MIRINZ LOW TEMPERATURE RENDERING PROCESS

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INTRODUCTION

The New Zealand (NZ) meat industry produces about 1.2 million tonnes (t) of carcass meat annually from grass-fed cattle and sheep. About 75% of the beef, 65% of the mutton and 98% of the lamb is exported. Most of the beef is exported as frozen boneless meat, but a large proportion of the sheepmeat is still exported as frozen carcasses.

Most New Zealand slaughterhouses have an in-house rendering department, although there are service renderers that process butcher shop wastes and material from small slaughterhouses. In New Zealand, meat production is seasonal, especially lamb production. A large number of sheep are processed, which, coupled with the seasonal kill, presents special problems for rendering. The raw material usually has a high moisture content, it may have a low bone content, and it may contain paunch material (semidigested grass) that can reduce tallow quality if the viscera are not thoroughly washed.

In the 1970s, the Meat Industry Research Institute of NZ (MIRINZ) surveyed the four main rendering systems used in Australasia (continuous and batch dry rendering, Centrimeal and Pfaudler), and found none to be ideal for the NZ industry. Therefore MIRINZ set out to design an 'ideal' system, based on 'first principles' of process engineering (Fernando 1982).

The rendering process was first defined in terms of the unit operations involved: size reduction, heat and mass transfer, phase separation and solids drying. Each operation was then optimised. For example, in MIRINZ' ideal system, tallow should be produced and separated from the wet solids at low temperatures (< 100°C rather than the 110-130°C that can occur in dry rendering). Low temperatures reduce energy requirements and pose less risk of degrading the tallow and meal. As no suitable equipment was available for this heat- and mass-transfer operation, MIRINZ designed a rendering vessel that met the criteria of high rates of heat and mass transfer, minimal emulsification of fat, minimal raw material residence time and simple design. The vessel is a continuously stirred tank reactor in which only rendered material rises to the top- Heat is supplied by an internal steam coil, designed to ensure self-cleaning.

Approximately 200 trials were performed in a pilot plant, which could process 0.25-1 t/h of raw material, to investigate the effects of raw material composition; tallow to raw material ratio; agitation rate; type, location and diameter of the impeller; necessity of baffles; and residence time in the vessel on the rendering process. Pilot-plant trials were also performed with fish-processing wastes, and extensive trials were conducted using a modified MLTR for defatting mutton to produce a high-protein material that could be used in processed meat products (Swan and Catcheside 1984).

In the MLTR process, comminuted material, together with 90°C tallow, is fed into a vessel maintained at 90-95°C. The rendered material overflows into a decanter, which separates solid and liquid phases, and the separated solids are dried in a steam-heated or direct-fired dryer. The liquid phase is acidified to enhance tallow and stickwater separation. Some tallow is recycled to the rendering vessel and the rest goes to storage (Figure 1). The stickwater can be either further treated (Caddigan 1983) or discharged.

Two microbiological evaluations of MLTR systems have been done. During pilot-plant trials, one extensive evaluation showed that the decanter solids, tallow and stickwater all have low microbiological populations, and that 99.9% of the viable organisms are destroyed in the rendering vessel (Lowry 1983), although some bacterial spores and small numbers of Gram-positive cocci survive. The microbial quality of the tallow and dried meal is similar to that of products from dry batch rendering systems (Lowry et al. 1979), even though the heat treatment is much lower. A microbiological investigation in a commercial MLTR plant confirmed these findings.

ACCEPTANCE OF THE MLTR BY INDUSTRY

Pilot-plant trials in 1980 led to the installation of the first commercial MLTR plant in December of that year. Since then, 21 more plants have been commissioned, four being outside NZ. These plants are processing a variety of materials ranging from mutton-only wastes, through mixed kill and service rendering to beef-only wastes. One

Table 1. Actual energy use and product yields for MLTR processing and calculated energy use and yields for dry rendering. Raw material (RM), S (sheep material; 60% water, 22% fat, 18% fat-free solids) and B (beef; 43% water, 34% fat, 23% fat-free solids) represents the extremes of RM composition that New Zealand rendering systems encounter.

	MLTR processing		Dry rendering	
	S	B	S	B
Product yields, t/t RM				
meat meal	0.21	0.25	0.22	0.27
tallow	0.20	0.32	0.18	0.30
550 kPa steam used				
t/t water evaporated	1.40	1.18	1.50	1.50
t/t RM	0.40	0.40	0.82	0.64
Electricity, kWh/t RM	28	53	40	40
Total energy use				
GJ/t RM	0.93	1.02	1.97	1.43
GJ/t product	2.27	1.79	4.92	2.51
Breakdown of energy use, %				
electricity	11	19	8	11
steam for rendering	31	28	) 92	) 89
steam for drying	58	53	)	)
85°C water produced, t/t RM	1.35	1.60	4.21	2.97
Net energy use, GJ/t RM	0.51	0.51	0.65	0.50

plant is processing fish waste, and one was producing high-protein edible material from sheep carcasses.

The MLTR is modular, with each unit processing 5 t/h of raw material. Process specifications outlining standard operating conditions, as well as the maximal residual fat in the meal, maximal loss of fat and fat-free solids from the raw material, and tallow bleach colour, have been issued. Patents have been granted in several countries. The international licence has been given to two companies, and the Australasian licence can be held by three companies.

Table 2. Composition of meat meals and quality of tallow produced by MLTR or dry rendering slaughterhouse wastes (viscera and bones). (Swan, 1985)

	Sheep material		Beef material	
	MLTR	Dry	MLTR	Dry
Meal composition, % dry matter				
crude protein	57	59	50	52
fat	11	15	8	14
ash	20	26	36	29
Meal gross energy, MJ/kg	18.5	17.3	13.7	16.0
Tallow bleach colour	0.3R	1.5R	0.3R	0.5R

MLTR PERFORMANCE

MIRINZ surveyed several industrial MLTR plants to assess process capabilities, product yields and quality and energy use. The surveys indicated that the plants were working well and meeting specifications.

Energy and yield data for the MLTR system, obtained from industrial surveys (Caddigan and Swan 1985), are summarized in Table 1. Comparable data for dry rendering were calculated using information from the initial rendering surveys done by MIRINZ in the 1970s. The raw material compositions in Table 1 represent the extremes that can occur in the NZ meat industry.

Most NZ rendering plants are associated with slaughterhouses, so any hot water generated by recovering heat from the dryer vent steam can be used on the' slaughter floor. Thus, net energy use is important. However, rendering plants often continue operating after slaughtering operations have stopped, and any hot water generated will be wasted if there is insufficient storage capacity.

Because the MLTR uses less steam than dry rendering systems, lower-capacity boilers can be installed, reducing capital costs. The lower total energy use of the MLTR is advantageous to service renderers, who usually have little use for hot water, and to beef processing plants, which use much less hot water than sheep processing plants [Downey (1982) reported that some NZ sheep plants used 8 litres of hot water per kg of dressed carcass].

The electrical energy used in MLTR plants decreases as plant throughput approaches the design capacity thus decreasing total energy use per unit weight of raw material processed.

Data in Table 2 show that both the raw material composition and the type of rendering process used affect the composition and quality of the meat meal and tallow produced. In this example, the MLTR plant processed unwashed sheep viscera and the dry rendering plant processed washed viscera; nevertheless, the former produced a much higher quality tallow.

MEAL NUTRITIONAL VALUE

The nutritional value of meals manufactured from beef or sheep raw materials processed by MLTR or dry rendering was compared in a limited number of chick-raising trials. Feed consumption to four weeks was not significantly different for any of the meals, and both MLTR meals gave slightly better growth rates than their dry-rendered counterparts (Swan 1984).

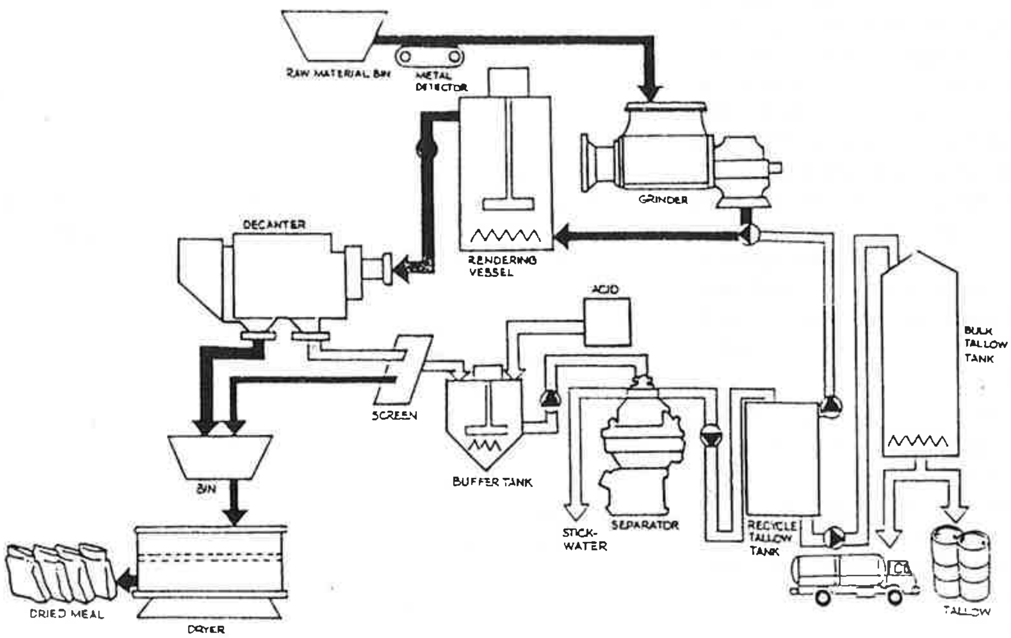

Figure 1. Schematic description of the MLTR.

A more extensive trial comparing the nutritional value of MLTR and dry rendered meals manufactured from lamb slaughter wastes has been done using rats and cockerels (Savage et al. in preparation). Before and after MLTR processing, the protein's true digestibility (TD) and biological value (BV) remained unchanged at 86% and 46% respectively. After dry rendering the TD had increased from 75% in the raw material to 82% in the meal, but the BV had decreased from 46% to 34%. The cockerel bioassay indicated that the Corrected Amino Acid Availability (CAAA) of the raw material was about 80%. MLTR processing increased CAAA by 9%, but dry rendering increased CAAA by only 3%.

POLLUTION LOADING

An MLTR produces less odour pollution than dry rendering systems because it subjects the raw material to a much milder heat treatment and removes half the water mechanically. The quantity of stickwater produced is directly related to the moisture content of the raw material, but chemical oxygen demand (COD) is fairly constant. Rendering raw material with a 55% moisture content produces about 0.4m^3 Of stickwater with a COD of 60 000 g/m^3.

Stickwater need not be dumped. It can be concentrated by evaporation or ultrafiltration (Caddigan 1983) and then be recycled to the rendering vessel without adversely affecting the tallow quality added to the meal during drying or used as a stockfood additive. If the MLTR is processing edible material, the concentrate can be used as a meat flavouring- In NZ, where effluent disposal charges are low, concentrating stickwater is only marginally economic.

CAPITAL COST AND STAFFING

The MLTR, like many other continuous systems, can be operated automatically or manually. Most plants commissioned in NZ have not included sophisticated control and automation. Instead, one to three workers per shift run a 5 t/h module, overseeing all aspects of the process from raw material input to tallow storage and meal drying, grinding and bagging. The MLTR is capital cost competitive with other rendering systems that incorporate waste heat recovery and pollution abatement equipment. Its success has been evidenced by its rapid adoption within the traditionally conservative NZ meat industry: in the last 8 years, one-third of the industry has installed MLTR systems.

ADVANTAGES OF THE MLTR

- A wide variety of raw materials can be processed, including those originating from beef, lambs, sheep, young calves, slinks and fish. Material can be processed either in single streams or mixtures, and the MLTR can be used for edible as well as inedible processing.
- Unwashed raw material containing paunch contents can be processed into bleachable tallow.
- A low-fat (8-10%) meal is produced. Meal moisture can be controlled to X-10% because the meal is not dried in the rendering vessel.
- If required, the meal and tallow can be sterilized separately using conditions that maximize quality retention yet ensure sterility.
- The stickwater can be treated to ensure that product loss is small and pollution load is low.
- Steam usage is 50-65% that of dry rendering; the equipment requires minimal space; and process control is simple and suited for automation.
- The process is modular, which gives flexible capacity. Existing dry rendering systems can be converted to an MLTR using the dry rendering vessel as a dryer.

ACKNOWLEDGMENTS

T. Fernando developed the MLTR and M.S.C. Caddigan, S. Dunn and other MIRINZ staff carried out the trials and surveys.

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