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ANAEROBIC TREATMENT OF THERMO-MECHANICAL PULP MILL WASTE WATER.

A thesis presented in partial fulfilment of the
requirements for the degree of
Doctor of Philosophy in
Process and Environmental Technology
at Massey University.

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1994

ACKNOWLEDGEMENTS

I would like to thank the following:

- Dr A.H.J. Paterson, Dr A.J. Mawson and Dr Rao Bhamidimarri for their supervision and assistance.

- Tony Paterson and Neville Dow for their late night work and encouragement.

- Mr J.T Alger, Mr R.B. Collins, Mr D. McLean, Mr P. Shaw and Mr W. Mallet for their skills, help and experience in building and maintaining equipment.

- John especially for his patience, advise and the extensive use of his workshop tools for many activities.

- Mike Stevens for his advise and help with the University administrative system.

- Mrs A-M Jackson, Mrs J. Collins, Mr J. Sykes and Mr M. Sahayam for their assistance and patience with equipment dissapearing overnight.

- Prof R.L Earle and the staff of the P.E.T. department for their assistance and encouragement.

- Dr P.N. MacFarlane, Dr T. Clarke and the N.Z.F.R.I. for their assistance.

- P.A.P.R.O.N.Z, the University Grants Committee, the extramural bar and rock and roll for financial assistance.

- Pan-Pacific Forest Industries for their eager provision of 20 tonnes of TMP wastewater.

and especially Janine, Katrina, Bella and Veronica for their support, patience for the extreme demands of anaerobic digestion work and for providing an existance outside Massey.

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 Zealands 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 $kgCOD.m^{-3}.d^{-1}$. 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.

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