9502414

MONFORT WASTE CONVERSION DEMONSTRATION

QUARTERLY PROGRESS REPORT

FOR PERIOD JANUARY 1, 1977 - MARCH 31, 1977

HAMILTON STANDARD DIVISION

UNITED TECHNOLOGIES CORPORATION

WINDSOR LOCKS, CONNECTICUT 06096

APRIL, 1977

MASTER

NOTICE

PORTIONS OF THIS REPORT ARE ILLEGIBLE. It has been reproduced from the best available copy to permit the broadest possible availability.

There is no objection from the patent point of view to the publication or dissemination of the document(s) listed in this list.

UNITED STATES PATENT GROUP

6/15/77 CM

PREPARED BY:

M. TURK, PROCESS ENGINEER

APPROVED BY:

W. B. COE, PRINCIPAL INVESTIGATOR

APPROVED BY:

D. J. LIZDAS, PROGRAM MANAGER

PREPARED FOR:

THE U. S. ENERGY RESEARCH & DEVELOPMENT ADMINISTRATION
UNDER CONTRACT NO. EY-76-C-02-2952

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

1.0 INTRODUCTION

This quarterly progress report describes the activities of the Hamilton Standard mobile fermentation system at the Monfort Feedlots during the period from January 1, 1977 through March 31, 1977.

2.0 TEST RESULTS

Towards the end of the last quarter, Hamilton Standard recommended that additional research effort be directed toward evaluating various start-up procedures. These recommendations were based upon comments made at the December Quarterly Review Meeting concerning traditional experience with waste treatment processes. Specifically, the two areas of concern were:

- a) Start-up and operation with a maximum Total Volatile Acid (TVA) concentrations of 1000 mg/l.
- b) Operation at a temperature further into the thermophilic range (135°F/57.2°C vs. 125°F/51.7°C).

Hamilton Standard has, in the past, successfully started fermentators with TVA concentrations of 2000-4000 mg/l. The major concern expressed was that, even though good gas production rates were achieved at this condition, the system might be in a stressed mode and therefore more susceptible to failure.

Increasing the temperature further into the thermophilic range (135°F/57.2°C) would eliminate the possibility of an ambivalent microbial colony. That is, if, in fact, operation at 125°F/51.7°C was somewhere between mesophilic and thermophilic a stable colony would have difficulty establishing itself.

For the several weeks between the last Quarterly Review Meeting (December 13-14, 1976) and approval to investigate the aforementioned areas, an attempt was made to start the fermentor using existing fermentor contents. This consisted primarily of lowering the TVA concentration by the use of dilution water. This attempt did not result in any improvement in performance.

Evaluation of new start-up procedures, and their effect upon ultimate process yields, was begun at the beginning of the year. In an attempt to maximize the information obtained in the shortest time period, both concepts (i.e. higher temperature and maintenance of low TVA concentrations) were combined.

Draining the fermentor began on January 6, 1977 and continued for several days. During the emptying procedure, samples of both fermentor contents and residual grit (from the bottom of the fermentor) were taken. Analysis of these samples indicated the following:

<u>SAMPLE</u>	<u>%DM</u>	<u>%ASH</u>
Contents	1.1	45.5
Residual Grit	71.8	96.0

The data indicates that the settled grit at the bottom of the fermentor was, for all intents and purposes, total "ash" material exhibiting very little entrapment of organic matter. In addition, the total mass of ash collected represented approximately one-third the ash entering the fermentor during the preceeding months of operation. The remainder of the non-volatile material passed through the system by means of the centrifuge cake and centrate.

After cleaning, the fermentor was loaded on January 11, 1977 with 14.6 pounds of volatile solids obtained from residue collected at the Kurer feedlot shipping area. This material represented fresh, readily available feedlot beef waste. As such, this residue contained all the expected constituents, including pharmaceuticals, that would be encountered during actual operation. In addition, the indigenous bacterial colony would not have to face a stringent adaptation period. Review of the operating parameters during this start-up were within normal ranges. Daily loadings of this material continued for the next several weeks. In an attempt to maintain TVA concentration below 1000 mg/l these loadings represented, of necessity, relatively small amounts of volatile solids. In fact, volatile solids concentration in the fermentor were approximately 0.3%. This methodology continued until February 2, 1977 without indicating typical start-up phenomena.

By February 6, 1977 it was decided to drain the fermentor and restart with fresh dairy waste. Use of the residue from the shipping area had introduced the possibility that pharmaceuticals injurious to the microbial colony had been introduced.

Beginning on February 6, 1977 the fermentor was drained and steam cleaned to remove all traces of potentially inhibiting substances. After the cleaning, 17.2# volatile solids obtained from a local dairy were introduced (February 12, 1977). Use of the fresh dairy waste eliminated the possibility of pharmaceutical introduction while still utilizing fresh residue.

Review of the process parameters indicated that the TVA remained at approximately 1000 mg/l while gas production, due to an acid/alkaline reaction, increased. On February 10, 1977 an additional load of 18.5# volatile solids were introduced. The only effect noted was an increase in fermentor TVA concentration to 1500 mg/l.

By February 25, 1977, it was apparent that a typical start-up was not occurring. The major areas of difference between this and our previous successful start-ups were:

- a. Maintenance of a temperature of 135°F (57.2°C) rather than 125°F (51.7°C).
- b. Maintenance of low TVA levels in the fermentor.

This second factor, by its very nature, required exceedingly light loadings of volatile solids. The volatile solids concentration during other successful initiations were on the order of 2-4%. It was felt that the higher volatile solids loadings would have had the following effects:

- a. increase in the TVA
- b. decrease in pH associated with the TVA increase
- c. increase in the fermentor volatile and suspended solids concentration.

The first two factors (higher TVA and lower pH) could contribute to a more suitable environment for the bacterial colony to initiate their associated functions. The third factor (higher solids concentration) could contribute activation sites for the microbial colony.

To insure a more typical start-up, a loading of 127.2# volatile solids were introduced into the fermentor on February 25, 1977.

The immediate effects of this loading were an increase in contents TVA from 1500 mg/l to 3000 mg/l and a gas production of 2 ft.³/hr. This gas production is due to a reaction of TVA and alkalinity and should not be construed to be of biological origin. The initial spurt in gas production, in fact, subsequently fell back to 1 ft.³/hr. During this period, the volatile solids concentration rose to 1.5%. At the same time pH decreased from 7.4 to 6.5 while TVA subsequently rose to and levelled off at 4000 mg/l.

After stabilizing at 4000 mg/l, the TVA concentration started a moderately rapid decline. During this time, the gas production increased substantially to 4 ft.³/hr. indicating

typical start-up phenomena as the high backlog of TVA was consumed. In keeping with the philosophy of maintaining fermentor contents TVA low, no additional organic material was inputted to the fermentor until the TVA fell below 1000 mg/l.

By March 26, 1977 the TVA had levelled off at 1000 mg/l with gas production averaging approximately 1 ft.³/hr. Nominal daily loadings of 0.03 # volatile solids/ft.³ were begun as a prelude to establishing operating conditions of 0.25# volatile solids/ft.³/day loading along with a 10 day residence time. At the end of the reporting period TVA appears to have stabilized at 1000 mg/l, while gas production is averaging approximately 1 ft.³/hr. These operating conditions yield, although for an admittedly short time span, a specific gas yield of approximately 4.1 ft.³ of methane/# volatile solids fed.

It should be noted that this start-up was accomplished utilizing fresh dairy waste. This material allowed the loading of the fermentor with fresh, pharmaceutical-free residue material. Arrangements are being made to set aside, at Monfort, approximately 20 steers as a source of supply for the fermentor. These animals will be fed a typical finishing ration with the exception that pharmaceuticals will be excluded as will all implants. In this way, a source of fresh, pharmaceutical-free residue material will be available on a daily basis. It is anticipated that use of this material will begin early next reporting period.

3.0 PROBLEMS

None.

4.0 PLANNED EFFORT

During the next Quarterly Reporting Period it is planned to complete the following activities:

- The evaluation of fermentor start-up methods will continue. That is, the ultimate effects of adaptation of the fermentor to operating conditions at 135°F/57.2°C while maintaining low TVA concentrations will be investigated.
- Use of beef steer residue fed a typical finishing ration as the source will commence.
- Baseline performance at a loading of 0.25# volatile solids/ft.³ coupled with a ten day residence time will be established.

- . After establishment of the baseline performance, the pharmaceuticals in question will be selectively fed to the steers. The residue from these animals will then be introduced into the fermentor to evaluate their effect upon performance.
- . Performance characteristics of typical dirt feedlot residues will be evaluated.

LOGAN, J. W. 1964

NO. 3410-25 DIST. CHAMP. HAN. 20 x 20 M. 1/2 IN.

FIGURE 1

LOG LINEAR SCALE

NO. 3410-20 DIETZEN GRAPH BOARD
20 X 30 PER INCH

A-2

FIGURE 2

PROCESS GAS YIELD TOTAL GAS

FIGURE 3

PROCESS GAS YIELD TOTAL GAS

FIGURE 3 (Continued)

GAS PRODUCTION RATE

FIGURE 4

GAS PRODUCTION RATE

FIGURE 4 (Continued)

PROCESS GAS QUALITY METHANE GAS

FIGURE 5

PROCESS GAS QUALITY METHANE GAS

FIGURE 5 (Continued)

FERMENTOR GAS YIELD METHANE GAS

FIGURE 6

CU FT METHANE/CU FT FERMENTOR VOLUME

2/18 3/14 3/8 3/12 3/16 3/20 3/24 3/28 4/1

FIGURE 6 (Continued)

FERMENTOR LOADING VOLATILE MATTER

FIGURE 7

FERMENTOR LOADING VOLATILE MATTER

FIGURE 7 (Continued)

RAW WASTE DRY MATTER

FIGURE 8

RAW WASTE DRY MATTER

FIGURE 8 (Continued)

RAW WASTE VOLATILE MATTER

FIGURE 9

RAW WASTE VOLATILE MATTER

FIGURE 9 (Continued)

PROCESSED WASTE LOAD DRY MATTER

A-17

3

20

10

PERCENT

FIGURE 10

1/30 1/3 1/7 1/11 1/5 1/9 1/23 1/27 1/31 1/4 1/8 1/12 1/16 1/20 1/24 1/28

PROCESSED WASTE LOAD DRY MATTER

A-18

PERCENT

30

20

10

$\frac{2}{20}$ $\frac{3}{4}$ $\frac{3}{8}$ $\frac{3}{12}$ $\frac{3}{16}$ $\frac{3}{20}$ $\frac{3}{24}$ $\frac{3}{28}$ 4

FIGURE 10 (Continued)

PROCESSED WHITE EGG FOR

LBS V.S. FED/DAY

Date	Feeding (LBS/DAY)
1/30	5
1/31	5
2/1	15
2/3	8
2/4	8
2/5	8
2/6	8
2/7	8
2/8	8
2/9	8
2/10	8
2/11	8
2/12	8
2/13	8
2/14	8
2/15	18
2/16	18
2/17	30
2/18	125
2/19	120
2/20	115
2/21	110
2/22	105
2/23	100
2/24	105
2/25	110
2/26	115
2/27	120
2/28	115

FIGURE 11

PROCESSED WASTE LOAD VOLATILE MATTER

FIGURE 11 (Continued)

PROCESSED WASTE LOAD pH

FIGURE 12

PROCESSED WASTE LOAD pH

FIGURE 12 (Continued)

PROCESSED WASTE LOAD ALKALINITY

FIGURE 13

PROCESSED WASTE LOAD ALKALINITY

FIGURE 13 (Continued)

PROCESSED WASTE LOAD TOTAL VOLATILE ACIDS

FIGURE 14

PROCESSED WASTE LOAD TOTAL VOLATILE ACIDS

FIGURE 14 (Continued)

FERMENTOR CONTENTS DRY MATTER

FIGURE 15

FERMENTOR CONTENTS DRY MATTER

FIGURE 15 (Continued)

FERMENTOR CONTENTS VOLATILE MATTER

FIGURE 16

FERMENTOR CONTENTS VOLATILE MATTER

FIGURE 16 (Continued)

FERMENTOR CONTENTS pH

FIGURE 17

FERMENTOR CONTENTS pH

FIGURE 17 (Continued)

FERMENTOR CONTENTS ALKALINITY

FIGURE 18

FERMENTOR CONTENTS ALKALINITY

FIGURE 18 (Continued)

FERMENTOR CONTENTS TVA

FIGURE 19

FERMENTOR CONTENTS TVA

FIGURE 19 (Continued)

FERMENTOR TEMP

FIGURE 20

FERMENTOR TEMP

FIGURE 20 (Continued)

FERMENTOR CONTENTS-MISCELLANEOUS ANALYSES

FIGURE 21

FERMENTOR CONTENTS-MISCELLANEOUS ANALYSES

FIGURE 21 (Continued)

FERMENTOR CONTENTS-MISCELLANEOUS ANALYSES

TVA
ALK
A-41

Na

P

FIGURE 22

FIGURE 22 (Continued)