MASTER

DIRT FEEDLOT RESIDUE EXPERIMENTS

QUARTERLY PROGRESS REPORT

FOR THE PERIOD OCTOBER 1, 1977 - NOVEMBER 30, 1977

HAMILTON STANDARD DIVISION

UNITED TECHNOLOGIES CORPORATION

WINDSOR LOCKS, CONNECTICUT 06096

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.0 Introduction

This progress report describes the program activities for the Hamilton Standard mobile fermentation system at the Monfort feedlot during the October-November 1977 period.

2.0 Activities During the Reporting Period

2.1 Objectives

During the reporting period, the objectives established for the field experimental program were:

- Continued use of aged pen 307 residue at a nominal loading rate of 0.25 pounds volatile solids/ft³/day along with a 10 day retention time and an operating temperature of 57°C for the purpose of establishing comparative yields.
- Evaluate the nutritional benefits obtained by refeeding the fermentor contents prior to application of centrifugal separation technology.
- Evaluate the capture efficiency of the centrifuge.
- Initiate evaluation of the comparative yield obtained from a typical aged pen residue obtained from another feedlot.

2.2 Test Results

Loading of pen 307 residue, which had begun on August 11, 1977, continued throughout the reporting period. At the end of the last quarter Total Volatile Acid (TVA) concentration had reached 4,000-5,000 mg/L while specific methane yield was approximately 2.53 ft.³ CH₄/# volatile solids loaded. Due to mechanical difficulties, the system was not loaded on September 27, 1977, or October 5, 1977. While the initial lack of feed did not seem to affect the unit, the second exclusion initiated a considerable decrease in TVA concentration. By October 9, 1977, the TVA level had decreased from 5,000 mg/L to 3,000 mg/L while the pH remained unchanged indicating the buffering capacity of the system. From this point in time until the end of the reporting period TVA concentration remained stable at 3,000 mg/L. The ten day running average³ of specific methane yield increased to an indicated yield of 3.0 ft³ CH₄/# volatile solids representing approximately 75% of that obtained from the fresh residue. During this entire period no attempts at controlling TVA concentration were made.

In spite of the elevated TVA, which may have been causing additional stress upon the fermentation system, stable operating conditions were achieved and encouraging methane yields were obtained.

2.3 Centrifuge Evaluation

Preliminary investigation of the centrifuge capture efficiency was begun this period. Fermentor contents were metered into the centrifuge by a Moyno progressing cavity pump. Varying flowrates were established and capture efficiencies (both of dry matter and suspended solids) as well as nutritional quality of the cake produced were evaluated. This testing program was performed without the use of flocculant aids. As seen in Figure 5, the suspended solids capture rate was 80-90% while the dry matter capture efficiency was 45-50% indicating a high level of dissolved solids. The cause for the lower values at 0.25 gpm is not understood at this time. Crude protein analysis of the cake averaged 19% on a dry matter basis while the cake itself was 25-30% dry matter.

Chemical analysis of the fermentor contents indicates that, if the total organic nitrogen is considered, a product of 33% crude protein (dry matter basis) is theoretically possible. Because of this potential for improvement, evaluation of flocculant aids will be performed. These aids will provide a mechanism for accretion of the microbial cell mass (average size 1-5 μ). While improving the suspended solids capture to some degree, the greater effect should be an increase in the crude protein value of the cake produced.

2.4 Sulfide/Sulfate Analysis

Chemical analysis of the fermentor contents for sulfide/sulfate continued to indicate the absence of sulfide coupled with sulfate levels of approximately 600 mg/L. A suitable explanation for the lack of reduction of the sulfate to sulfide has not been found. In addition, an attempt to correlate the data relative to TVA level, specific methane yield and the sulfate levels in either the water used for slurring or the fermentor contents did not yield any significant results.

2.5 Cattle Refeeding Trial

Twenty head of cattle for the liquid refeeding trial arrived on November 30, 1977. The actual trial will begin next reporting period. A diet has been formulated that parallels that received by a typical feedlot steer at the Monfort facility. This diet includes all pharmaceuticals, vitamins, and minerals. Analysis of the contents indicates that if the total daily contents withdrawn were spread over the daily feed, a supplemental protein level of 0.3# crude protein/head/day would be achieved. The remainder of the supplemental protein normally fed per day (0.7#/head) will be provided by the standard supplement used at the time (e.g., urea). Weight gain, feed conversion, mortality and morbidity will be monitored to evaluate the effect of the alternate protein source upon the cattle.

2.6 Pen Residue Characterization Study

Previous results of the pen residue characterization study were reported in the Quarterly Progress Report covering the period April 1, 1977 through June 30, 1977 (Report # MWCD-045 dated August 4, 1977). That data indicated the variability of the organic fraction (expressed on a dry matter basis) of samples collected from various locations throughout the Kurer facility. The data shown in Table I expands this information with additional Kurer feedlots as well as analyses of samples collected at the Monfort Gilcrest facility. The degree of variability remains essentially unchanged ranging from approximately 25-80%.

3.0 Problems

None

4.0 Planned Effort

During the next quarterly period it is planned to complete the activities:

- . Evaluate the nutritional benefits of the non-dewatered fermentor contents.
- . Evaluate the residue obtained from a different feedlot location to determine the variability of dirt lot residue as well as the potential "uniqueness" of the Kurer material.
- . Complete evaluation of the centrifuge capture efficiency including use of flocculant aids.

TABLE I
PEN RESIDUE CHARACTERIZATION STUDY

<u>Date</u>	<u>Pen</u>	<u>Location</u>	<u>Dry Matter %</u>	<u>Ash(%)</u>	<u># Volatile Solids</u> <u># Residue</u>
6/23/77	172	Bunk	71.78	69.59	.218
6/23/77	173	Bunk	59.65	40.53	.355
6/23/77	176	Bunk	62.37	52.47	.296
6/23/77	177	Bunk	56.90	43.38	.322
6/24/77	162	Main Alley	41.98	47.78	.219
6/24/77	166	Main Alley	74.63	78.42	.161
6/24/77	171	Main Alley	61.35	50.23	.305
6/24/77	175	Main Alley	76.99	78.56	.165
7/6/77	150	Main Alley	64.15	44.40	.357
7/6/77	154	Main Alley	72.11	50.61	.356
7/6/77	161	Main Alley	71.95	45.91	.389
7/6/77	165	Main Alley	67.14	45.78	.364
7/7/77	138	Alley	69.46	32.27	.470
7/7/77	144	Alley	68.05	38.85	.416
7/7/77	149	Alley	73.39	51.51	.356
7/7/77	155	Alley	73.11	45.57	.398
7/13/77	156	Alley	57.36	57.97	.241
7/13/77	154	Alley	74.04	76.40	.175
7/13/77	161	Alley	70.98	77.77	.158
7/13/77	165	Alley	71.45	75.75	.173
7/14/77	52	Bunk	76.22	14.94	.648
7/14/77	52	Bunk	57.24	16.90	.476
7/14/77	53	Bunk	66.15	15.65	.558
7/14/77	53	Bunk	72.09	19.69	.579
7/20/77	114	Stockpile	74.65	75.25	.185
7/20/77	116	Stockpile	74.61	75.63	.182
7/20/77	117	Stockpile	73.66	72.46	.203
7/20/77	120	Stockpile	72.88	69.34	.223
<u>Gilcrest</u>					
	224	Back fence	72.00	72.46	.521
	224	Bunk	63.81	48.29	.308
	226	Fence	74.06	77.50	.574
	226	Bunk	60.32	49.29	.248
	610	Bunk	66.67	46.69	.311
	155	Bunk	61.12	31.66	.194
	63	Bunk	60.15	30.47	.183
	611	Bunk	56.65	47.16	.267
	433	Bunk	58.04	31.29	.182
	519	Bunk	57.18	31.11	.178
	153	Fence	66.88	63.75	.426
	153	Bunk	69.22	29.85	.207
	518	Bunk	89.87	46.94	.422
	94	Bunk	58.03	35.83	.208
	432	Bunk	68.21	32.38	.221
	149	Bunk	62.00	41.37	.256
	155	Fence	59.14	49.53	.293

FIGURE 1

FIGURE 1 (Continued)

FIGURE 2

MINI-RM 024-02
IN MINIMUM RESIDUE UIC-01-01-01

FIGURE 2 (continued)

FIGURE 3 (Continued)

FIGURE 4 (Continued)

CENTRIFUGE EFFICIENCY (Non-Flocced)

○ - SPS Solids

▽ - DRY MATTER

CAPTURE EFFICIENCY (%)

FLOW RATE (GPM)

□ C.P. (%)

11/17/72
W

100

90

80

70

60

50

40

30

20

10

0.25

0.50

0.75

1.00

1.25

1.50

25

20

15

10

FIGURE 5

APPENDIX A

GRAPHICAL DATA

Figure 1 is a scatter plot on a grid. The vertical axis (Y-axis) is labeled "SCF/LB V.S." and ranges from 2 to 10. The horizontal axis (X-axis) represents dates, starting from 9/1 and ending at 11/22. The data points are represented by inverted triangles. The plot shows a general upward trend in the Y-value over time, with some fluctuations. The Y-values start around 4.5 in early September and rise to between 5.5 and 7.5 by late November.

FIGURE 1

PROCESS GAS YIELD TOTAL GAS

FIGURE 1

GAS PRODUCTION RATE

FIGURE 2

GAS PRODUCTION RATE

PROCESS GAS QUALITY METHANE GAS

FIGURE 3

PROCESS GAS QUALITY METHANE GAS

FIGURE 3

FERMENTOR GAS YIELD METHANE GAS

FIGURE 4

FERMENTOR GAS YIELD METHANE GAS

FIGURE 4

PROTEIN FERMENTATION PRODUCTS TOTAL WEIGHT

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POUNDS/DAY

A-5

FIGURE 5

9/7 9/11 9/15 9/19 9/23 9/27 10/1 10/5 10/9 10/13 10/17 10/21 10/25 10/29 11/2 11/6 11/10 11/14 11/18 11/22

PROTEIN FERMENTATION PRODUCTS TOTAL WEIGHT

POUNDS/DAY

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FIGURE 5

"1/8 "1/2 "3/4 "1 1 1/4 1 1/2 1 3/4

PROTEIN FERMENTATION PRODUCT DRY MATTER

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FIGURE 6

A-6

PERCENT

9/7 9/11 9/15 9/19 9/23 9/27 10/1 10/5 10/9 10/13 10/17 10/21 10/25 10/29 11/2 11/6 11/10 11/14 11/18 11/22

PROTEIN FERMENTATION PRODUCT DRY A MATTER

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PERCENT

A-6

FIGURE 6

"18 "22 "26 "30 124 128 1212 1216

PROTEIN FERMENTATION PRODUCT CRUDE PROTEIN

PERCENT

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FIGURE 1

A-7

9/17 9/11 9/15 9/19 9/23 9/27 10/1 10/5 10/9 10/13 10/17 10/21 10/25 10/29 11/2 11/6 11/10 11/14 11/18 11/22

PROTEIN FERMENTATION PRODUCT CRUDE PROTEIN

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PERCENT

A-7

FIGURE 7

$\frac{1}{18}$ $\frac{1}{22}$ $\frac{1}{26}$ $\frac{1}{30}$ $\frac{1}{4}$ $\frac{1}{8}$ $\frac{1}{12}$ $\frac{1}{16}$

FERMENTOR LOADING VOLATILE MATTER

FIGURE 8

FERMENTOR LOADING VOLATILE MATTER

FIGURE 8

FERMENTOR RESIDENCE TIME

FIGURE 9

FERMENTOR RESIDENCE TIME

FIGURE 9

RAW WASTE TOTAL WEIGHT

FIGURE 10

RAW WASTE TOTAL WEIGHT

FIGURE 10

RAW WASTE DRY MATTER

FIGURE 11

RAW WASTE VOLATILE MATTER

FIGURE 12

RAW WASTE VOLATILE MATTER

FIGURE 12

POUND
A-13

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"118	"122	"130	124	128	1212	1216
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FIGURE 13

DIETZGEN CORPORATION
MADE IN U.S.A.

NO. 340-20 DIETZGEN GRAPH PAPER
20 X 20 PER INCH

RECYCLE WASTE (CENTRATE) TOTAL WEIGHT

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POUND

A-13

11/22
11/21
11/20
11/19
11/18
11/17
11/16
11/15
11/14
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11/12
11/11
11/10
11/9
11/8
11/7
11/6
11/5
11/4
11/3
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11/1
10/31
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9/7
9/6
9/5
9/4
9/3
9/2
9/1

FIGURE 14

DIETZGEN CORPORATION
MADE IN U.S.A.

NO. 340-20 DIETZGEN GRAPH PAPER
20 X 20 PER INCH

RECYCLE WASTE (CENTRATE) DRY MATTER

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PERCENT

9/17 9/11 9/15 9/19 9/23 9/27 10/1 10/5 10/9 10/13 10/17 10/21 10/25 10/29 11/2 11/6 11/10 11/14 11/18 11/22

RECYCLE WASTE (CENTRATE) DRY MATTER

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PERCENT

A-14

11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

RECYCLE WASTE (CENTRATE) VOLATILE MATTER

FIGURE 15

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PERCENT

9/7 9/11 9/15 9/19 9/23 9/27 10/1 10/5 10/9 10/13 10/17 10/21 10/25 10/29 11/2 11/6 11/10 11/14 11/18 11/22

FIGURE 15

RECYCLE WASTE (CENTRATE) VOLATILE MATTER

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PERCENT

11.18 11.22 11.26 11.30 12.14 12.18 12.12 12.16

MAKE-UP WATER TOTAL WEIGHT

FIGURE 16

MAKE-UP WATER TOTAL WEIGHT

FIGURE 16

RESIDUAL GRIT VOLATILE MATTER

FIGURE 17

RESIDUAL GRIT VOLATILE MATTER

FIGURE 17

PROCESSED WASTE LOAD TOTAL WEIGHT

FIGURE 18

PROCESSED WASTE LOAD TOTAL WEIGHT

FIGURE 18

PROCESSED WASTE LOAD DRY MATTER

PROCESSED WASTE LOAD DRY MATTER

FIGURE 19

40

A-19

30

20

10

PERCENT

"1/8 "1/22 "1/26 "1/30 12/4 12/8 12/12 12/16

PROCESSED WASTE LOAD VOLATILE MATTER

PROCESSED WASTE LOAD VOLATILE MATTER

FIGURE 20

PROCESSED WASTE LOAD pH

FIGURE 21

PROCESSED WASTE LOAD pH

FIGURE 21

PROCESSED WASTE LOAD ALKALINITY

FIGURE 22

PROCESSED WASTE LOAD ALKALINITY

FIGURE 22

PROCESSED WASTE LOAD TOTAL VOLATILE ACIDS

FIGURE 23

PROCESSED WASTELOAD TOTAL VOLATILE ACIDS

FIGURE 23

FERMENTOR CONTENTS DRY MATTER

FIGURE 24

FERMENTOR CONTENTS DRY MATTER

FIGURE 24

FERMENTOR CONTENTS VOLATILE MATTER

FIGURE 25

FERMENTOR CONTENTS VOLATILE MATTER

FIGURE 25

FERMENTOR CONTENTS pH

FIGURE 26

FERMENTOR CONTENTS ALKALINITY

FIGURE 27

FERMENTOR CONTENTS pH

FIGURE 26

FERMENTOR CONTENTS ALKALINITY

FIGURE 27

FERMENTOR CONTENTS ALKALINITY

FIGURE 27

FERMENTOR CONTENTS TVA

FIGURE 28

FERMENTOR CONTENTS TVA

FIGURE 28

FIGURE 29

FIGURE 29

FERMENTOR CONTENTS-MISCELLANEOUS ANALYSES

FIGURE 30

FERMENTOR CONTENTS-MISCELLANEOUS ANALYSES

FIGURE 30

FERMENTOR CONTENTS-MISCELLANEOUS ANALYSES

FIGURE 31

FERMENTOR CONTENTS-MISCELLANEOUS ANALYSES

FIGURE 31