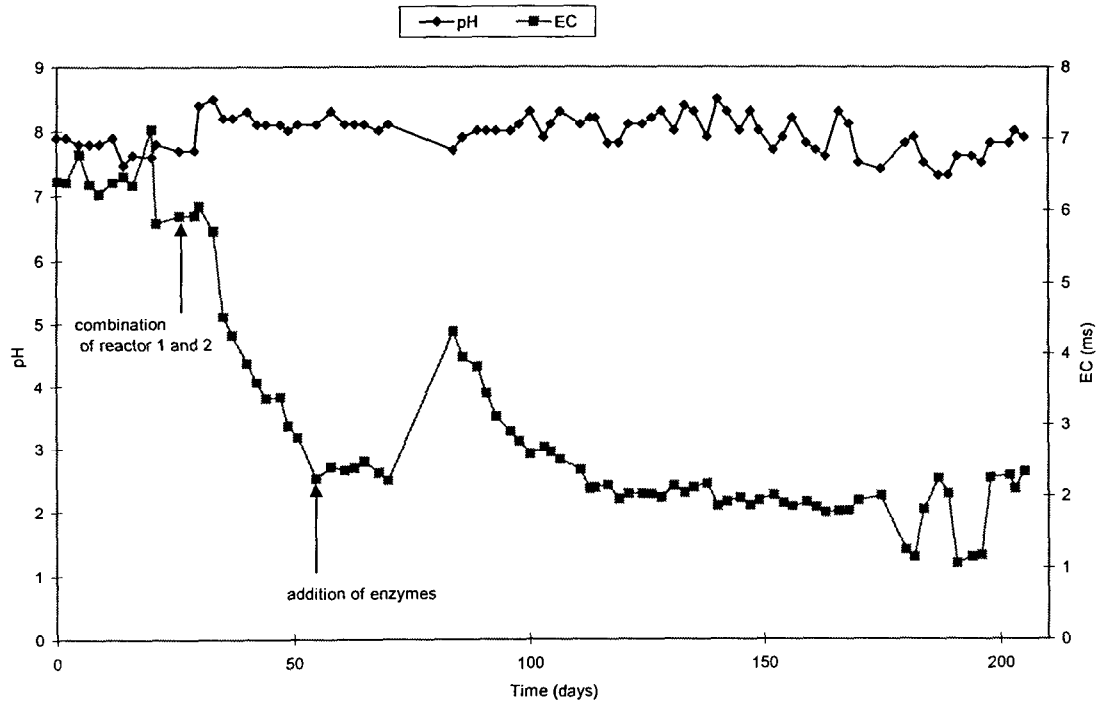


Figure 3-4 Reactor 2: pH and EC in reactor

### 3.2.2 Dry matter, organic matter and ashes

A decrease of dry matter is noticed in Figure 3-5 until a stabilisation value of 5 g/l was reached. The decrease was due to a change in feeding regime. Instead of fresh faecal material, cake was fed into the second demonstration reactor. The ash concentration was constant during the period when enzymes were added.

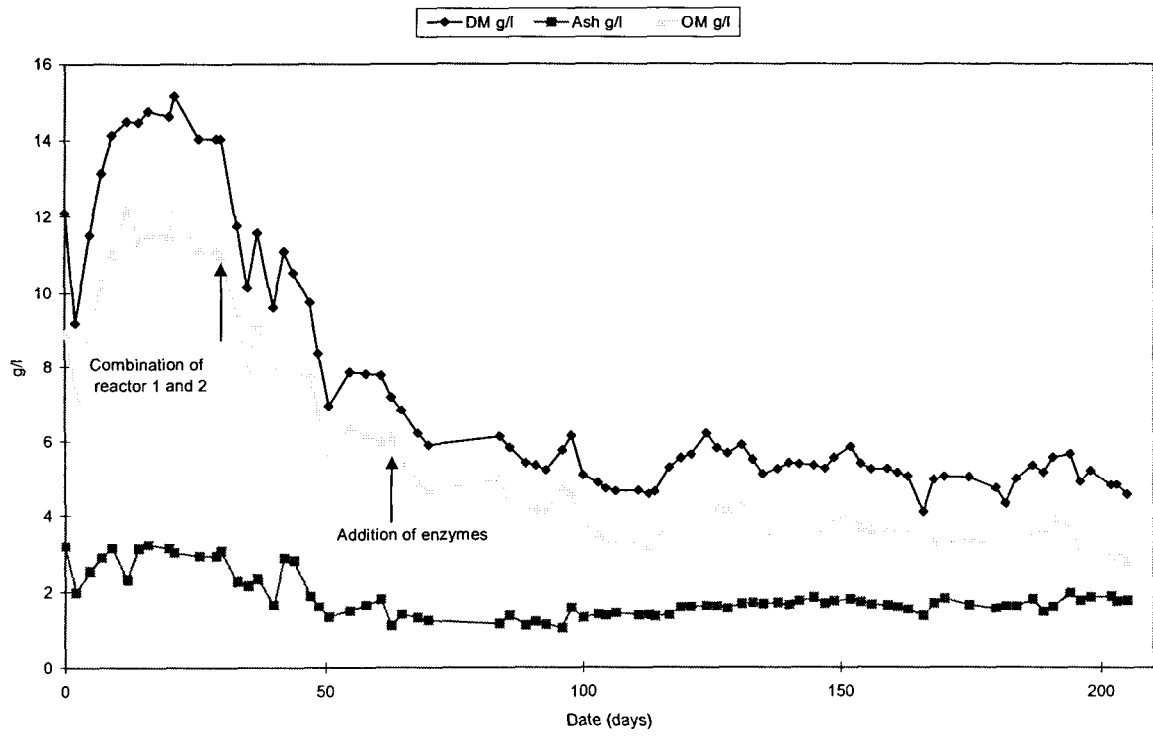


Figure 3-5 Reactor 2: Dry matter and Ash in reactor

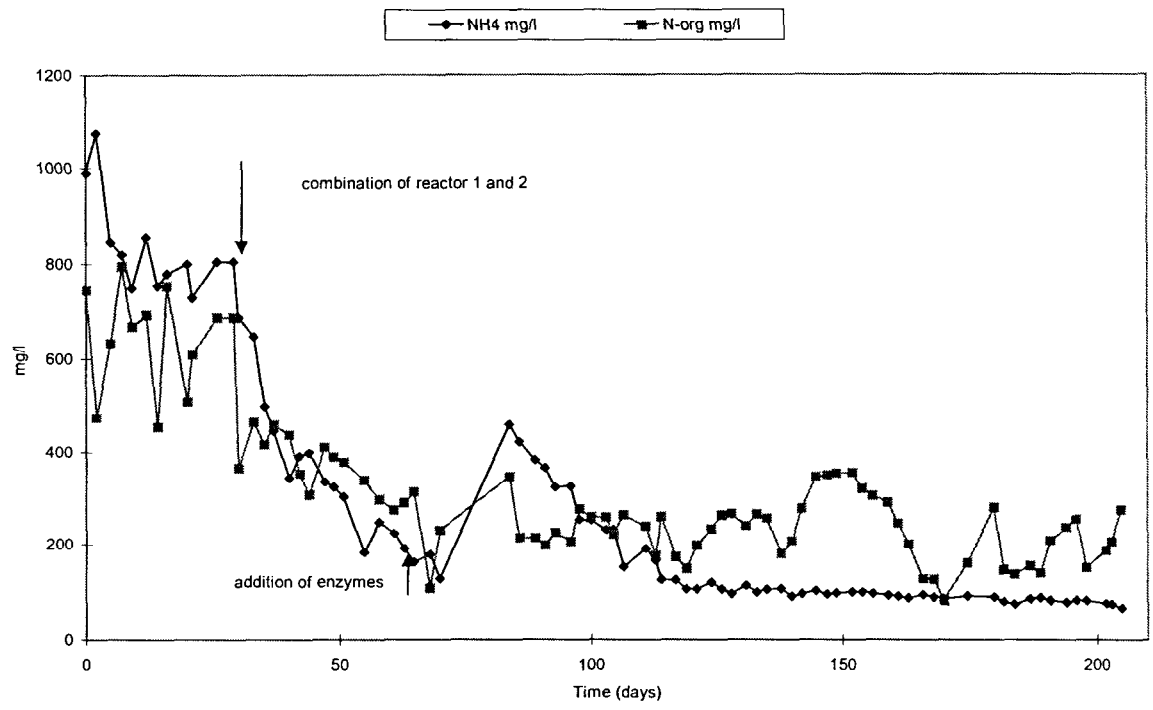


Figure 3-6 Reactor 2: NH<sub>4</sub> and N-org in reactor



### 3.2.3 NH<sub>4</sub> and N-org

The same phenomenon can be observed. A decrease in NH<sub>4</sub> and N-org due to an alteration in feeding regime is noticed in Figure 3-6. The increase of NH<sub>4</sub> and N-org at day 69 was due to the addition of gelatine during the Christmas period. Due to the fact that not all ammonium could be separated from the cake and therefore the NH<sub>4</sub>-N concentration in the cake was variable, fluctuations in NH<sub>4</sub>-N concentrations can be noticed.

### 3.2.4 Volatile fatty acids

The volatile fatty acids decreased due to a change in feeding regime and due to the production of methane. An increase was noticed after the Christmas period when starch and gelatine were fed into the reactor. Starch is considered as 100% biodegraded by anaerobic bacteria and therefore an increase in volatile fatty acids was observed. Mainly propionic acid was produced, what can be seen in Figure 3-8.

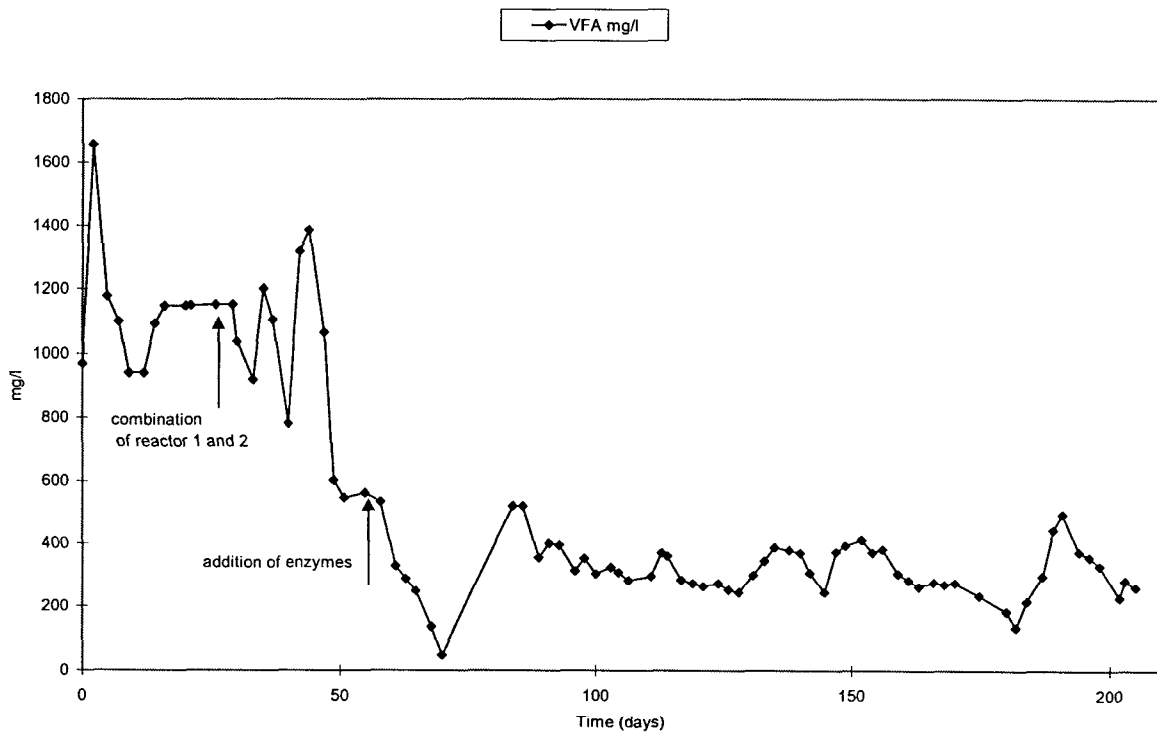


Figure 3-7 Reactor 2: Volatile fatty acids in reactor

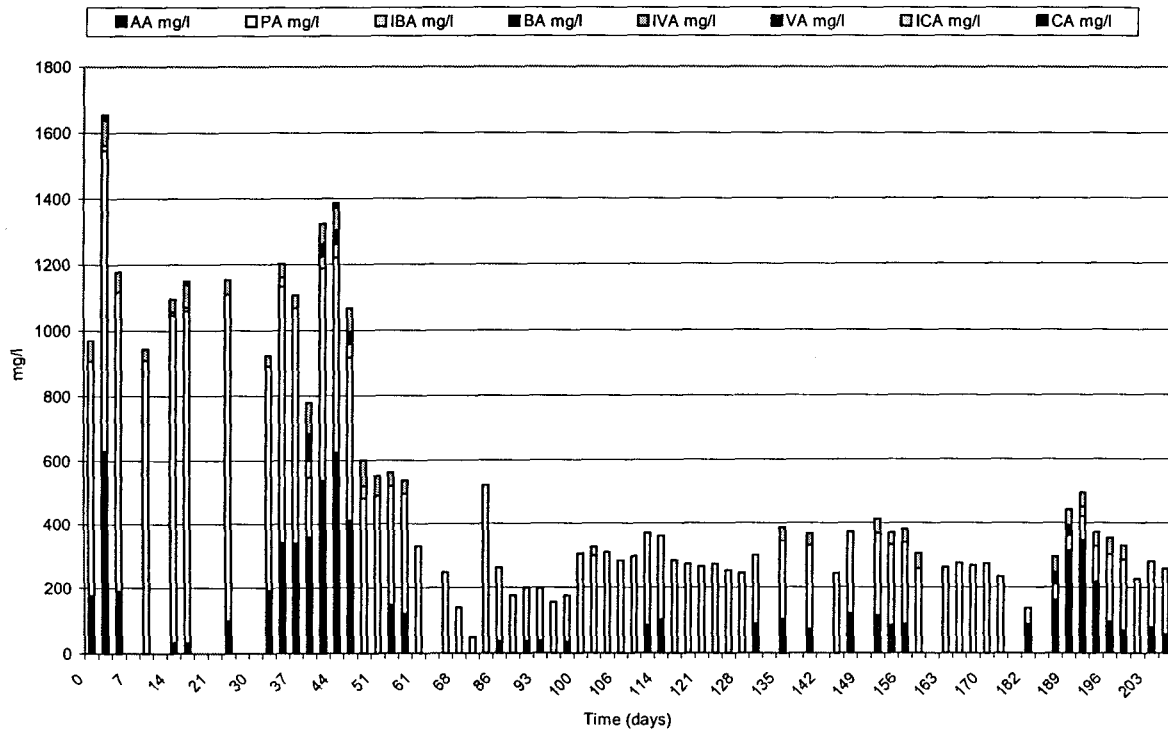


Figure 3-8 Reactor 2: VFA composition in feed

### 3.2.5 Gas production

The cumulative gas production is represented in Figure 3-9. Before the two reactors were combined, the second demonstration reactor was fed with fresh faecal material. This resulted in high biogas productions. When the two reactors were combined, the second demonstration reactor was fed with the cake of the first reactor and smaller biogas productions can be observed. The biogas present in the second reactor consisted of an average of 70 vol% methane and 30 vol% CO<sub>2</sub>.

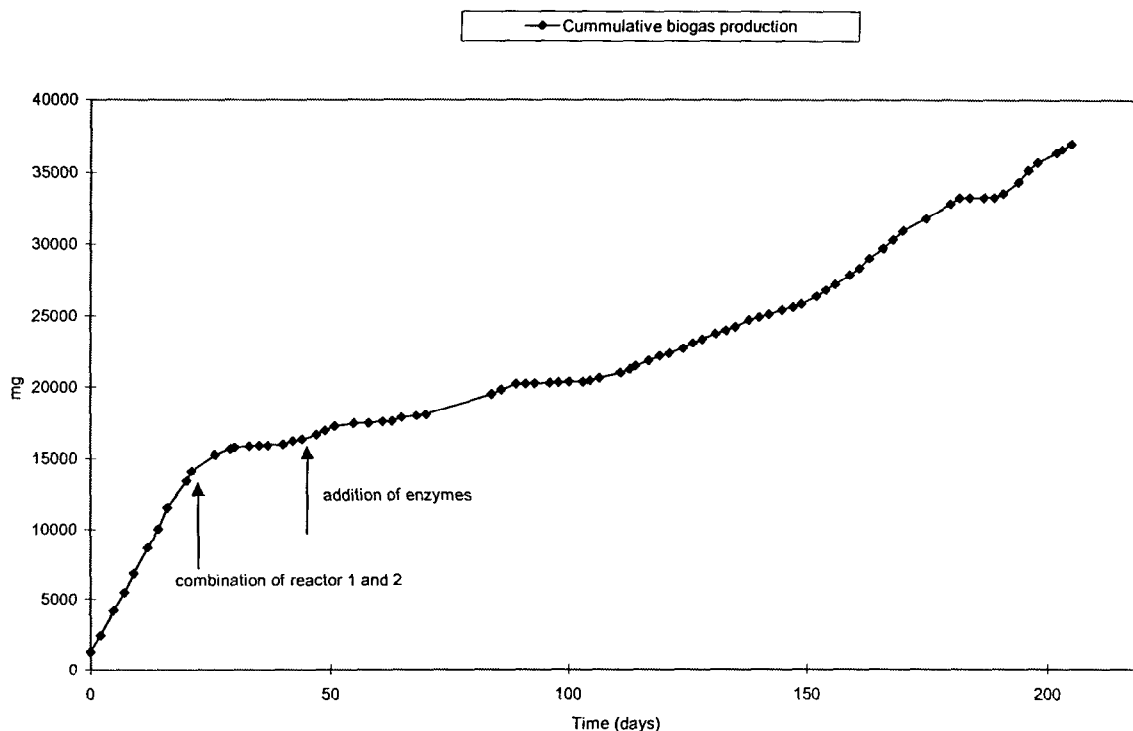


Figure 3-9 Reactor 2: Cumulative biogas production

### 3.2.6 Conversion efficiencies

At pH 8 methanogens are active and therefore higher total conversion efficiencies in comparison with MELISSA efficiencies can be observed. The total conversion efficiency reached a stable value of around 38%. Proteins were converted for 40% and fibres for 37%. The fibre efficiency found in reactor 2 reached a higher value than the one obtained in reactor 1. This is possible due to the addition of enzymes. Also the produced VFA and  $\text{NH}_4$  in reactor 1 are removed by centrifugation. Only the cake, containing small amounts of VFA and  $\text{NH}_4$ , was fed in the second reactor. Therefore the acidification can continue in reactor 2 without being inhibited by its own reaction products (VFA and  $\text{NH}_4$ ).

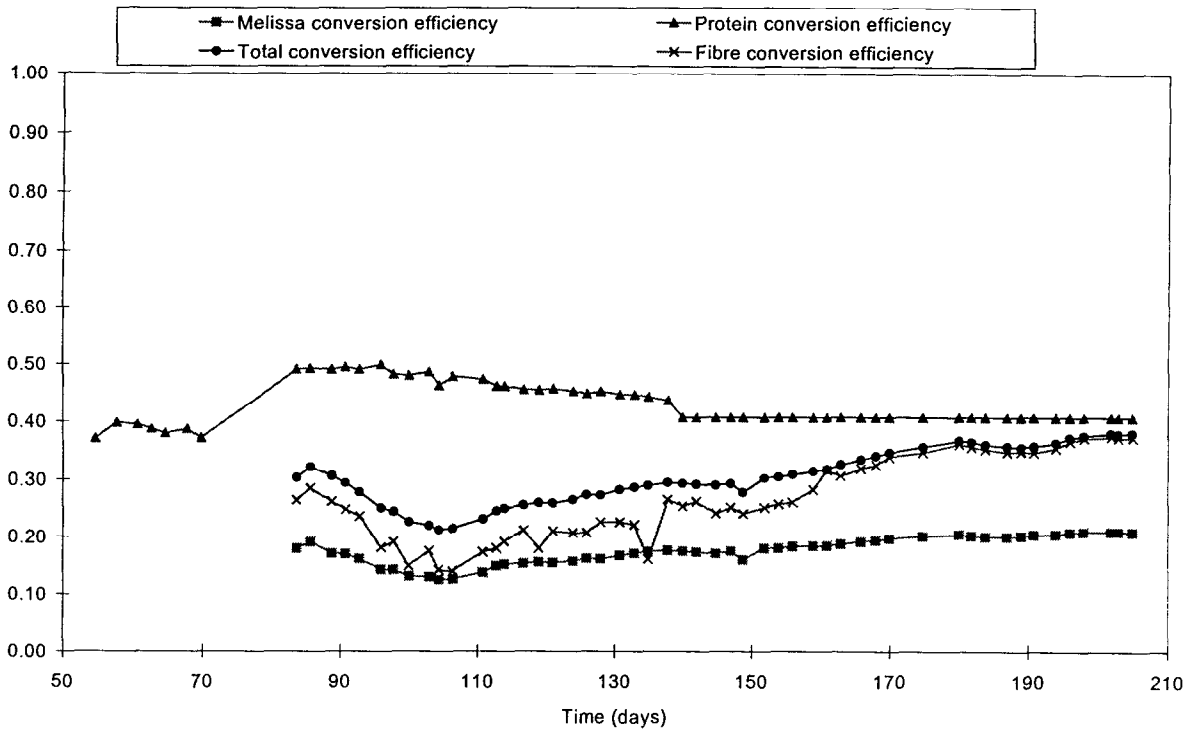


Figure 3-10 Reactor 2: Conversion efficiencies after the addition of enzymes

## 4. Combination of the two demonstration reactors

### 4.1 Conversion efficiency: maximal separation efficiency

The total conversion efficiency of the combined demonstration reactors, when maximal separation efficiencies of the organic matter can be obtained, is represented in Figure 4-3. The non-biodegraded faecal material of reactor 1 is separated from the produced VFA and  $\text{NH}_4$  by centrifugation. This non-biodegraded material is incubated with enzymes and fed in the second demonstration reactor. When maximal separation efficiencies could be obtained, all non-biodegraded organic material from reactor 1 is fed into the second reactor. When this occurred high conversion efficiencies were feasible. A total conversion efficiency of 63% was present. Proteins were converted for 75% and fibres for 55% (Figure 4-1).

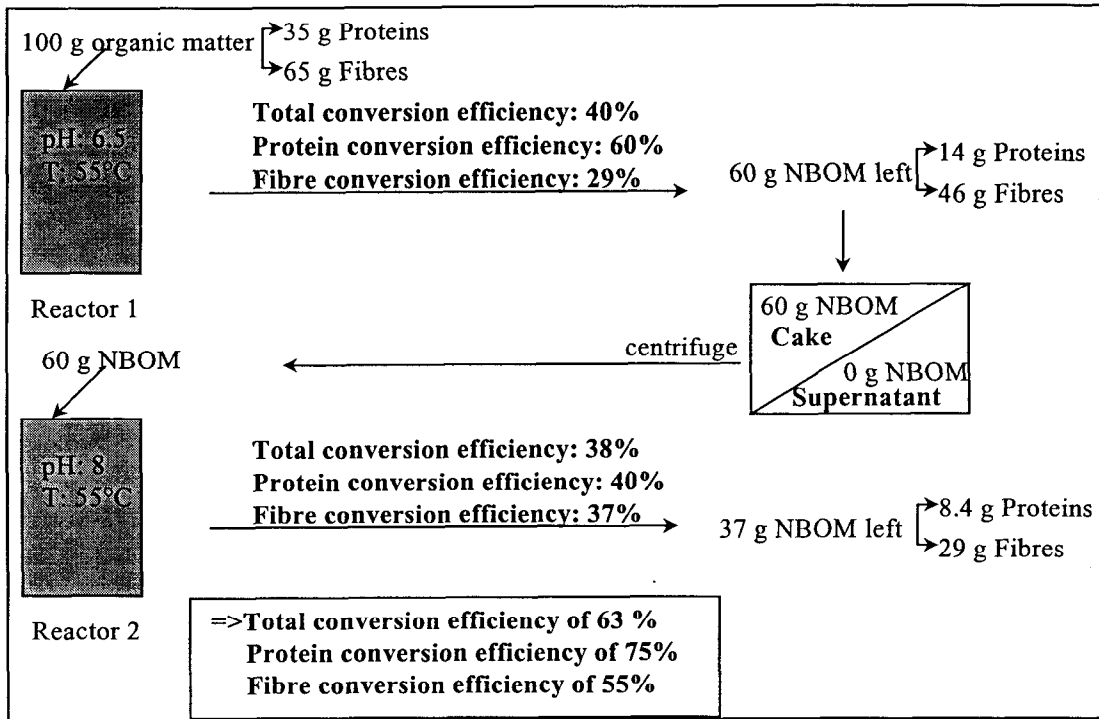


Figure 4-1 Combination of the two demonstration reactors: Maximal separation efficiency

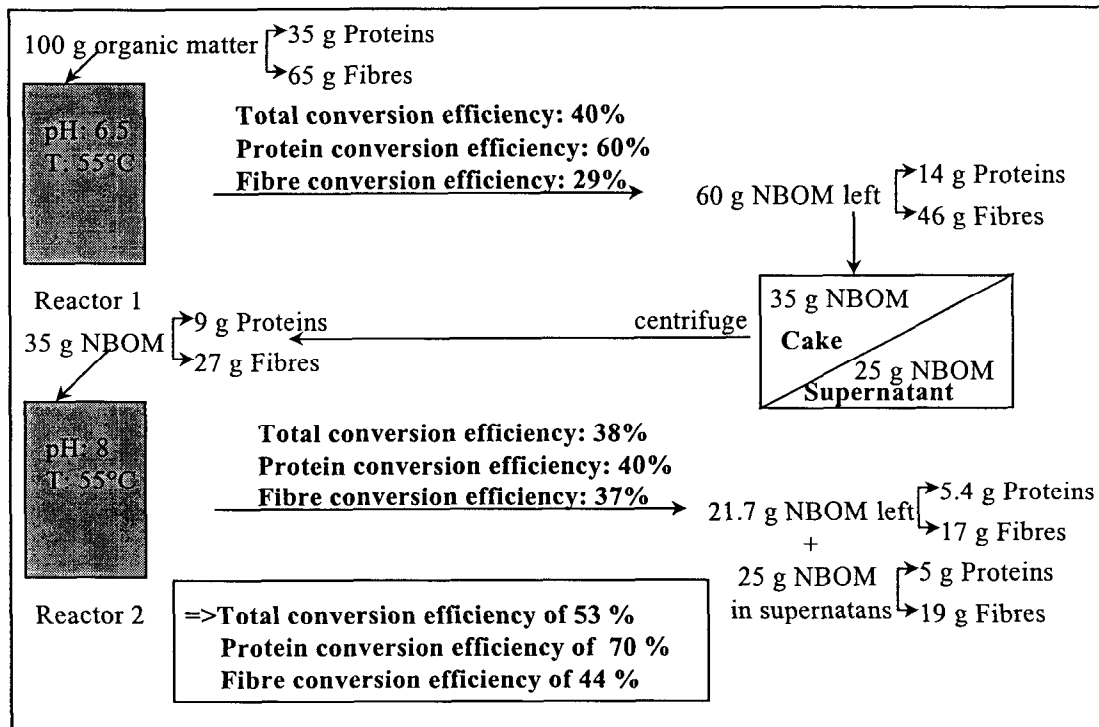


Figure 4-2 Combination of the two demonstration reactors: 58% separation efficiency

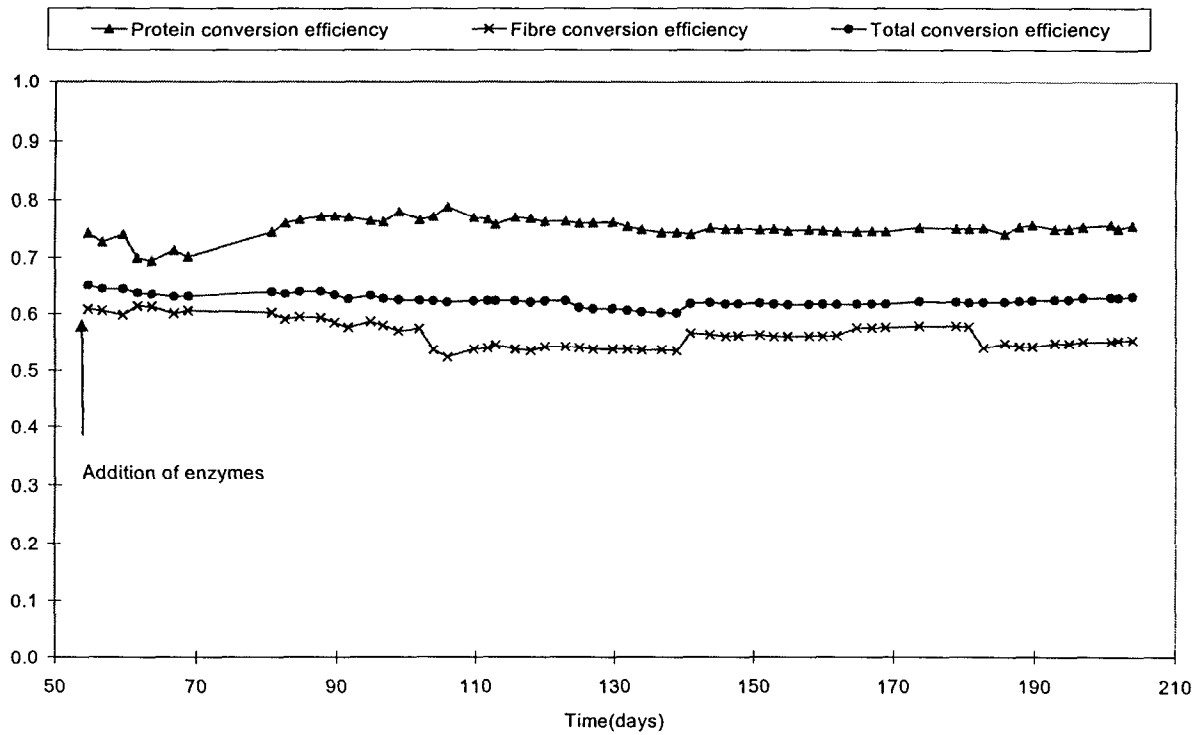


Figure 4-3 Combination of reactor 1+2: Conversion efficiencies (maximal separation efficiency)

#### 4.2 Conversion efficiency: 58% separation efficiency

In present conditions only 58% of the non-biodegraded organic material from effluent 1 can be recycled and fed in reactor 2. Therefore in this case the combination of the reactors resulted in conversion efficiencies, much lower than the one obtained when maximal separation efficiency is possible. In present conditions a total conversion efficiency of 53%, a protein conversion efficiency of 70% and a fibre conversion efficiency of 44% were reached (Figure 4-4).

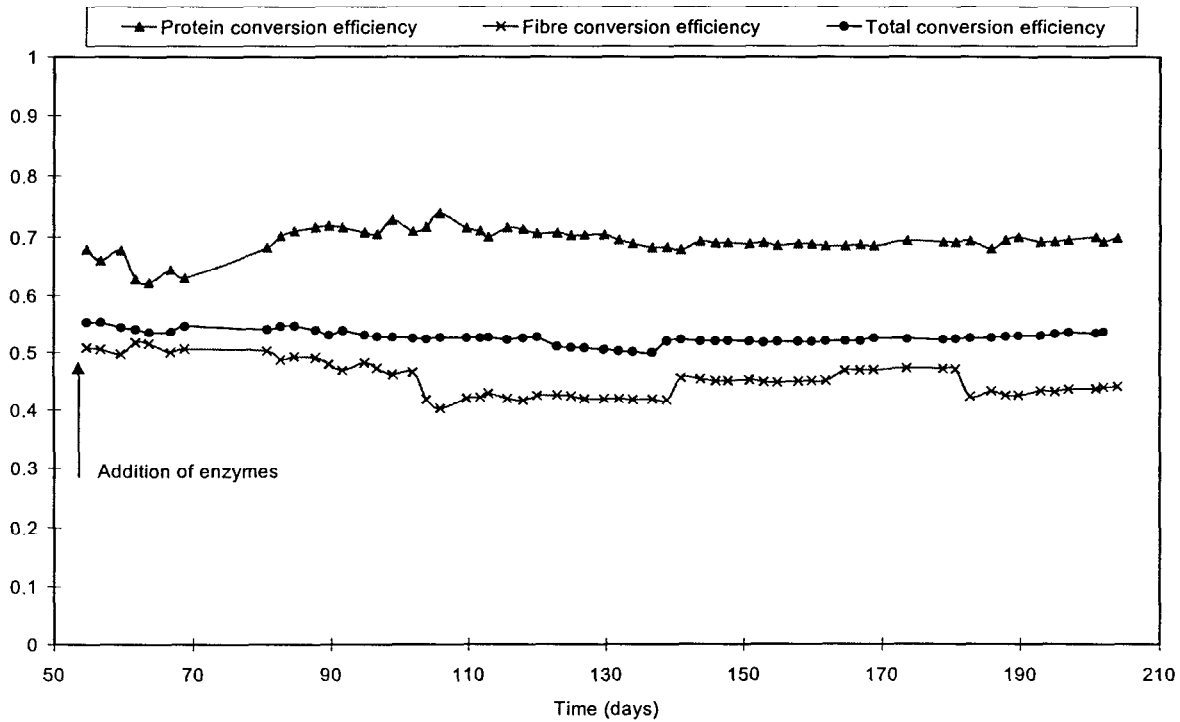


Figure 4-4 Combination of reactor 1+2: Conversion efficiencies (58% separation efficiency)

## 5. Conclusion

The microbial community of the MELISSA demonstration reactor was characterised, using DGGE analyses. Three dominant bacteria present in the reactor are related with *Ruminococcus bromii*, *Petrotoga mobilis* and CDC group DF-3. In future more detailed microbiological characterisation will be proposed.

The demonstration reactor was operated at a pH of 6.5. At this pH methanogens were inhibited and no methane was produced. The total conversion efficiency was equal to 40%. Proteins were converted for 60 and the conversion efficiency of fibres was 29%.

The second demonstration reactor, which was operated at pH 8 and fed with pretreated cake of reactor 1 had a total conversion efficiency of 38%. Proteins were converted for 40% and the fibrous fraction for 37%.

The combination of two demonstration reactors resulted in a higher conversion efficiency. Until now only 58% of the non-biodegraded organic matter can be separated from the effluent of the first demonstration reactor. Therefore a suitable filtration technique is necessary in order to increase the separation efficiency so a total conversion efficiency of 63%, protein conversion efficiency of 75% and fibre efficiency of 55% can be reached.

The final resistant fraction which is not biodegraded may be pretreated with hydrogen peroxide. Hydrogen peroxide is a strong oxidiser and can be produced by electrolysis.

## **6. References**

**Lien, T., Madsen, M., Rainey, F.A. and Birkeland, N.-K.** (1998). *Petrotoga mobilis* sp. nov., from a North Sea oil-production well. *International Journal of Systematic Bacteriology*, 48, 1007-1013.

**Vandamme, P., Vancanneyt, M., Van Belkum, A., Segers, P., Quint, W.G.V., Kersters, K., Paster, B.J. and Dewhirst, F.E.** (1996). Polyphasic analysis of strains of the genus *Capnocytophaga* and centers for disease control group DF-3. *International Journal of Systematic Bacteriology*, 46 (3), 782-791.



ADDENDUM REACTOR 1

Feed of reactor 1

Date	Day	pH	DM g/l	Ash g/l	NH <sub>4</sub> -N mg/l	Ntot mg/l	VFA mg/l	Amount L
16/09/98	0.0	6.5	18.81	2.96	67	685	1011	0.15
18/09/98	2.0	6.5	18.81	2.96	67	685	1011	0.15
21/09/98	5.0	6.5	18.81	2.96	67	685	1011	0.15
23/09/98	7.0	6.5	18.81	2.96	67	685	1011	0.15
25/09/98	9.2	6.5	18.81	2.96	67	685	1011	0.15
28/09/98	11.9	6.5	18.81	2.96	67	685	1011	0.15
30/09/98	13.9	6.5	18.81	2.96	67	685	1011	0.15
2/10/98	15.9	6.6	17.10	3.01	98	1405	1720	0.15
5/10/98	19.2	6.6	17.10	3.01	98	1405	1720	0.15
7/10/98	21.1	6.6	17.10	3.01	98	1405	1720	0.15
9/10/98	23.1	6.6	17.10	3.01	98	1405	1720	0.15
12/10/98	26.1	6.6	17.10	3.01	98	1405	1720	0.3
14/10/98	28.2	6.9	22.25	3.42	111	1405	705	0.15
16/10/98	30.2	6.9	22.25	3.42	111	1405	705	0.15
19/10/98	32.9	6.9	22.25	3.42	111	1405	705	0.15
21/10/98	35.1	6.5	19.32	2.65	57	1340	705	0.15
23/10/98	36.9	6.5	19.32	2.65	57	1340	705	0.15
26/10/98	40.0	6.5	19.32	2.65	57	1340	705	0.15
28/10/98	42.1	6.5	19.32	2.65	57	1340	705	0.15
30/10/98	44.0	6.5	19.32	2.65	57	1340	705	0.15
3/11/98	48.1	6.8	21.88	3.77	174	1700	1129	0.15
4/11/98	49.1	6.8	21.88	3.77	174	1700	1129	0.15
9/11/98	53.9	6.8	21.88	3.77	174	1700	1129	0.15
12/11/98	57.2	6.8	21.88	3.77	174	1700	1129	0.15
13/11/98	58.1	6.8	21.88	3.77	174	1700	1129	0.15
16/11/98	61.1	6.8	21.88	3.77	174	1700	1129	0.15
18/11/98	63.2	7.3	25.40	4.57	140	1410	671	0.15
20/11/98	65.1	7.3	25.40	4.57	140	1410	671	0.15
23/11/98	68.2	7.3	25.40	4.57	140	1410	671	0.15
25/11/98	70.2	7.3	25.40	4.57	140	1410	671	0.15
27/11/98	72.1	7.3	25.40	4.57	140	1410	671	0.15
30/11/98	75.2	7.5	26.00	4.00	98	1190	423	0.15
2/12/98	76.9	7.5	26.00	4.00	98	1190	423	0.15
4/12/98	78.9	7.5	26.00	4.00	98	1190	423	0.15
7/12/98	82.1	7.5	26.00	4.00	98	1190	423	0.3
9/12/98	84.0	7.5	26.00	4.00	98	1190	423	0.15
11/12/98	86.0	7.5	26.00	4.00	98	1190	423	0.15
14/12/98	88.9	7.5	26.00	4.00	98	1190	423	0.15
16/12/98	91.0	7	26.53	3.83	74	950	625	0.15
18/12/98	92.9	7	26.53	3.83	74	950	625	0.15
21/12/98	96.1	7	26.53	3.83	74	950	625	0.15
23/12/98	98.1	7	26.53	3.83	74	950	625	0.15
4/01/99	110.0	7	26.53	3.83	74	950	625	0.15
6/01/99	111.9	7	26.53	3.83	74	950	625	0.15
8/01/99	114.0	7	26.53	3.83	74	950	625	0.15
11/01/99	117.0	7	26.53	3.83	74	950	625	0.15
13/01/99	119.0	7	26.53	3.83	74	950	625	0.15
15/01/99	121.0	7	26.53	3.83	74	950	625	0.15
18/01/99	124.1	7	26.53	3.83	74	950	625	0.15
20/01/99	125.9	7	26.53	3.83	74	950	625	0.15
22/01/99	128.2	7	26.53	3.83	74	950	625	0.15
25/01/99	131.1	7	26.53	3.83	74	950	625	0.15
27/01/99	133.1	6.6	23.22	4.19	106	1200	1113	0.15
29/01/99	135.1	6.6	23.22	4.19	106	1200	1113	0.15
2/02/99	139.0	6.6	23.22	4.19	106	1200	1113	0.15
4/02/99	141.0	6.6	23.22	4.19	106	1200	1113	0.15
5/02/99	142.1	6.6	23.22	4.19	106	1200	1113	0.15
8/02/99	144.9	6.6	23.22	4.19	106	1200	1113	0.15
10/02/99	147.1	6.6	23.22	4.19	106	1200	1113	0.15
12/02/99	149.1	6.6	23.22	4.19	106	1200	1113	0.15
15/02/99	152.1	6.6	23.22	4.19	106	1200	1113	0.15
17/02/99	154.1	7.6	29.55	5.04	78	1290	541	0.15
19/02/99	156.1	7.6	29.55	5.04	78	1290	541	0.15
22/02/99	158.9	7.6	29.55	5.04	78	1290	541	0.15
24/02/99	161.1	7.6	29.55	5.04	78	1290	541	0.15
26/02/99	163.1	7.6	29.55	5.04	78	1290	541	0.15
1/03/99	165.9	7.6	29.55	5.04	78	1290	541	0.15
3/03/99	168.1	7.6	29.55	5.04	78	1290	541	0.3
5-03-99	170.1	7.4	31.59	4.97	94	1310	647	0.15
8-03-99	172.9	7.4	31.59	4.97	94	1310	647	0.15
10-03-99	175.1	7.4	31.59	4.97	94	1310	647	0.15

Date	Day	pH	DM g/l	Ash g/l	NH <sub>4</sub> -N mg/l	Ntot mg/l	VFA mg/l	Amount L
12-03-99	176.9	7.4	31.59	4.97	94	1310	647	0.15
15-03-99	180.1	7.4	31.59	4.97	94	1310	647	0.15
17-03-99	182.1	7.4	31.59	4.97	94	1310	647	0.15
19-03-99	184.1	7.4	31.59	4.97	94	1310	647	0.15
22-03-99	187.1	7.4	31.59	4.97	94	1310	647	0.15
24-03-99	189.1	7.4	31.59	4.97	94	1310	647	0.15
26-03-99	191.1	7.4	31.59	4.97	94	1310	647	0.15
29-03-99	194.0	6.7	21.12	2.64	136	805	978	0.15
31-03-99	196.1	6.7	21.12	2.64	136	805	978	0.15
2-04-99	198.1	6.7	21.12	2.64	136	805	978	0.15
7-04-99	202.9	6.7	21.12	2.64	136	805	978	0.15
12-04-99	208.1	6.7	21.12	2.64	136	805	978	0.15
14-04-99	209.9	6.7	21.12	2.64	136	805	978	0.15
16-04-99	212.0	6.9	17.03	2.67	45	905	786	0.15
19-04-99	215.0	6.9	17.03	2.67	45	905	786	0.15
21-04-99	217.1	6.9	17.03	2.67	45	905	786	0.15
23-04-99	218.9	6.9	17.03	2.67	45	905	786	0.15
26-04-99	222.1	6.9	17.03	2.67	45	905	786	0.15
28-04-99	224.1	6.9	17.03	2.67	45	905	786	0.15
30-04-99	226.1	6.9	17.03	2.67	45	905	786	0.15
4-05-99	230.1	6.9	17.03	2.67	45	905	786	0.15
5-05-99	231.1	6.9	17.03	2.67	45	905	786	0.15
7-05-99	233.1	6.9	17.03	2.67	45	905	786	0.15

with 28/10/98: pH set at 6.5

09/11/98: combination of reactor 1 and 2

### Volatile fatty acid composition in feed

Date	Day	VFA mg/l	AA mg/l	PA mg/l	IBA mg/l	BA mg/l	IVA mg/l	VA mg/l	ICA mg/l	CA mg/l
16/09/98	0.0	-	-	-	-	-	-	-	-	-
18/09/98	2.0	-	-	-	-	-	-	-	-	-
21/09/98	5.0	-	-	-	-	-	-	-	-	-
23/09/98	7.0	-	-	-	-	-	-	-	-	-
25/09/98	9.2	-	-	-	-	-	-	-	-	-
28/09/98	11.9	-	-	-	-	-	-	-	-	-
30/09/98	13.9	-	-	-	-	-	-	-	-	-
2/10/98	15.9	1720.00	709.00	317.00	16.00	507.00	24.00	73.00	0.00	74.00
5/10/98	19.2	1720.00	709.00	317.00	16.00	507.00	24.00	73.00	0.00	74.00
7/10/98	21.1	1720.00	709.00	317.00	16.00	507.00	24.00	73.00	0.00	74.00
9/10/98	23.1	1720.00	709.00	317.00	16.00	507.00	24.00	73.00	0.00	74.00
12/10/98	26.1	1720.00	709.00	317.00	16.00	507.00	24.00	73.00	0.00	74.00
14/10/98	28.2	705.00	0.00	705.00	0.00	0.00	0.00	0.00	0.00	0.00
16/10/98	30.2	705.00	0.00	705.00	0.00	0.00	0.00	0.00	0.00	0.00
19/10/98	32.9	705.00	0.00	705.00	0.00	0.00	0.00	0.00	0.00	0.00
21/10/98	35.1	-	-	-	-	-	-	-	-	-
23/10/98	36.9	-	-	-	-	-	-	-	-	-
26/10/98	40.0	-	-	-	-	-	-	-	-	-
28/10/98	42.1	-	-	-	-	-	-	-	-	-
30/10/98	44.0	-	-	-	-	-	-	-	-	-
3/11/98	48.1	1129.29	464.34	174.58	39.11	306.89	60.64	46.24	0.00	37.49
4/11/98	49.1	1129.29	464.34	174.58	39.11	306.89	60.64	46.24	0.00	37.49
9/11/98	53.9	1129.29	464.34	174.58	39.11	306.89	60.64	46.24	0.00	37.49
12/11/98	57.2	1129.29	464.34	174.58	39.11	306.89	60.64	46.24	0.00	37.49
13/11/98	58.1	1129.29	464.34	174.58	39.11	306.89	60.64	46.24	0.00	37.49
16/11/98	61.1	1129.29	464.34	174.58	39.11	306.89	60.64	46.24	0.00	37.49
18/11/98	63.2	670.62	276.42	122.56	41.63	128.11	68.36	33.54	0.00	0.00
20/11/98	65.1	670.62	276.42	122.56	41.63	128.11	68.36	33.54	0.00	0.00
23/11/98	68.2	670.62	276.42	122.56	41.63	128.11	68.36	33.54	0.00	0.00
25/11/98	70.2	670.62	276.42	122.56	41.63	128.11	68.36	33.54	0.00	0.00
27/11/98	72.1	670.62	276.42	122.56	41.63	128.11	68.36	33.54	0.00	0.00
30/11/98	75.2	422.89	199.53	63.23	33.19	52.21	52.95	21.78	0.00	0.00
2/12/98	76.9	422.89	199.53	63.23	33.19	52.21	52.95	21.78	0.00	0.00
4/12/98	78.9	422.89	199.53	63.23	33.19	52.21	52.95	21.78	0.00	0.00
7/12/98	82.1	422.89	199.53	63.23	33.19	52.21	52.95	21.78	0.00	0.00
9/12/98	84.0	422.89	199.53	63.23	33.19	52.21	52.95	21.78	0.00	0.00
11/12/98	86.0	422.89	199.53	63.23	33.19	52.21	52.95	21.78	0.00	0.00
14/12/98	88.9	422.89	199.53	63.23	33.19	52.21	52.95	21.78	0.00	0.00
16/12/98	91.0	624.56	276.89	131.04	32.60	99.81	48.54	35.69	0.00	0.00
18/12/98	92.9	624.56	276.89	131.04	32.60	99.81	48.54	35.69	0.00	0.00
21/12/98	96.1	624.56	276.89	131.04	32.60	99.81	48.54	35.69	0.00	0.00
23/12/98	98.1	624.56	276.89	131.04	32.60	99.81	48.54	35.69	0.00	0.00
4/01/99	110.0	624.56	276.89	131.04	32.60	99.81	48.54	35.69	0.00	0.00
6/01/99	111.9	624.56	276.89	131.04	32.60	99.81	48.54	35.69	0.00	0.00
8/01/99	114.0	624.56	276.89	131.04	32.60	99.81	48.54	35.69	0.00	0.00
11/01/99	117.0	624.56	276.89	131.04	32.60	99.81	48.54	35.69	0.00	0.00
13/01/99	119.0	624.56	276.89	131.04	32.60	99.81	48.54	35.69	0.00	0.00
15/01/99	121.0	624.56	276.89	131.04	32.60	99.81	48.54	35.69	0.00	0.00
18/01/99	124.1	624.56	276.89	131.04	32.60	99.81	48.54	35.69	0.00	0.00
20/01/99	125.9	624.56	276.89	131.04	32.60	99.81	48.54	35.69	0.00	0.00
22/01/99	128.2	624.56	276.89	131.04	32.60	99.81	48.54	35.69	0.00	0.00
25/01/99	131.1	624.56	276.89	131.04	32.60	99.81	48.54	35.69	0.00	0.00
27/01/99	133.1	1112.73	642.14	147.32	33.06	185.47	49.11	27.60	0.00	28.03
29/01/99	135.1	1112.73	642.14	147.32	33.06	185.47	49.11	27.60	0.00	28.03
2/02/99	139.0	1112.73	642.14	147.32	33.06	185.47	49.11	27.60	0.00	28.03
4/02/99	141.0	1112.73	642.14	147.32	33.06	185.47	49.11	27.60	0.00	28.03
5/02/99	142.1	1112.73	642.14	147.32	33.06	185.47	49.11	27.60	0.00	28.03
8/02/99	144.9	1112.73	642.14	147.32	33.06	185.47	49.11	27.60	0.00	28.03
10/02/99	147.1	1112.73	642.14	147.32	33.06	185.47	49.11	27.60	0.00	28.03
12/02/99	149.1	1112.73	642.14	147.32	33.06	185.47	49.11	27.60	0.00	28.03
15/02/99	152.1	1112.73	642.14	147.32	33.06	185.47	49.11	27.60	0.00	28.03
17/02/99	154.1	541.13	263.77	84.03	39.95	58.91	67.58	26.89	0.00	0.00
19/02/99	156.1	541.13	263.77	84.03	39.95	58.91	67.58	26.89	0.00	0.00
22/02/99	158.9	541.13	263.77	84.03	39.95	58.91	67.58	26.89	0.00	0.00
24/02/99	161.1	541.13	263.77	84.03	39.95	58.91	67.58	26.89	0.00	0.00
26/02/99	163.1	541.13	263.77	84.03	39.95	58.91	67.58	26.89	0.00	0.00
1/03/99	165.9	541.13	263.77	84.03	39.95	58.91	67.58	26.89	0.00	0.00
3/03/99	168.1	541.13	263.77	84.03	39.95	58.91	67.58	26.89	0.00	0.00
5-03-99	170.1	647.37	343.48	96.94	28.00	92.95	59.56	26.44	0.00	0.00
8-03-99	172.9	647.37	343.48	96.94	28.00	92.95	59.56	26.44	0.00	0.00
10-03-99	175.1	647.37	343.48	96.94	28.00	92.95	59.56	26.44	0.00	0.00
12-03-99	176.9	647.37	343.48	96.94	28.00	92.95	59.56	26.44	0.00	0.00

Date	Day	VFA mg/l	AA mg/l	PA mg/l	IBA mg/l	BA mg/l	IVA mg/l	VA mg/l	ICA mg/l	CA mg/l
15-03-99	180.1	647.37	343.48	96.94	28.00	92.95	59.56	26.44	0.00	0.00
17-03-99	182.1	647.37	343.48	96.94	28.00	92.95	59.56	26.44	0.00	0.00
19-03-99	184.1	647.37	343.48	96.94	28.00	92.95	59.56	26.44	0.00	0.00
22-03-99	187.1	647.37	343.48	96.94	28.00	92.95	59.56	26.44	0.00	0.00
24-03-99	189.1	647.37	343.48	96.94	28.00	92.95	59.56	26.44	0.00	0.00
26-03-99	191.1	647.37	343.48	96.94	28.00	92.95	59.56	26.44	0.00	0.00
29-03-99	194.0	977.72	447.56	177.81	39.67	191.46	58.39	39.06	0.00	23.77
31-03-99	196.1	977.72	447.56	177.81	39.67	191.46	58.39	39.06	0.00	23.77
2-04-99	198.1	977.72	447.56	177.81	39.67	191.46	58.39	39.06	0.00	23.77
7-04-99	202.9	977.72	447.56	177.81	39.67	191.46	58.39	39.06	0.00	23.77
12-04-99	208.1	977.72	447.56	177.81	39.67	191.46	58.39	39.06	0.00	23.77
14-04-99	209.9	977.72	447.56	177.81	39.67	191.46	58.39	39.06	0.00	23.77
16-04-99	212.0	786.31	342.80	167.05	29.64	127.37	38.46	49.15	0.00	31.84
19-04-99	215.0	786.31	342.80	167.05	29.64	127.37	38.46	49.15	0.00	31.84
21-04-99	217.1	786.31	342.80	167.05	29.64	127.37	38.46	49.15	0.00	31.84
23-04-99	218.9	786.31	342.80	167.05	29.64	127.37	38.46	49.15	0.00	31.84
26-04-99	222.1	786.31	342.80	167.05	29.64	127.37	38.46	49.15	0.00	31.84
28-04-99	224.1	786.31	342.80	167.05	29.64	127.37	38.46	49.15	0.00	31.84
30-04-99	226.1	786.31	342.80	167.05	29.64	127.37	38.46	49.15	0.00	31.84
4-05-99	230.1	786.31	342.80	167.05	29.64	127.37	38.46	49.15	0.00	31.84
5-05-99	231.1	786.31	342.80	167.05	29.64	127.37	38.46	49.15	0.00	31.84
7-05-99	233.1	786.31	342.80	167.05	29.64	127.37	38.46	49.15	0.00	31.84

with 28/10/98: pH set at 6.5

09/11/98: combination of reactor 1 and 2

### Parameters of Reactor 1

Date	Day	Volume L	pH	EC mS	DM g/l	Ash g/l	NH <sub>4</sub> -N mg/l	Ntot mg/l	N-org mg/l	VFA mg/l	Gas cm	Gas ml	CH <sub>4</sub> %	CO <sub>2</sub> mg
16/09/98	0.0	1.1	7.8	11.00	14.18	2.54	1345	1970	625	1216	14.9	749	62.55	509
18/09/98	2.0	1.1	7.8	10.82	12.12	2.35	1400	1875	475	1281	14.9	749	62.55	509
21/09/98	5.0	1.1	7.6	10.61	12.16	2.53	1270	1805	535	1042	14.9	749	62.55	509
23/09/98	7.0	1.1	7.9	10.07	12.41	2.53	1315	1830	515	807	14.9	749	62.55	509
25/09/98	9.2	1.1	7.8	9.20	12.22	2.82	1170	1660	490	720	14.9	749	62.55	509
28/09/98	11.9	1.1	7.7	8.89	12.21	2.93	1150	1625	475	650	14.9	749	62.55	509
30/09/98	13.9	1.1	7.9	8.73	11.80	2.66	970	1655	685	564	14.9	749	62.55	509
2/10/98	15.9	1.1	8.2	7.71	10.51	2.43	1005	1855	850	652	12.0	603	62.55	410
5/10/98	19.2	1.1	7.8	8.08	11.57	2.63	995	1763	768	638	15.0	754	62.55	513
7/10/98	21.1	1.1	8.0	7.67	10.72	2.57	850	1717	867	764	23.8	1196	62.55	814
9/10/98	23.1	1.1	8.2	6.74	10.81	2.75	950	1670	720	747	16.0	804	62.55	547
12/10/98	26.1	1.1	8.0	7.11	13.09	2.83	955	1600	645	665	17.1	860	62.55	585
14/10/98	28.2	1	7.9	6.54	12.14	2.84	995	1670	675	896	27.7	1392	62.55	947
16/10/98	30.2	1	8.0	6.57	8.93	1.78	900	1720	820	857	17.3	870	62.55	591
19/10/98	32.9	1	7.7	6.92	12.91	2.72	845	1380	535	885	17.0	854	62.55	5811
21/10/98	35.1	1	7.8	6.57	12.10	2.58	845	1490	645	686	16.0	804	62.55	547
23/10/98	36.9	0.9	7.9	6.87	12.06	2.88	790	1585	795	550	20.3	1020	62.55	694
26/10/98	40.0	1.6	7.5	4.53	7.54	1.72	474	890	416	367	9.6	483	62.55	328
28/10/98	42.1	1.6	7.7	4.67	9.17	1.93	464	750	287	588	7.1	357	62.55	243
30/10/98	44.0	1.6	6.9	5.37	8.16	1.88	525	860	335	588	5.0	251	11.16	405
3/11/98	48.1	1.6	6.8	6.02	12.59	2.17	570	960	390	1247	4.7	236	11.16	381
4/11/98	49.1	1.6	7.0	5.09	12.60	2.54	525	975	450	1647	2.8	141	11.16	227
9/11/98	53.9	1.6	7.1	5.07	14.62	2.49	615	1110	495	2047	3.1	156	0	1149
12/11/98	57.2	1.6	6.4	6.81	12.87	2.43	650	1080	430	2079	0	0	0	835
13/11/98	58.1	1.6	6.7	6.13	16.89	2.48	595	1045	450	2075	0	0	0	835
16/11/98	61.1	1.6	6.5	7.19	17.03	2.96	660	1205	545	2558	0	0	0	1149
18/11/98	63.2	1.6	6.3	6.55	15.49	2.91	650	1115	465	2905	0	0	0	835
20/11/98	65.1	1.6	6.0	6.48	21.92	3.49	540	1155	615	3000	0	0	0	840
23/11/98	68.2	1.6	6.2	6.86	20.28	3.18	499	1145	647	3275	0	0	0	1200
25/11/98	70.2	1.6	6.4	6.62	20.39	5.34	690	1085	395	3645	0	0	0	850
27/11/98	72.1	1.6	6.4	6.98	17.79	3.57	740	1050	310	4053	0	0	0	850
30/11/98	75.2	1.6	6.3	7.08	20.08	4.66	800	1360	560	3985	0	0	0	1100
2/12/98	76.9	1.6	6.4	6.39	22.37	5.45	775	1450	675	3033	0	0	0	860
4/12/98	78.9	1.6	6.3	7.18	19.29	3.80	775	1555	780	3178	0	0	0	860
7/12/98	82.1	1.6	6.3	7.10	26.90	5.86	800	1495	695	3226	0	0	0	1100
9/12/98	84.0	1.6	6.6	6.95	21.14	6.31	775	1410	635	3276	0	0	0	845
11/12/98	86.0	1.6	6.6	6.99	23.05	6.76	715	1360	645	3032	0	0	0	845
14/12/98	88.9	1.6	6.4	7.13	24.84	6.45	765	1365	600	2943	0	0	0	1200
16/12/98	91.0	1.6	6.5	6.50	25.04	3.96	600	1360	760	2611	0	0	0	852
18/12/98	92.9	1.6	6.7	5.94	26.49	4.55	570	1355	785	2611	0	0	0	852
21/12/98	96.1	1.6	6.6	6.20	25.64	5.21	640	1355	715	2279	0	0	0	1100
23/12/98	98.1	1.6	6.8	6.00	24.21	4.56	580	1320	740	2496	0	0	0	845
4/01/99	110.0	1.6	6.7	6.71	20.09	3.39	765	1525	760	3093	0	0	0	1100
6/01/99	111.9	1.6	6.6	7.62	20.08	3.58	820	1390	570	2837	0	0	0	855
8/01/99	114.0	1.6	6.8	6.22	23.17	4.20	830	1415	585	3349	0	0	0	855
11/01/99	117.0	1.6	6.5	7.06	22.68	3.83	835	1443	608	3310	0	0	0	1100
13/01/99	119.0	1.6	6.5	6.98	21.13	3.75	820	1470	650	2852	0	0	0	855
15/01/99	121.0	1.6	6.4	7.31	20.57	3.51	790	1410	620	2313	0	0	0	855
18/01/99	124.1	1.6	6.5	6.94	21.09	4.39	740	1475	735	2876	0	0	0	1149
20/01/99	125.9	1.6	6.7	7.14	21.26	3.33	715	1473	758	2433	0	0	0	845
22/01/99	128.2	1.6	6.9	6.61	21.43	3.96	710	1470	760	2332	0	0	0	845
25/01/99	131.1	1.6	6.5	6.60	23.51	4.12	705	1380	675	2166	0	0	0	1149
27/01/99	133.1	1.6	6.7	6.88	23.58	4.09	730	1320	590	2237	0	0	0	835
29/01/99	135.1	1.6	6.7	6.42	21.84	4.13	725	1330	605	2117	0	0	0	835
2/02/99	139.0	1.6	6.7	7.00	19.80	3.70	720	1340	620	2214	0	0	0	1100
4/02/99	141.0	1.6	7.1	6.52	19.87	3.70	700	1300	600	2241	0	0	0	835
5/02/99	142.1	1.6	6.7	6.95	19.22	3.68	650	1260	610	2331	0	0	0	835
8/02/99	144.9	1.6	6.5	7.06	18.91	3.66	745	1290	545	2225	0	0	0	1148
10/02/99	147.1	1.6	6.5	6.9	21.07	4.43	734	1280	546	2063	0	0	0	683
12/02/99	149.1	1.6	6.5	7.20	18.93	3.83	695	1235	540	2375	0	0	0	876
15/02/99	152.1	1.6	6.4	7.22	19.89	4.04	710	1245	535	2254	0	0	0	1220
17/02/99	154.1	1.6	6.7	7.35	19.94	4.04	685	1255	570	2265	0	0	0	944
19/02/99	156.1	1.6	6.8	6.92	20.55	4.55	705	1310	605	2207	0	0	0	839
22/02/99	158.9	1.6	6.5	7.71	21.15	5.05	715	1475	760	2207	0	0	0	1077
24/02/99	161.1	1.6	6.4	7.50	19.98	4.41	665	1425	760	2161	0	0	0	763
26/02/99	163.1	1.6	6.8	7.01	20.95	3.86	635	1390	755	2115	0	0	0	716
1/03/99	165.9	1.6	6.7	7.31	23.29	4.63	605	1260	655	1996	0	0	0	1173
3/03/99	168.1	1.6	7.0	6.74	21.82	4.22	625	1305	680	2358	0	0	0	1079
5-03-99	170.1	1.6	6.9	6.70	21.79	4.32	615	1320	705	2665	0	0	0	1949
8-03-99	172.9	1.6	6.9	7.05	23.75	5.13	735	1435	700	2696	0	0	0	1742
10-03-99	175.1	1.6	6.8	6.69	23.07	4.92	725	1475	750	2583	0	0	0	742
12-03-99	176.9	1.6	6.6	6.88	23.71	4.70	735	1380	645	2715	0	0	0	1091

Date	Day	Volume L	pH m	EC mS	DM g/l	Ash g/l	NH <sub>4</sub> -N mg/l	Ntot mg/l	N-org mg/l	VFA mg/l	Gas cm	Gas ml	CH <sub>4</sub> %	CO <sub>2</sub> mg
15-03-99	180.1	1.6	6.7	7.03	25.23	4.97	725	1475	750	2460	0	0	0	1804
17-03-99	182.1	1.6	6.7	7.35	22.59	4.99	750	1493	743	2142	0	0	0	1335
19-03-99	184.1	1.6	6.7	7.52	22.78	4.61	715	1434	719	2001	0	0	0	1109
22-03-99	187.1	1.6	6.7	7.32	24.12	5.07	745	1375	630	2083	0	0	0	1528
24-03-99	189.1	1.6	6.7	6.64	24.05	5.10	740	1510	770	2198	0	0	0	1141
26-03-99	191.1	1.6	6.6	7.30	24.21	5.06	720	1350	630	2113	0	0	0	1310
29-03-99	194.0	1.6	6.8	7.50	23.04	4.89	725	1295	570	2177	0	0	0	1478
31-03-99	196.1	1.6	6.8	7.41	24.60	5.50	720	1240	520	2210	0	0	0	955
2-04-99	198.1	1.6	6.6	7.32	22.43	4.50	685	1230	545	2058	0	0	0	1084
7-04-99	202.9	1.6	6.9	7.30	21.53	4.30	750	1335	585	2153	0	0	0	1985
12-04-99	208.1	1.6	6.7	5.90	22.65	4.20	710	1325	615	2171	0	0	0	614
14-04-99	209.9	1.6	6.7	5.60	19.29	3.95	685	1200	515	2094	0	0	0	614
16-04-99	212.0	1.6	6.8	6.42	20.17	3.76	690	1400	710	2450	0	0	0	614
19-04-99	215.0	1.6	6.7	6.28	18.57	3.60	550	1105	555	2564	0	0	0	614
21-04-99	217.1	1.6	6.8	5.74	18.08	3.64	690	1080	390	2747	0	0	0	6114
23-04-99	218.9	1.6	6.6	4.12	17.465	3.59	720	1250	530	2987	0	0	0	614
26-04-99	222.1	1.6	6.3	3.92	20.38	3.665	625	1045	420	3026	0	0	0	1009
28-04-99	224.1	1.6	6.5	4.55	17.105	3.21	625	1065	440	2873	0	0	0	614
30-04-99	226.1	1.6	6.3	6.02	18.405	3.475	645	1165	520	3361	0	0	0	795
4-05-99	230.1	1.6	6.4	5.68	17.25	3.36	685	1265	580	3125	0	0	0	1609
5-05-99	231.1	1.6	6.6	5.25	17.475	3.23	595	1115	520	2949	0	0	0	420
7-05-99	233.1	1.6	6.6	5.58	17.495	3.355	645	1070	425	3265	0	0	0	790

with 28/10/98: pH set at 6.5

09/11/98: combination of reactor 1 and 2

**Volatile fatty acid composition of the reactor content 1**

Date	Day	VFA mg/l	AA mg/l	PA mg/l	IBA mg/l	BA mg/l	IVA mg/l	VA mg/l	ICA mg/l	CA mg/l
16/09/98	0.0	-	-	-	-	-	-	-	-	-
18/09/98	2.0	-	-	-	-	-	-	-	-	-
21/09/98	5.0	-	-	-	-	-	-	-	-	-
23/09/98	7.0	-	-	-	-	-	-	-	-	-
25/09/98	9.2	-	-	-	-	-	-	-	-	-
28/09/98	11.9	-	-	-	-	-	-	-	-	-
30/09/98	13.9	564.00	0.00	564.00	0.00	0.00	0.00	0.00	0.00	0.00
2/10/98	15.9	652.00	0.00	652.00	0.00	0.00	0.00	0.00	0.00	0.00
5/10/98	19.2	638.00	0.00	638.00	0.00	0.00	0.00	0.00	0.00	0.00
7/10/98	21.1	764.00	37.00	727.00	0.00	0.00	0.00	0.00	0.00	0.00
9/10/98	23.1	747.00	0.00	747.00	0.00	0.00	0.00	0.00	0.00	0.00
12/10/98	26.1	665.00	0.00	665.00	0.00	0.00	0.00	0.00	0.00	0.00
14/10/98	28.2	896.00	89.00	785.00	0.00	0.00	22.00	0.00	0.00	0.00
16/10/98	30.2	857.00	57.00	800.00	0.00	0.00	0.00	0.00	0.00	0.00
19/10/98	32.9	885.00	51.00	834.00	0.00	0.00	0.00	0.00	0.00	0.00
21/10/98	35.1	686.00	0.00	686.00	0.00	0.00	0.00	0.00	0.00	0.00
23/10/98	36.9	-	-	-	-	-	-	-	-	-
26/10/98	40.0	367.00	0.00	367.00	0.00	0.00	0.00	0.00	0.00	0.00
28/10/98	42.1	588.48	238.57	312.14	0.00	0.00	37.77	0.00	0.00	0.00
30/10/98	44.0	-	-	-	-	-	-	-	-	-
3/11/98	48.1	1246.66	671.50	353.84	43.21	69.72	108.39	0.00	0.00	0.00
4/11/98	49.1	-	-	-	-	-	-	-	-	-
9/11/98	53.9	2046.82	1085.60	500.02	86.66	152.87	190.43	16.14	0.00	15.10
12/11/98	57.2	2079.00	1070.00	490.00	109.00	176.00	213.00	21.00	0.00	0.00
13/11/98	58.1	2075.00	1018.00	487.00	110.00	200.00	224.00	21.00	0.00	15.00
16/11/98	61.1	2558.00	1231.00	599.00	143.00	255.00	286.00	25.00	0.00	19.00
18/11/98	63.2	2905.48	1394.09	678.27	161.91	294.99	323.67	29.00	0.00	23.55
20/11/98	65.1	-	-	-	-	-	-	-	-	-
23/11/98	68.2	-	-	-	-	-	-	-	-	-
25/11/98	70.2	3645.27	1699.65	849.08	220.70	378.19	444.51	30.87	0.00	22.27
27/11/98	72.1	4053.06	1854.62	945.63	259.25	410.61	526.65	33.98	0.00	22.32
30/11/98	75.2	3985.49	1796.78	954.29	261.15	394.72	525.21	32.69	0.00	20.65
2/12/98	76.9	3033.19	1453.09	805.51	236.87	492.86	28.23	0.00	0.00	16.64
4/12/98	78.9	3177.59	1356.05	789.45	227.50	333.74	470.85	0.00	0.00	0.00
7/12/98	82.1	3226.08	1227.79	842.94	248.04	352.66	508.73	29.48	0.00	16.45
9/12/98	84.0	3275.65	1324.13	877.60	237.64	330.54	505.75	0.00	0.00	0.00
11/12/98	86.0	3032.09	1066.99	813.85	253.67	340.51	526.72	30.36	0.00	0.00
14/12/98	88.9	2942.81	964.62	820.18	259.37	335.70	533.25	29.69	0.00	0.00
16/12/98	91.0	-	-	-	-	-	-	-	-	-
18/12/98	92.9	-	-	-	-	-	-	-	-	-
21/12/98	96.1	2279.24	619.25	659.60	226.23	270.58	477.24	26.32	0.00	0.00
23/12/98	98.1	2495.99	727.27	734.76	236.52	279.67	489.32	28.44	0.00	0.00
4/01/99	110.0	3093.42	724.28	1163.13	265.50	362.01	535.93	30.38	0.00	12.19
6/01/99	111.9	2837.11	621.38	1063.59	251.88	357.50	514.76	28.00	0.00	0.00
8/01/99	114.0	3348.63	765.24	1263.59	285.75	416.62	589.60	27.83	0.00	0.00
11/01/99	117.0	3310.23	683.96	1285.33	293.26	415.25	598.98	33.45	0.00	0.00
13/01/99	119.0	2852.14	556.17	1116.72	259.11	362.19	530.28	27.67	0.00	0.00
15/01/99	121.0	2616.38	469.10	1019.65	248.40	346.65	503.81	28.77	0.00	0.00
18/01/99	124.1	2875.75	365.30	1197.25	286.66	391.75	582.77	37.04	0.00	14.98
20/01/99	125.9	2432.76	261.93	1053.86	246.62	331.32	510.39	28.64	0.00	0.00
22/01/99	128.2	2331.56	167.51	1033.58	253.08	330.39	512.51	34.49	0.00	0.00
25/01/99	131.1	2165.98	83.71	942.21	252.22	322.25	530.67	34.92	0.00	0.00
27/01/99	133.1	2236.96	101.99	989.92	256.14	321.13	532.71	35.07	0.00	0.00
29/01/99	135.1	2116.81	162.57	892.28	237.81	299.24	496.30	28.61	0.00	0.00
2/02/99	139.0	2214.24	111.00	965.16	254.45	320.24	532.75	30.64	0.00	0.00
4/02/99	141.0	2240.94	157.21	964.28	249.33	319.29	519.83	31.02	0.00	0.00
5/02/99	142.1	2330.96	234.46	963.10	249.31	328.27	523.57	32.26	0.00	0.00
8/02/99	144.9	2224.79	225.09	909.67	237.34	310.46	496.12	29.79	0.00	16.33
10/02/99	147.1	2062.69	224.18	831.38	220.34	292.03	452.03	27.19	0.00	15.54
12/02/99	149.1	2375.10	258.35	952.45	250.89	337.89	526.00	30.94	0.00	18.58
15/02/99	152.1	2254.30	230.47	906.96	239.95	326.60	502.61	29.42	0.00	18.29
17/02/99	154.1	2265.09	316.01	866.56	234.97	320.31	487.10	24.93	0.00	15.20
19/02/99	156.1	2206.91	287.89	842.71	224.37	316.39	492.19	27.25	0.00	16.10
22/02/99	158.9	2206.91	220.60	850.26	227.45	310.13	503.99	79.37	0.00	15.11
24/02/99	161.1	-	-	-	-	-	-	-	-	-
26/02/99	163.1	2114.58	197.15	816.02	245.93	300.09	527.71	27.67	0.00	0.00
1/03/99	165.9	1996.19	264.37	765.13	206.17	259.94	462.96	37.61	0.00	0.00
3/03/99	168.1	2358.45	483.76	812.74	243.23	274.67	514.75	29.32	0.00	0.00
5-03-99	170.1	2665.41	749.39	821.07	247.03	270.41	515.70	61.81	0.00	0.00
8-03-99	172.9	2695.86	726.43	847.18	241.23	269.72	536.62	74.68	0.00	0.00
10-03-99	175.1	2583.27	609.55	863.75	250.81	275.90	556.22	27.04	0.00	0.00
12-03-99	176.9	2715.19	551.03	927.85	284.69	289.16	601.19	61.27	0.00	0.00

Date	Day	VFA mg/l	AA mg/l	PA mg/l	IBA mg/l	BA mg/l	IVA mg/l	VA mg/l	ICA mg/l	CA mg/l
15-03-99	180.1	2460.33	346.89	920.12	271.94	272.39	578.13	70.86	0.00	0.00
17-03-99	182.1	2141.74	219.57	823.80	262.13	257.37	554.50	24.37	0.00	0.00
19-03-99	184.1	2000.53	183.30	766.13	249.20	246.14	529.93	25.83	0.00	0.00
22-03-99	187.1	2082.55	154.18	823.71	260.78	255.20	559.40	29.28	0.00	0.00
24-03-99	189.1	2198.03	154.59	862.97	280.40	269.47	600.13	30.47	0.00	0.00
26-03-99	191.1	2113.09	168.60	833.86	265.10	252.13	567.63	25.77	0.00	0.00
29-03-99	194.0	2176.95	137.88	894.05	275.45	258.61	583.71	27.25	0.00	0.00
31-03-99	196.1	2209.64	182.59	890.46	270.79	261.44	575.64	28.72	0.00	0.00
2-04-99	198.1	2058.03	235.73	779.68	243.75	250.37	520.53	27.97	0.00	0.00
7-04-99	202.9	2152.56	81.28	913.56	269.63	278.45	577.87	31.77	0.00	0.00
12-04-99	208.1	2170.79	67.32	917.97	270.74	284.73	578.68	36.55	0.00	14.80
14-04-99	209.9	2093.81	197.82	813.73	244.87	264.81	539.97	32.61	0.00	0.00
16-04-99	212.0	2449.89	421.36	868.26	255.61	278.23	564.43	42.39	0.00	19.61
19-04-99	215.0	2563.77	616.69	862.50	241.54	271.95	514.02	38.83	0.00	18.24
21-04-99	217.1	2747.23	767.18	876.04	254.31	273.42	516.25	40.68	0.00	19.35
23-04-99	218.9	2986.60	940.44	913.64	259.62	282.74	525.97	42.28	0.00	21.91
26-04-99	222.1	3026.48	1050.37	886.63	238.73	287.67	499.74	41.55	0.00	21.79
28-04-99	224.1	2872.77	1021.63	826.75	221.99	276.65	464.83	39.82	0.00	21.10
30-04-99	226.1	3361.27	1227.87	960.12	251.96	326.72	525.56	45.33	0.00	23.71
4-05-99	230.1	3124.66	997.34	959.70	257.01	327.20	519.67	41.30	0.00	22.44
5-05-99	231.1	2949.12	922.08	893.52	236.82	312.85	505.05	48.44	0.00	30.36
7-05-99	233.1	3264.98	1035.24	1002.42	261.86	346.96	534.64	51.61	0.00	32.25

with 28/10/98: pH set at 6.5

09/11/98: combination of reactor 1 and 2



ADDENDUM REACTOR 2

Feed of reactor 2

Date	Day	pH	DM g/l	Ash g/l	NH <sub>4</sub> -N mg/l	Ntot mg/l	VFA mg/l	Amount L
14/10/98	0.0	6.9	22.25	3.42	111	1405	705	0.15
16/10/98	2.0	6.9	22.25	3.42	111	1405	705	0.15
19/10/98	4.7	6.9	22.25	3.42	111	1405	705	0.15
21/10/98	7.0	6.5	19.32	2.65	57	1340	705	0.15
23/10/98	9.0	6.5	19.32	2.65	57	1340	705	0.15
26/10/98	11.8	6.5	19.32	2.65	57	1340	705	0.15
28/10/98	14.0	6.9	22.25	3.42	111	1405	705	0.15
30/10/98	15.9	6.5	19.32	2.65	57	1340	705	0.15
3/11/98	19.9	6.5	19.32	2.65	57	1340	705	0.15
4/11/98	20.9	6.8	21.88	3.77	174	1700	577	0.15
9/11/98	25.7	7.1	14.62	2.49	174	1110	577	0.1
12/11/98	29.0	7.1	7.87	1.16	104	404	450	0.1
13/11/98	29.9	7.1	7.87	1.16	104	404	450	0.1
16/11/98	33.0	7.1	7.87	1.16	104	404	450	0.1
18/11/98	35.0	7.1	7.87	1.16	104	404	450	0.1
20/11/98	36.9	7.1	7.87	1.16	104	404	450	0.1
23/11/98	40.0	6.9	10.31	1.37	95	411	807	0.1
25/11/98	42.0	6.9	10.31	1.37	95	411	807	0.1
27/11/98	43.9	6.7	8.31	1.16	128	281	807	0.1
30/11/98	47.0	6.7	8.31	1.16	128	281	807	0.1
2/12/98	48.7	6.7	7.52	0.76	44	289	243.01	0.1
4/12/98	50.7	6.6	7.82	0.81	44	311	591.48	0.1
8/12/98	54.7	6.8	6.81	0.94	51.5	237.5	530.73	0.1
11/12/98	57.8	6.8	6.81	0.63	59	164	469.97	0.1
14/12/98	60.7	6.8	6.40	0.79	48	195	196.15	0.1
16/12/98	62.8	6.8	7.06	1.37	37	249	483.11	0.1
18/12/98	64.7	6.8	5.93	0.60	25	303	483.11	0.1
21/12/98	67.9	6.8	6.09	0.85	36	247	156	0.1
23/12/98	69.9	6.8	7.71	0.95	43	278	172	0.1
6/01/99	83.7	6.8	5.38	0.61	39	170	157	0.1
8/01/99	85.7	6.8	6.02	0.57	36	191	130	0.1
11/01/99	88.8	6.8	5.70	0.63	36	194	131	0.1
13/01/99	90.8	6.8	4.94	0.47	36	172	128	0.1
15/01/99	92.8	6.8	6.23	0.66	38	186	139	0.1
18/01/99	95.9	6.8	5.68	0.55	39.5	218.5	109	0.1
20/01/99	97.7	6.8	6.46	0.71	37	202	102	0.1
22/01/99	100.0	6.8	4.52	0.60	27	173	89	0.1
25/01/99	102.9	6.8	5.68	0.67	37	151	113	0.1
27/01/99	104.4	6.8	5.38	0.65	31	198	98	0.1
29/01/99	106.4	6.8	5.38	0.65	31	198	98	0.1
2/02/99	110.8	6.8	5.29	0.63	28	171	88	0.1
4/02/99	112.8	6.8	5.95	0.71	34	227	103	0.1
5/02/99	113.9	6.8	5.36	0.70	31	189	104	0.1
8/02/99	116.7	6.8	6.70	0.82	28	197	99	0.1
10/02/99	119.0	6.8	5.39	0.97	97	303	309	0.1
12/02/99	121.0	6.8	6.40	0.88	42	219	129	0.1
15/02/99	123.9	6.8	4.78	0.63	26	183	88	0.1
17/02/99	126.0	6.8	6.63	0.94	53	303	232	0.1
19/02/99	128.0	6.8	5.57	0.73	35	197	134	0.1
22/02/99	130.8	6.8	6.50	0.82	43	276	151	0.1
24/02/99	132.9	6.8	6.42	0.98	85	337	258	0.1
26/02/99	134.9	6.8	6.03	0.97	53	424	188	0.1
1/03/99	137.8	6.8	5.84	0.74	45	188	117	0.1
3/03/99	139.9	6.8	6.68	0.94	81	320	241	0.1
05-03-99	141.9	6.8	6.56	0.92	48	236	173	0.1
08-03-99	144.8	6.8	6.77	1.03	53	324	201	0.1
10-03-99	146.9	6.8	6.54	1.16	85	316	212	0.1
12-03-99	148.8	6.8	6.42	1.00	47	239	185	0.1
15-03-99	151.9	6.8	6.92	1.02	47	356	224	0.1
17-03-99	153.9	6.8	6.19	0.91	39	309	115	0.1
19-03-99	155.9	6.8	7.23	1.11	49	377	131	0.1
22-03-99	159.0	6.8	6.83	1.01	54	293	147	0.1
24-03-99	160.9	6.8	6.93	1.04	46	61	129	0.1
26-03-99	163.0	6.8	7.42	1.04	48	246	134	0.1
29-03-99	165.8	6.8	6.82	1.03	36	198	125	0.1
31-03-99	168.0	6.8	6.64	1.01	46	212	137	0.1
02-04-99	170.0	6.8	6.47	1.00	36	141	111	0.1
07-04-99	174.7	6.8	7.33	1.10	47	216	184	0.1
12-04-99	179.9	6.8	7.09	0.49	46	185	155	0.1
14-04-99	181.8	6.8	6.68	0.91	45	201	140	0.1
16-04-99	183.8	6.8	4.74	0.64	21	109	91	0.1

Date	Day	pH	DM g/l	Ash g/l	NH <sub>4</sub> -N mg/l	Ntot mg/l	VFA mg/l	Amount L
19-04-99	186.9	6.8	5.91	0.71	36	170	158	0.1
21-04-99	188.9	6.8	5.56	0.69	35	137	173	0.1
23-04-99	190.7	6.8	5.73	0.73	40	191	194	0.1
26-04-99	193.9	6.8	4.69	0.60	29	134	208	0.1
28-04-99	195.9	6.8	5.25	0.47	30	145	208	0.1
30-04-99	197.9	6.8	4.86	0.54	38	135	208	0.1
04-05-99	201.9	6.8	5.19	0.58	30	168	182	0.1
05-05-99	203.0	6.8	4.68	0.51	30	168	166	0.1
07-05-99	205.0	6.8	4.80	0.51	24	172	149	0.1

with: 09/11/98 combination of reactor 1 and 2  
08/12/98 addition of enzymes

**Volatile fatty acid composition in feed**

Date	Day	VFA mg/l	AA mg/l	PA mg/l	IBA mg/l	BA mg/l	IVA mg/l	VA mg/l	ICA mg/l	CA mg/l
14/10/98	0.0	705.00	0.00	705.00	0.00	0.00	0.00	0.00	0.00	0.00
16/10/98	2.0	705.00	0.00	705.00	0.00	0.00	0.00	0.00	0.00	0.00
19/10/98	4.7	705.00	0.00	705.00	0.00	0.00	0.00	0.00	0.00	0.00
21/10/98	7.0	705.00	0.00	705.00	0.00	0.00	0.00	0.00	0.00	0.00
23/10/98	9.0	705.00	0.00	705.00	0.00	0.00	0.00	0.00	0.00	0.00
26/10/98	11.8	705.00	0.00	705.00	0.00	0.00	0.00	0.00	0.00	0.00
28/10/98	14.0	705.00	0.00	705.00	0.00	0.00	0.00	0.00	0.00	0.00
30/10/98	15.9	705.00	0.00	705.00	0.00	0.00	0.00	0.00	0.00	0.00
3/11/98	19.9	705.00	0.00	705.00	0.00	0.00	0.00	0.00	0.00	0.00
4/11/98	20.9	-	-	-	-	-	-	-	-	-
9/11/98	25.7	-	-	-	-	-	-	-	-	-
12/11/98	29.0	-	-	-	-	-	-	-	-	-
13/11/98	29.9	-	-	-	-	-	-	-	-	-
16/11/98	33.0	449.58	198.81	103.44	36.55	51.45	59.33	0.00	0.00	0.00
18/11/98	35.0	-	-	-	-	-	-	-	-	-
20/11/98	36.9	-	-	-	-	-	-	-	-	-
23/11/98	40.0	806.98	375.43	188.59	55.23	88.55	99.18	0.00	0.00	0.00
25/11/98	42.0	-	-	-	-	-	-	-	-	-
27/11/98	43.9	-	-	-	-	-	-	-	-	-
30/11/98	47.0	806.59	348.97	191.61	63.34	84.74	117.93	0.00	0.00	0.00
2/12/98	48.7	243.01	107.39	57.12	0.00	33.87	44.63	0.00	0.00	0.00
4/12/98	50.7	-	-	-	-	-	-	-	-	-
8/12/98	54.7	-	-	-	-	-	-	-	-	-
11/12/98	57.8	939.94	356.67	243.99	78.95	105.55	154.79	0.00	0.00	0.00
14/12/98	60.7	392.29	130.37	97.67	41.54	50.28	72.43	0.00	0.00	0.00
16/12/98	62.8	966.21	316.28	266.95	89.67	115.30	178.01	0.00	0.00	0.00
18/12/98	64.7	-	-	-	-	-	-	-	-	-
21/12/98	67.9	155.81	45.12	39.25	18.94	21.11	31.40	0.00	0.00	0.00
23/12/98	69.9	171.92	49.78	44.94	20.24	22.62	34.34	0.00	0.00	0.00
6/01/99	83.7	156.90	40.40	49.04	17.96	20.60	28.90	0.00	0.00	0.00
8/01/99	85.7	130.43	33.00	38.55	15.82	18.51	24.57	0.00	0.00	0.00
11/01/99	88.8	130.85	33.72	38.77	15.63	18.54	24.20	0.00	0.00	0.00
13/01/99	90.8	127.59	31.68	37.09	15.70	18.59	24.54	0.00	0.00	0.00
15/01/99	92.8	139.00	33.93	43.42	16.35	19.48	25.82	0.00	0.00	0.00
18/01/99	95.9	108.78	0	44.92	17.08	20.19	26.60	0.00	0.00	0.00
20/01/99	97.7	102.18	0	41.99	16.23	18.97	24.99	0.00	0.00	0.00
22/01/99	100.0	88.68	0	34.83	14.79	17.02	22.05	0.00	0.00	0.00
25/01/99	102.9	112.90	0.00	45.67	17.73	20.33	29.18	0.00	0.00	0.00
27/01/99	104.4	98.24	0.00	37.55	16.33	18.34	26.02	0.00	0.00	0.00
29/01/99	106.4	-	-	-	-	-	-	-	-	-
2/02/99	110.8	88.22	0.00	33.14	15.08	16.83	23.17	0.00	0.00	0.00
4/02/99	112.8	103.18	0.00	40.91	16.64	18.80	26.83	0.00	0.00	0.00
5/02/99	113.9	104.11	0.00	40.87	16.92	19.18	27.13	0.00	0.00	0.00
8/02/99	116.7	99.30	0.00	38.50	16.35	18.56	25.90	0.00	0.00	0.00
10/02/99	119.0	308.70	39.46	118.45	35.84	44.66	70.30	0.00	0.00	0.00
12/02/99	121.0	129.21	0.00	52.56	19.82	23.44	33.40	0.00	0.00	0.00
15/02/99	123.9	88.12	0.00	32.15	15.15	17.38	23.45	0.00	0.00	0.00
17/02/99	126.0	232.30	32.90	85.50	27.84	34.88	51.19	0.00	0.00	0.00
19/02/99	128.0	133.51	32.96	37.71	17.11	19.57	26.16	0.00	0.00	0.00
22/02/99	130.8	150.89	34.67	45.70	18.63	21.87	30.02	0.00	0.00	0.00
24/02/99	132.9	257.97	43.63	92.78	30.45	34.85	56.24	0.00	0.00	0.00
26/02/99	134.9	-	-	-	-	-	-	-	-	-
1/03/99	137.8	117.44	0.00	45.05	19.07	21.41	31.91	0.00	0.00	0.00
3/03/99	139.9	240.73	47.63	85.37	23.46	31.85	52.41	0.00	0.00	0.00
05-03-99	141.9	173.12	48.06	49.49	19.71	21.46	34.39	0.00	0.00	0.00
08-03-99	144.8	201.18	66.90	54.96	17.87	23.06	38.39	0.00	0.00	0.00
10-03-99	146.9	211.98	64.96	61.48	22.20	23.47	39.87	0.00	0.00	0.00
12-03-99	148.8	184.53	50.43	54.15	20.67	21.81	37.48	0.00	0.00	0.00
15-03-99	151.9	224.08	57.27	72.43	18.81	26.38	49.20	0.00	0.00	0.00
17-03-99	153.9	115.03	0.00	45.62	18.45	19.19	31.77	0.00	0.00	0.00
19-03-99	155.9	131.00	0.00	52.88	20.48	21.72	35.93	0.00	0.00	0.00
22-03-99	159.0	146.89	0.00	58.09	22.83	23.15	42.83	0.00	0.00	0.00
24-03-99	160.9	128.54	0.00	49.63	20.61	20.80	37.50	0.00	0.00	0.00
26-03-99	163.0	134.47	0.00	55.34	14.34	22.92	41.88	0.00	0.00	0.00
29-03-99	165.8	125.05	0.00	49.39	19.83	20.13	35.70	0.00	0.00	0.00
31-03-99	168.0	136.94	0.00	136.94	0.00	0.00	0.00	0.00	0.00	0.00
02-04-99	170.0	110.50	0.00	43.59	17.81	18.07	31.04	0.00	0.00	0.00
07-04-99	174.7	183.70	35.06	60.11	23.08	23.85	41.60	0.00	0.00	0.00
12-04-99	179.9	155.16	0.00	62.85	23.64	24.50	44.17	0.00	0.00	0.00
14-04-99	181.8	139.65	0.00	56.74	21.56	22.66	38.70	0.00	0.00	0.00
16-04-99	183.8	91.15	0.00	33.36	15.56	16.56	25.68	0.00	0.00	0.00
19-04-99	186.9	158.46	35.71	46.99	20.00	21.30	34.47	0.00	0.00	0.00

Date	Day	VFA mg/l	AA mg/l	PA mg/l	IBA mg/l	BA mg/l	IVA mg/l	VA mg/l	ICA mg/l	CA mg/l
21-04-99	188.9	172.59	47.16	49.64	20.03	21.59	34.17	0.00	0.00	0.00
23-04-99	190.7	194.44	57.22	54.25	21.33	23.37	38.28	0.00	0.00	0.00
26-04-99	193.9	208.28	111.96	38.18	15.99	15.83	26.33	0.00	0.00	0.00
28-04-99	195.9	-	-	-	-	-	-	-	-	-
30-04-99	197.9	208.48	73.09	54.92	20.79	23.79	35.90	0.00	0.00	0.00
04-05-99	201.9	181.71	64.68	46.58	18.47	21.24	30.75	0.00	0.00	0.00
05-05-99	203.0	165.71	53.76	43.92	17.49	20.36	30.19	0.00	0.00	0.00
07-05-99	205.0	148.81	45.27	41.79	15.20	19.01	27.55	0.00	0.00	0.00

with: 09/11/98 combination of reactor 1 and 2  
08/12/98 addition of enzymes

**Parameters of Reactor 2**

Date	Day	Volume L	pH m	EC mS	DM g/l	Ash g/l	NH <sub>4</sub> -N mg/l	Ntot mg/l	VFA mg/l	Gas cm	Gas ml	CH <sub>4</sub> %
14/10/98	0.0	0.9	7.9	6.43	12.08	3.18	990	1735	970	14.3	718.78	69
16/10/98	2.0	0.9	7.9	6.41	9.19	1.99	1075	1550	1654	13.3	668.51	69
19/10/98	4.7	0.9	7.8	6.80	11.50	2.52	845	1480	1177	20.5	1030.41	70
21/10/98	7.0	0.9	7.8	6.39	13.12	2.88	820	1615	1100	15.1	758.99	70
23/10/98	9.0	0.9	7.8	6.25	14.13	3.13	750	1420	942	16	804.22	70
26/10/98	11.8	0.9	7.9	6.41	14.48	2.31	855	1550	942	21	1055.54	71
28/10/98	14.0	0.9	7.5	6.50	14.46	3.12	755	1210	1094	14.8	743.91	71
30/10/98	15.9	0.9	7.6	6.37	14.76	3.23	780	1535	1149	17	854.49	71
3/11/98	19.9	0.9	7.6	7.13	14.61	3.13	800	1310	1149	21.9	1100.78	69
4/11/98	20.9	0.9	7.8	5.85	15.15	3.01	730	1340	1150	8	402.11	69
9/11/98	25.7	0.9	7.7	5.95	14.04	2.92	805	1495	1152	18.3	919.83	51
12/11/98	29.0	0.9	7.7	5.95	14.04	2.92	805	1495	1152	6.5	326.72	51
13/11/98	29.9	0.9	8.4	6.08	14.03	3.06	690	1055	1036	1.5	75.40	51
16/11/98	33.0	0.9	8.5	5.74	11.73	2.26	650	1115	921	0.9	45.24	69
18/11/98	35.0	0.9	8.2	4.55	10.14	2.16	500	915	1202	0.8	40.21	69
20/11/98	36.9	0.9	8.2	4.29	11.55	2.33	446	905	1105	0	0.00	69
23/11/98	40.0	0.9	8.3	3.88	9.61	1.66	343	780	781	0.4	20.11	75
25/11/98	42.0	0.9	8.1	3.61	11.07	2.87	391	743	1321	2.7	135.71	75
27/11/98	43.9	0.9	8.1	3.38	10.52	2.79	398	705	1386	1.4	70.37	75
30/11/98	47.0	0.9	8.1	3.40	9.73	1.89	335	745	1065	3.4	170.90	72
2/12/98	48.7	0.9	8.0	2.99	8.34	1.61	324	713	602	3.3	165.87	72
4/12/98	50.7	0.9	8.1	2.83	6.95	1.32	303	680	548	3.7	185.98	72
8/12/98	54.7	0.9	8.1	2.25	7.85	1.49	182	520	563	2.2	110.58	71
11/12/98	57.8	0.9	8.3	2.41	7.81	1.65	248	545	536	0.3	15.08	71
14/12/98	60.7	0.9	8.1	2.36	7.77	1.80	223	497	328	1.1	55.29	70
16/12/98	62.8	0.9	8.1	2.40	7.19	1.09	190	480	288	0.2	10.05	70
18/12/98	64.7	0.9	8.1	2.49	6.84	1.40	161	474	247	3.2	160.84	70
21/12/98	67.9	0.9	8.0	2.33	6.21	1.31	178	284	137	1.4	70.37	69
23/12/98	69.9	0.9	8.1	2.22	5.88	1.23	127	357	48	1	50.26	69
6/01/99	83.7	0.9	7.7	4.33	6.12	1.15	459	805	521	16.2	814.28	70
8/01/99	85.7	0.9	7.9	3.97	5.82	1.37	422	635	521	3.8	191.00	70
11/01/99	88.8	0.9	8.0	3.83	5.40	1.11	382	595	354	4.1	206.08	70
13/01/99	90.8	0.9	8.0	3.45	5.34	1.21	365	563	400	0.5	25.13	69
15/01/99	92.8	0.9	8.0	3.12	5.22	1.13	323	547	395	0.2	10.05	69
18/01/99	95.9	0.9	8.0	2.91	5.75	1.04	325	530	312	0.4	20.11	67
20/01/99	97.7	0.9	8.1	2.77	6.15	1.58	254	530	352	0.4	20.11	67
22/01/99	100.0	0.9	8.3	2.59	5.08	1.30	251.5	510	303	0.5	25.13	67
25/01/99	102.9	0.9	7.9	2.68	4.88	1.40	231	488	323.67	0	0.00	69
27/01/99	104.4	0.9	8.1	2.62	4.72	1.37	232	452	307	0.7	35.18	69
29/01/99	106.4	0.9	8.3	2.52	4.64	1.43	152	415	282	2.3	115.61	69
2/02/99	110.8	0.9	8.1	2.37	4.65	1.38	191	429	295	4.4	221.16	65
4/02/99	112.8	0.9	8.2	2.10	4.57	1.39	166	341	370	2.9	145.77	65
5/02/99	113.9	0.9	8.2	2.12	4.61	1.34	125	385	360	2.9	145.77	65
8/02/99	116.7	0.9	7.8	2.15	5.28	1.38	125	297	282	4.4	221.16	67
10/02/99	119.0	0.9	7.8	1.95	5.53	1.59	105	253	271	3.8	191.00	69
12/02/99	121.0	0.9	8.1	2.03	5.63	1.59	105	302	263	2.2	110.58	66
15/02/99	123.9	0.9	8.1	2.03	6.20	1.61	120	352	271	4	201.06	71
17/02/99	126.0	0.9	8.2	2.02	5.80	1.60	105	368	251	4.2	211.11	70
19/02/99	128.0	0.9	8.3	1.98	5.66	1.55	95	360	243	3	150.79	69
22/02/99	130.8	0.9	8.0	2.14	5.89	1.68	112	352	298	4.2	211.11	72
24/02/99	132.9	0.9	8.4	2.04	5.49	1.70	98	362	343	3.1	155.82	64
26/02/99	134.9	0.9	8.3	2.12	5.09	1.67	104	360	387	3	150.79	70
1/03/99	137.8	0.9	7.9	2.17	5.23	1.70	106	285	378	4.5	226.19	72
3/03/99	139.9	0.7	8.5	1.86	5.39	1.65	90	296	368	3.2	160.84	60
05-03-99	141.9	0.8	8.3	1.92	5.36	1.74	95	372	306	2.5	125.66	63
08-03-99	144.8	0.8	8.0	1.97	5.33	1.84	101	447	243	3.4	170.90	73
10-03-99	146.9	0.8	8.3	1.87	5.24	1.68	94	443	372	2.1	105.55	68
12-03-99	148.8	0.9	8.0	1.94	5.53	1.74	96	448	392	2.9	145.77	64
15-03-99	151.9	0.9	7.7	2.01	5.83	1.79	99	453	411	5.7	286.50	75
17-03-99	153.9	0.9	7.9	1.90	5.37	1.72	99	418	370	4.8	241.27	71
19-03-99	155.9	0.9	8.2	1.86	5.22	1.65	96	400	381	4.4	221.16	71
22-03-99	159.0	0.9	7.8	1.91	5.24	1.63	93	382	303	7.2	361.90	75
24-03-99	160.9	0.9	7.7	1.84	5.13	1.57	90	334	282	5.2	261.37	72
26-03-99	163.0	0.9	7.6	1.77	5.03	1.52	87	286	261	7.5	376.98	74
29-03-99	165.8	0.9	8.3	1.79	4.07	1.35	93	220	275	7.8	392.06	75
31-03-99	168.0	0.9	8.1	1.80	4.93	1.68	89	215	267	6.8	341.80	74
02-04-99	170.0	0.9	7.5	1.93	5.02	1.81	85	166	273	6.6	331.74	72
07-04-99	174.7	0.9	7.4	2.00	5.01	1.64	91	250	232	9.4	472.48	75
12-04-99	179.9	0.9	7.8	1.25	4.70	1.54	89	368	184	11	552.90	75
14-04-99	181.8	0.9	7.9	1.15	4.29	1.59	79	224	135	4.5	226.19	75
16-04-99	183.8	0.9	7.5	1.82	4.96	1.60	74	210	214	0.2	10.05	70
19-04-99	186.9	0.9	7.3	2.24	5.32	1.80	84	238	294	0	0.00	-

Date	Day	Volume L	pH m	EC mS	DM g/l	Ash g/l	NH <sub>4</sub> -N mg/l	Ntot mg/l	VFA mg/l	Gas cm	Gas ml	CH <sub>4</sub> %
21-04-99	188.9	0.9	7.3	2.03	5.14	1.47	87	226	441	0	0.00	-
23-04-99	190.7	0.9	7.6	1.06	5.54	1.60	82	290	493	3.2	160.84	70
26-04-99	193.9	0.9	7.6	1.15	5.63	1.95	77	313	371	8.5	427.24	76
28-04-99	195.9	0.9	7.5	1.18	4.89	1.77	82	336	355	8.7	437.30	76
30-04-99	197.9	0.9	7.8	2.25	5.19	1.85	81	232	327	6.1	306.61	73
04-05-99	201.9	0.9	7.8	2.29	4.79	1.87	75	262	226	7.5	376.98	76
05-05-99	203.0	0.9	8	2.10	4.80	1.75	74	279	279	2.1	105.55	78
07-05-99	205.0	0.9	7.9	2.34	4.54	1.78	66	340	258	4.2	211.11	79

with: 09/11/98 combination of reactor 1 and 2  
08/12/98 addition of enzymes

**Volatile fatty acid composition of the reactor content 2**

Date	Day	VFA mg/l	AA mg/l	PA mg/l	IBA mg/l	BA mg/l	IVA mg/l	VA mg/l	ICA mg/l	CA mg/l
14/10/98	0.0	970.00	178.00	728.00	0.00	0.00	64.00	0.00	0.00	0.00
16/10/98	2.0	1654.00	630.00	916.00	14.00	0.00	77.00	17.00	0.00	0.00
19/10/98	4.7	1177.00	191.00	924.00	0.00	0.00	62.00	0.00	0.00	0.00
21/10/98	7.0	-	-	-	-	-	-	-	-	-
23/10/98	9.0	942.00	0.00	908.00	0.00	0.00	35.00	0.00	0.00	0.00
26/10/98	11.8	-	-	-	-	-	-	-	-	-
28/10/98	14.0	1093.58	32.11	1012.43	9.06	0.00	39.98	0.00	0.00	0.00
30/10/98	15.9	1148.56	32.24	1024.66	11.31	0.00	67.81	12.54	0.00	0.00
3/11/98	19.9	-	-	-	-	-	-	-	-	-
4/11/98	20.9	-	-	-	-	-	-	-	-	-
9/11/98	25.7	1151.66	96.63	1010.91	0.00	0.00	44.12	0.00	0.00	0.00
12/11/98	29.0	-	-	-	-	-	-	-	-	-
13/11/98	29.9	-	-	-	-	-	-	-	-	-
16/11/98	33.0	922.00	192.00	697.00	0.00	0.00	33.00	0.00	0.00	0.00
18/11/98	35.0	1201.80	340.16	790.48	27.86	0.00	43.30	0.00	0.00	0.00
20/11/98	36.9	1105.06	337.80	727.03	0.00	0.00	40.23	0.00	0.00	0.00
23/11/98	40.0	781.01	360.02	184.38	55.37	82.00	99.24	0.00	0.00	0.00
25/11/98	42.0	1320.75	536.61	650.52	35.81	36.92	60.89	0.00	0.00	0.00
27/11/98	43.9	1386.08	623.35	595.85	40.30	41.59	71.50	0.00	0.00	13.49
30/11/98	47.0	1065.32	410.66	504.55	41.13	37.60	71.39	0.00	0.00	0.00
2/12/98	48.7	601.77	0.00	479.48	39.66	0.00	82.63	0.00	0.00	0.00
4/12/98	50.7	548.18	0.00	486.38	0.00	0.00	61.80	0.00	0.00	0.00
8/12/98	54.7	562.56	147.94	371.09	0.00	0.00	43.53	0.00	0.00	0.00
11/12/98	57.8	535.56	118.25	374.27	0.00	0.00	43.04	0.00	0.00	0.00
14/12/98	60.7	327.96	0.00	327.96	0.00	0.00	0.00	0.00	0.00	0.00
16/12/98	62.8	-	-	-	-	-	-	-	-	-
18/12/98	64.7	246.91	0.00	246.91	0.00	0.00	0.00	0.00	0.00	0.00
21/12/98	67.9	136.60	0.00	136.60	0.00	0.00	0.00	0.00	0.00	0.00
23/12/98	69.9	48.21	0.00	48.21	0.00	0.00	0.00	0.00	0.00	0.00
6/01/99	83.7	521.16	0.00	521.16	0.00	0.00	0.00	0.00	0.00	0.00
8/01/99	85.7	260.75	35.88	224.87	0.00	0.00	0.00	0.00	0.00	0.00
11/01/99	88.8	177.18	0.00	177.18	0.00	0.00	0.00	0.00	0.00	0.00
13/01/99	90.8	200.24	35.41	164.83	0.00	0.00	0.00	0.00	0.00	0.00
15/01/99	92.8	197.32	36.95	160.38	0.00	0.00	0.00	0.00	0.00	0.00
18/01/99	95.9	155.89	0.00	155.89	0.00	0.00	0.00	0.00	0.00	0.00
20/01/99	97.7	176.04	33.87	142.17	0.00	0.00	0.00	0.00	0.00	0.00
22/01/99	100.0	302.90	0.00	302.90	0.00	0.00	0.00	0.00	0.00	0.00
25/01/99	102.9	323.67	0.00	296.79	26.88	0.00	0.00	0.00	0.00	0.00
27/01/99	104.4	307.21	0.00	307.21	0.00	0.00	0.00	0.00	0.00	0.00
29/01/99	106.4	281.83	0.00	281.83	0.00	0.00	0.00	0.00	0.00	0.00
2/02/99	110.8	295.30	0.00	295.30	0.00	0.00	0.00	0.00	0.00	0.00
4/02/99	112.8	370.16	82.66	287.50	0.00	0.00	0.00	0.00	0.00	0.00
5/02/99	113.9	360.24	100.07	260.17	0.00	0.00	0.00	0.00	0.00	0.00
8/02/99	116.7	282.10	0.00	282.10	0.00	0.00	0.00	0.00	0.00	0.00
10/02/99	119.0	270.84	0.00	270.84	0.00	0.00	0.00	0.00	0.00	0.00
12/02/99	121.0	262.85	0.00	262.85	0.00	0.00	0.00	0.00	0.00	0.00
15/02/99	123.9	270.69	0.00	270.69	0.00	0.00	0.00	0.00	0.00	0.00
17/02/99	126.0	251.44	0.00	251.44	0.00	0.00	0.00	0.00	0.00	0.00
19/02/99	128.0	243.01	0.00	243.01	0.00	0.00	0.00	0.00	0.00	0.00
22/02/99	130.8	298.25	86.49	211.76	0.00	0.00	0.00	0.00	0.00	0.00
24/02/99	132.9	-	-	-	-	-	-	-	-	-
26/02/99	134.9	387.17	100.80	242.32	0.00	0.00	44.06	0.00	0.00	0.00
1/03/99	137.8	-	-	-	-	-	-	-	-	-
3/03/99	139.9	368.32	70.45	256.76	0.00	0.00	41.12	0.00	0.00	0.00
05-03-99	141.9	-	-	-	-	-	-	-	-	-
08-03-99	144.8	243.05	0.00	243.05	0.00	0.00	0.00	0.00	0.00	0.00
10-03-99	146.9	372.18	117.42	254.76	0.00	0.00	0.00	0.00	0.00	0.00
12-03-99	148.8	-	-	-	-	-	-	-	-	-
15-03-99	151.9	411.04	112.51	257.15	0.00	0.00	41.38	0.00	0.00	0.00
17-03-99	153.9	370.19	83.03	246.08	0.00	0.00	41.08	0.00	0.00	0.00
19-03-99	155.9	380.55	85.46	250.93	0.00	0.00	44.16	0.00	0.00	0.00
22-03-99	159.0	302.90	0.00	256.96	0.00	0.00	45.94	0.00	0.00	0.00
24-03-99	160.9	-	-	-	-	-	-	-	-	-
26-03-99	163.0	261.07	0.00	261.07	0.00	0.00	0.00	0.00	0.00	0.00
29-03-99	165.8	274.60	0.00	274.60	0.00	0.00	0.00	0.00	0.00	0.00
31-03-99	168.0	266.98	0.00	266.98	0.00	0.00	0.00	0.00	0.00	0.00
02-04-99	170.0	272.89	0.00	272.89	0.00	0.00	0.00	0.00	0.00	0.00
07-04-99	174.7	232.26	0.00	232.26	0.00	0.00	0.00	0.00	0.00	0.00
12-04-99	179.9	-	-	-	-	-	-	-	-	-
14-04-99	181.8	134.92	86.58	48.34	0.00	0.00	0.00	0.00	0.00	0.00
16-04-99	183.8	-	-	-	-	-	-	-	-	-
19-04-99	186.9	294.37	162.55	47.39	0.00	35.39	49.04	0.00	0.00	0.00

Date	Day	VFA mg/l	AA mg/l	PA mg/l	IBA mg/l	BA mg/l	IVA mg/l	VA mg/l	ICA mg/l	CA mg/l
21-04-99	188.9	440.92	310.85	49.82	0.00	31.59	48.66	0.00	0.00	0.00
23-04-99	190.7	493.39	346.65	73.92	27.73	0.00	45.09	0.00	0.00	0.00
26-04-99	193.9	371.35	217.59	106.82	0.00	0.00	46.94	0.00	0.00	0.00
28-04-99	195.9	354.95	93.97	206.82	0.00	0.00	54.16	0.00	0.00	0.00
30-04-99	197.9	327.37	68.01	216.05	0.00	0.00	43.31	0.00	0.00	0.00
04-05-99	201.9	226.03	0.00	226.03	0.00	0.00	0.00	0.00	0.00	0.00
05-05-99	203.0	278.64	75.74	202.90	0.00	0.00	0.00	0.00	0.00	0.00
07-05-99	205.0	257.51	56.24	201.27	0.00	0.00	0.00	0.00	0.00	0.00

with: 09/11/98 combination of reactor 1 and 2  
08/12/98 addition of enzymes