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ANAEROBIC TREATMENT OF
THERMO-MECHANICAL PULP MILL
WASTE WATER.

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requirements for the degree of
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ABSTRACT

The operation and performance of anaerobic digesters treating thermomechanical pulping wastewater was investigated. The aim of this work was to develop a reactor design that could successfully treat the wastewater with minimal pretreatment.

Six reactors were trialed, all modifications of the upflow anaerobic sludge blanket [UASB] reactor design. Seed sludge source, start-up regime and suspended solids retention were varied to determine effective operation methodology. A screw press effluent from Pan Pacific Forestry Industries Ltd thermomechanical pulp [TMP] mill at Whirinaki, North Island, New Zealand was used as feed for all of the reactors. Seed sludge was obtained in granular form from UASB reactors treating dairy industry wastewaters and in non-granular form from the aerated lagoons of the New Zealand's central North Island pulp mills. Operation of all six experimental reactors was difficult due to many feed blockages caused by the relatively high suspended solids concentration in the feed. Inhibition was frequently observed after feed interruptions with slow recovery of performance, possibly due to the lack of a co-metabolite soon after the feed supply ceased. Many modifications to the reactor inlet and feed system greatly reduced blockage problems.

In the later reactors a low suspended solids retention allowed granulation to be achieved from a non-granular forestry industry sludge. With the final reactor configuration total COD removals of 50-60% and dissolved COD removals of 70-85% were achieved at organic loading rates up to $40 \text{ kgCOD}\cdot\text{m}^{-3}\cdot\text{d}^{-1}$. A 20 to 50 % conversion of feed suspended solids to methane was calculated on a COD basis.

Granulation was achieved without a gas-solids-separator. This was attributed to the need for severe selection against poorly settling wood suspended solids, and the presence and precipitation of iron. The granules were approximately 37%

iron on a dry weight basis and had densities averaging 2000 kg.m^{-3} . Scanning electron microscope work indicated that extensive precipitates, presumed to be iron based complexes, were responsible for the structural integrity of the granule. An abundant layer of bacteria of predominantly *Methanothrix* morphotypes was found beneath the surface of the granules. The granules have been demonstrated to provide some protection from inhibition, probably by diffusional gradients.

After five years exposure to TMP wastewater a dissolved extract of feed resin acids exerted an inhibitory effect on granules at similar concentrations to that reported for dehydroabietic acid with unacclimated granules. Thus no acclimation to soluble resin acids was evident. Changes in the distribution of resin acids suggested that some degree of resin acid dissolution occurs within the reactors but degradation of the total concentration of resin acids is poor, averaging 10 % reduction as total acids.

Overall, the final reactor design has proved to be an effective treatment of TMP wastewater. Suspended solids removal rates are not high but equally the suspended solids do not threaten the viability of the reactor system. Changes in the nature of the suspended solids passing through the reactor are such that subsequent suspended solids removal will be more efficient and have a lower loading rate than for the untreated wastewater. The reactor has demonstrated a high degree of ability to accept large variations in feed rate and strength and still function efficiently.

The work has produced the basis for a successful primary reactor design for the treatment of a problem wastewater and the necessary information on which a pilot scale plant could be designed for high suspended solids wastewaters. A possible method for the cultivation of granules in difficult wastewaters has been identified.

TABLE OF CONTENTS

ABSTRACT	i
TABLE OF CONTENTS	iii
TABLE OF FIGURES	ix
TABLE OF TABLES	xvi
CHAPTER ONE INTRODUCTION	1.1
1.1 Reactor selection	1.5
1.2 Summary of early work	1.8
CHAPTER TWO LITERATURE REVIEW	2.1
2.1 FORESTRY INDUSTRY WASTEWATERS	2.1
2.1.1 Introduction	2.1
2.1.2 Thermomechanical pulping wastewaters	2.2
2.1.3 Anaerobic biodegradability of TMP wastewaters	2.2
2.1.4 Toxicity	2.3
2.1.5 Suspended solids removal	2.4
2.2 ANAEROBIC REACTOR DESIGNS	2.5
2.2.1 Introduction	2.5
2.2.2 Conventional single tank process	2.7
2.2.3 The anaerobic contact process	2.7
2.2.4 The upflow anaerobic sludge blanket (UASB) reactor	2.9
2.2.4.1 Granulation in UASB reactors	2.9

2.2.5	The anaerobic filter (AF) reactor	2.11
2.2.6	The downflow stationary fixed film (DSFF) reactor	2.11
2.2.7	The expanded bed (EB) reactor and the fluidised bed (FB) reactor	2.12
2.2.8	Combined systems	2.12
2.2.8.1	Two phase reactor systems	2.12
2.2.8.2	Hybrid reactors	2.13
2.3	ANAEROBIC DIGESTION	2.13
2.3.1	Introduction	2.13
2.3.2	Microbiology and biochemistry	2.15
2.3.4	Environmental factors	2.22
2.4	CONCLUDING REMARKS	2.24
	CHAPTER THREE MATERIALS AND METHODS	3.1
3.1	MATERIALS	3.1
3.1.1	General chemicals	3.1
3.1.2	Gases	3.1
3.1.3	Chromatography materials	3.1
3.1.4	Glassware	3.2
3.1.5	Feed	3.3
3.1.5.1	Lactic acid casein whey ultrafiltration permeate	3.3
3.1.5.2	Whole mill effluent	3.3
3.1.5.3	Screw press effluent	3.5
3.2	ANALYTICAL PROCEDURES	3.7
3.2.1	pH value	3.7
3.2.2	Alkalinity	3.7
3.2.3	Volatile fatty acids (VFA)	3.7
3.2.4	Chemical oxygen demand (COD)	3.8

3.2.5	Solids composition	3.9
3.2.6	Gas composition	3.10
3.2.7	Resin acids	3.11
3.3	SERUM BOTTLE ASSAYS	3.11
3.3.1	Equipment and instrumentation	3.11
3.3.2	Operating conditions	3.12
3.4	SCANNING ELECTRON MICROSCOPE SAMPLE PREPARATION	3.12
3.5	CONTINUOUS DIGESTION EXPERIMENTS	3.13
3.5.1	Reactor B. An upflow anaerobic sludge blanket reactor .	3.13
3.5.1.1	Feed and recycle provision.	3.16
3.5.2	Reactor A: A modified upflow anaerobic sludge blanket reactor	3.17
3.5.3	Reactor C: A modified upflow anaerobic sludge blanket reactor	3.19
3.5.4	Reactor D	3.21
3.5.5	Reactor summary	3.22
3.5.6	Inoculum sources and preparation	3.24
3.6	ANALYSIS OF DATA	3.27
3.6.1	Theoretical COD removal	3.27
3.6.2	Theoretical suspended solids removal	3.28
3.6.3	Wood fibre and bacterial cell volume	3.30
CHAPTER FOUR UASB REACTOR PERFORMANCE		4.1
4.1	INTRODUCTION	4.1

4.2	EXPERIMENTAL PROGRAMME	4.2
4.3	FEED VARIATION	4.3
4.4	REACTOR D: OPERATION	4.5
4.4.1	Volatile fatty acids	4.5
4.4.2	Methane percentage	4.7
4.4.3	Feed suspended solids entrapment in the sludge bed	4.8
4.4.4	Problems arising from high suspended solids accumulation	4.10
4.5	REACTOR C: OPERATION	4.13
4.5.1	Volatile fatty acids	4.13
4.5.2	The effects of feed suspended solids entrapment	4.15
4.5.2.1	Loss of sludge bed suspended solids	4.19
4.6	GENERAL OPERATIONAL CONSIDERATIONS	4.21
4.7	"PSEUDO-STEADY STATE" ANALYSIS	4.21
4.7.1	Dissolved COD removal	4.23
4.7.2	Apparent and theoretical COD and SS removal	4.25
4.8	COMPARISON WITH OTHER TMP ANAEROBIC DIGESTION	4.32
4.9	SUMMARY	4.36
	CHAPTER FIVE RESIN ACIDS	5.1
5.1	INTRODUCTION	5.1
5.2	RESIN ACID NOMENCLATURE	5.1

5.3	RESIN ACID ANALYSIS	5.2
5.4	CHANGES IN RESIN ACIDS IN THE UASB REACTORS ...	5.10
5.4.1	Resin acids in the feed	5.10
5.4.2	Resin acid mass balance over a reactor.	5.13
5.4.3	The effect of organic loading rate upon resin acid degradation	5.14
5.4.4	The effect of UASB reactor treatment upon individual resin acids	5.16
5.5	RESIN ACID AND FEED TOXICITY	5.20
5.5.1	Serum bottle experiment 6: Toxicity of a feed dilution series	5.21
5.5.2	Serum bottle experiment 8: A dichloromethane extract toxicity series	5.23
5.6	CONCLUSIONS.	5.28
CHAPTER SIX	GRANULES	6.1
6.1	INTRODUCTION	6.1
6.2	GRANULAR CHARACTERISTICS	6.1
6.2.1	The granular environment	6.1
6.2.1.1	Aggregation and the sludge bed matrix	6.3
6.2.1.2	Bed compression	6.5
6.2.2	Size distribution	6.6
6.2.3	Solids analysis	6.9
6.2.4	Elemental analysis	6.12
6.2.5	Structure	6.15

6.3	SERUM BOTTLE TESTS	6.31
6.3.1	General procedure	6.31
6.3.2	Inoculum source and quantity	6.32
6.3.3	Results and discussion	6.34
6.4	CONCLUSIONS	6.46
CHAPTER SEVEN CONCLUSIONS		7.1
CHAPTER EIGHT BIBLIOGRAPHY		8.1

TABLE OF FIGURES

Figure 2.1	Configurations for the anaerobic reactor design units.	2.8
Figure 2.2	Schematic representation of the substrate-linked redox processes operative during the microbially mediated conversion of organic wastes to methane (from Harper and Pohland, 1986)	2.17
Figure 2.3	Hydrogen-regulated catabolic pathways possible for the conversion of glucose in anaerobic wastewater treatment systems (after Mosey, 1983)	2.19
Figure 2.4	Graphical representation of the hydrogen-dependent thermodynamic favorability of acetogenic oxidations and inorganic respirations associated with the anaerobic degradation of waste organics. (1) Propionic acid oxidation to acetic acid. (2) Butyric acid oxidation to acetic acid. (3) Ethanol to acetic acid. (4) Lactic acid to acetic acid. (5) Acetogenic respiration of bicarbonate (CO ₂). (6) Methanogenic respiration of bicarbonate. (7) Respiration of sulphate to sulphide. (8) Respiration of sulphite to sulphide. (9) Methanogenic cleavage of acetic acid. (10) SRB-mediated cleavage of acetic acid. Acetic acid, 25 mM; propionic, butyric, lactic acids, and ethanol, 10 mM; sulphate and sulphite, 5 mM; bicarbonate, 20 mM; methane, 0.7 atm. (Harper and Pohland 1986).	2.21
Figure 3.1	Diazomethane Generator.	3.2
Figure 3.2	Reactor B	3.15
Figure 3.3	Final feed system.	3.17
Figure 3.4	Reactor A	3.18
Figure 3.5	Reactor C.	3.19
Figure 3.6	Reactor C	3.20

Figure 3.7	Reactor D	3.21
Figure 3.8	Reactor D.	3.22
Figure 4.1	The total gas production rate, methane production rate and organic loading rate for reactor D.	4.5
Figure 4.2	The acetate and propionate concentration at the exit of reactor D. The three "pseudo steady state" time periods for this reactor are indicated.	4.6
Figure 4.3	The methane composition of the digester gas, methane yield and gas yield for reactor D.	4.7
Figure 4.4	Theoretical minimum COD removal efficiency (COD to CH ₄), apparent COD removal efficiency (COD measured) and actual dissolved COD removal efficiency (dCOD measured) for reactor D.	4.8
Figure 4.5	Bed volume and effluent suspended solids concentration for reactor D. The calculated volumetric wood suspended solids accumulation (Wood accum), wood plus bacterial suspended solids accumulation (biomass accum) and wood plus bacterial suspended solids accumulation where wood replaces the bacterial cells all of which are assumed to be lost from the reactor (biomass lost) are plotted for each "pseudo steady state"	4.10
Figure 4.6	Bed volume and gas yield (gas/ feedin) for reactor D. The volume of the main body of the reactor is also plotted. . .	4.11
Figure 4.7	The total gas production rate, applied organic loading rate and the methane production rate for reactor C.	4.13
Figure 4.8	Methane percentage, methane yield and gas yield (gas/ feedin) for reactor C.	4.14

Figure 4.9	Methane percentage, methane yeild and gas yeild (gas/ feedin) for reactor C	4.15
Figure 4.10	Theoretical minimum (COD to CH ₄) and apparent (COD measured) total COD removal efficiencies and actual dissolved COD (dCOD) efficiency for reactor C.	4.16
Figure 4.11	Bed volume and effluent suspended solids concentration for reactor C. The calculated volumetric wood suspended solids accumulation (Wood accum), wood plus bacterial suspended solids accumulation (biomass accum) and wood plus bacterial suspended solids accumulation where wood replaces the bacterial cells all of which are assumed to be lost from the reactor (biomass lost) are plotted for each "pseudo steady state".	4.17
Figure 4.12	Bed volume and gas yield (gas/ feedin) for reactor C. The volume of the main body of the reactor is also plotted. . .	4.17
Figure 4.13	COD removal percentages for reactors B, C and D at various "pseudo steady states" versus organic loading rate.	4.23
Figure 4.14	COD removal efficiencies for reactor C only.	4.24
Figure 4.15	COD removal efficiencies for apparent (COD), theoretical (CH ₄ COD) and dissolved COD (dCOD) for reactor D only.	4.25
Figure 4.16	COD removal efficiencies vs the applied HRT for the "pseudo steady states".	4.26
Figure 4.17	Suspended solids removals in relation to normalised bed volumes.	4.28
Figure 4.18	Suspended solids removals vs the SS inflow.	4.29
Figure 4.19	Suspended solids removals vs organic loading rates.	4.31

Figure 4.20	A comparison of literature COD and dissolved COD removal values with those generated in this work. The points marked with an superscript "H" are the higher solids feed experiments. The two points marked with arrows are those that were recalculated and the actual COD reduction points from this are marked with subscript "C".	4.35
Figure 5.1	Pimarane and Abietane skeletons from Chang et al (1971).	5.1
Figure 5.2	Structures, systematic and simple names of significant resin acids (Chang et al,1771).	5.4
Figure 5.3	Resin Acid sample pairs. Samples are reactor D effluent. Details for the 15/12/91 and 20/2/92 samples are given in Table 5.3, the third and last sets of data respectively. a - first analysis b - second analysis.	5.10
Figure 5.4	Resin acid mass balance on Reactor D.	5.13
Figure 5.5	Effluent resin acids plotted against the organic loading rate for reactor C.	5.15
Figure 5.6	Effluent resin acids plotted against the organic loading rate for reactor D.	5.16
Figure 5.7	Difference in Resin Acid concentrations between the feed and effluent.	5.17
Figure 5.8	Resin Acid of seed components at the start for reactor C.	5.19
Figure 5.9	Resin Acid profile at the end for reactor C.	5.20
Figure 5.10	Serum bottle experiment run 6.	5.22
Figure 5.11	Specific methane production rate for serum bottle run 6. .	5.23

Figure 5.12	Methane production as a function of extracted resin acid concentration in Serum bottle run 8.	5.25
Figure 5.13	Profile of methane production over time with resin acid concentrations.	5.26
Figure 6.1	Granule size distribution. The dry weight of the granules of a given size fraction are plotted against the nominal size fraction.	6.2
Figure 6.2	Wet granules. The smaller divisions of the scale are 1 mm.	6.3
Figure 6.3	Granule solids analysis. Volatile solids, total solids and the ratio (TS/VS x 1000) are plotted from the data given in Table 6.3.	6.10
Figure 6.4	Granule ICP analysis. (* indicates plotted at the limit of detection. The actual level of these species is below the detection limit.)	6.13
Figure 6.5	ICP analysis of the feeds.	6.14
Figure 6.6	Large Granules Each division on the scale is one millimetre	6.16
Figure 6.7	SEM of granule surface. The SEM preparation process involves fixing and drying the granule. Magnification (x50).	6.16
Figure 6.8	SEM of granule surface at the higher magnification of 6,000.	6.17
Figure 6.9	Loose granular surface structure formed from inorganic compounds. Some of the blunt-ended rod shaped bacteria present appear to have deposits of the inorganic material upon their surface (x6,000)	6.17
Figure 6.10	Open granular surface structure. (x1,200)	6.18

Figure 6.11	Enlarged pore from Figure 6.10 (x6,000)	6.19
Figure 6.12	Unwashed granule surface with wood fibre fragments. (x1,200)	6.20
Figure 6.13	An unwashed granule surface (x6,000)	6.20
Figure 6.14	A tightly aggregated area of a granule. (x6,000)	6.21
Figure 6.15	A lower magnification of the tightly aggregated area of an unwashed granule (x1,200)	6.22
Figure 6.16	The broken edge of a 5-6 mm uniform granule at x111 magnification.	6.23
Figure 6.17	A large granule that has been fractured open. The divisions are in millimetres.	6.24
Figure 6.18	Methanotrix sp. from an acetate fed granule (Forster, 1991)	6.24
Figure 6.19	SEM of the inside of the shell of a large granule showing the rod shaped bacteria present. (x6,000)	6.26
Figure 6.20	SEM of inside of large granule at lower magnification, (x1,200).	6.26
Figure 6.21	The edge of the shell layer of a granule. (x87)	6.27
Figure 6.22	Views of the cross-section of the shell layers shown in Figure 6.21 a - (Upper left) Outer layer (x6,000); b - (upper right) Outer layer (x1,200); c (lower left) Transition between layers, outer layer towards the bottom of the photograph (x6,000); d - (lower right) Inner layer (x1,200)	6.29
Figure 6.23	SEM of the side of the shell layer showing two pieces of wood fibre. (x1,800)	6.30

Figure 6.24	Total average methane production for experiment 1 with granule size as a parameter.	6.37
Figure 6.25	Methane production rates for experiment 1 with granule size as a parameter.	6.37
Figure 6.26	Surface area specific methane production rates with granule size as a parameter.	6.29
Figure 6.27	Effect of feed concentration factor relative to the full strength feed on the methane production rate in experiment 6. . . .	6.41
Figure 6.28	Total methane production for experiment 2 with granule size as a parameter.	6.43
Figure 6.29	Specific methane production rate for experiment 2.	6.44
Figure 6.30	Specific methane production for experiment 3.	6.45

TABLE OF TABLES

Table 2.1	Stoichiometry and change in free energy values for propionate and butyrate degradation reactions (after Harper and Pohland, 1986).	2.20
Table 3.1	A typical composition of lactic casein whey permeate	3.4
Table 3.2	A typical analysis of the whole mill effluent from the Pan-Pacific Forest Industries thermo-mechanical pulp mill. . . .	3.4
Table 3.3	The composition of thermo-mechanical pulp mill screw press effluent used for this work and that of one specific batch. . . .	3.6
Table 3.4	Composition of volatile fatty acid standard solutions.	3.8
Table 3.5	A summary of the characteristics of the reactors used in the project.	3.22
Table 3.6	Ratio and source of pulp mill sludges.	3.26
Table 4.1	An overview of the experimental programme for reactors C and D.	4.3
Table 4.2	"Pseudo-steady state" ("SS") parameters	4.22
Table 4.3	Wastewater composition and operational performance reported for anaerobic treatment of TMP wastewaters.	4.33
Table 5.1	Resin acid "pairs" with similar elution times	5.5
Table 5.2	Estimation of the precision of resin acid and long chain fatty acid measurement for a typical feed sample.	5.7
Table 5.3	Acid sums before and after varied storage times	5.8
Table 5.4	Distribution of resin and LCFAs between the dissolved and suspended solids fractions of feed and effluent samples.	5.12

Table 5.5	Experimental conditions for serum bottle experiment 6 . .	5.21
Table 5.6	Experimental conditions for serum bottle experiment 8. . .	5.24
Table 6.1	Mesh sizes and weight fractions for solids distribution analysis of reactor C sludge	6.7
Table 6.2	Average particle diameter and particle numbers	6.8
Table 6.3	Solids analysis for granules	6.11
Table 6.4	Experimental conditions for serum bottle experiments one to three	6.33
Table 6.5	Actual and theoretical yields of methane from serum bottle runs for experiments 1 and 2	6.34
Table 6.6	Calculated average granule surface areas	6.40