MEAT RESEARCH REPORT

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EVALUATION OF A SYSTEM FOR CUTTING AND WASHING SOFT OFFALS, BASED AROUND A MODIFIED BRENTWOOD SHREDDER

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SUMMARY

The cutting and washing of waste soft products from abattoir slaughter floors is generally not performed efficiently. Improvements in this area would lead to substantial increases in the revenue from tallow and meat meal production.

Investigations into the cutting of soft offals indicated that by utilising a machine which has a scissor-like cutting action, a product of more consistent particle size and shape could be achieved. The Brentwood Shredder was selected as a suitable basis for such a machine. To complement this, a washing system incorporating high pressure spray nozzles was constructed. This system was trialed in conjunction with a number of different de-watering devices.

Tests results indicate that the modified Brentwood is a good soft offal cutter and that washing and de-watering can be carried out efficiently with the prototype units.

1. INTRODUCTION

Non-edible gut material from the slaughter floor needs to be size reduced, washed and dewatered before dry rendering. The equipment used for this purpose in most Australian abattoirs does not perform these functions as efficiently as is desirable. The most common, the disc hasher-washer, has several shortcomings. Cutting efficiency is such that a large amount of separated fat particles ('pea' fat) is generated, much of which is lost to the effluent system. Other size reduction machines, such as the pre-breaker or hogger, cause similar problems.

Washing and de-watering is usually performed by a rotating, perforated trommel. The cut material is rigorously tumbled around inside these trommels for an extended period of time. Washing is inadequate and much of the gut content becomes imbedded in the tissue. The tumbling action inside the trommel further promotes the formation of 'pea' fat, which can then pass through the perforations and be washed away.

The presence of excess ingesta in the raw material affects the quality and yield of tallow and meat meal from dry rendering. The amount of tallow which can be pressed out of the cracklings is reduced and there is a dilution in the protein value of the meat meal. The colour of raw and bleached tallow is also increased, as is the level of free fatty acid (F.F.A.).

Investigations into the problem indicated that by adopting a scissor action in cutting the material and developing a novel washing system, losses and downgrading could be kept to a minimum. Because of the design and principle of cutting of the Brentwood Shredder, it was decided that it would make an ideal starting point for a specialised gut cutter. One of these machines, an AZ15W, was acquired from Shred Tech Pty. Ltd. for further development. The concept for washing was to use a series of high pressure spray nozzles in a chute mounted directly below the Brentwood cutters. The washing unit and associated dewatering units were constructed and set-up for trialing with the Brentwood machine.

2. DEVELOPMENT AND EVALUATION OF EQUIPMENT

2.1 Brentwood Shredder

2.1.1 Redesign

The cutting action of the standard Brentwood Shredder is such that two rows of counter-rotating, hooked cutters capture and crush/shred the particles in the area encompassing their line of intersection. It was decided that with a reverse direction of travel, the desired cutting action could be achieved with newly designed cutters (Fig.1)

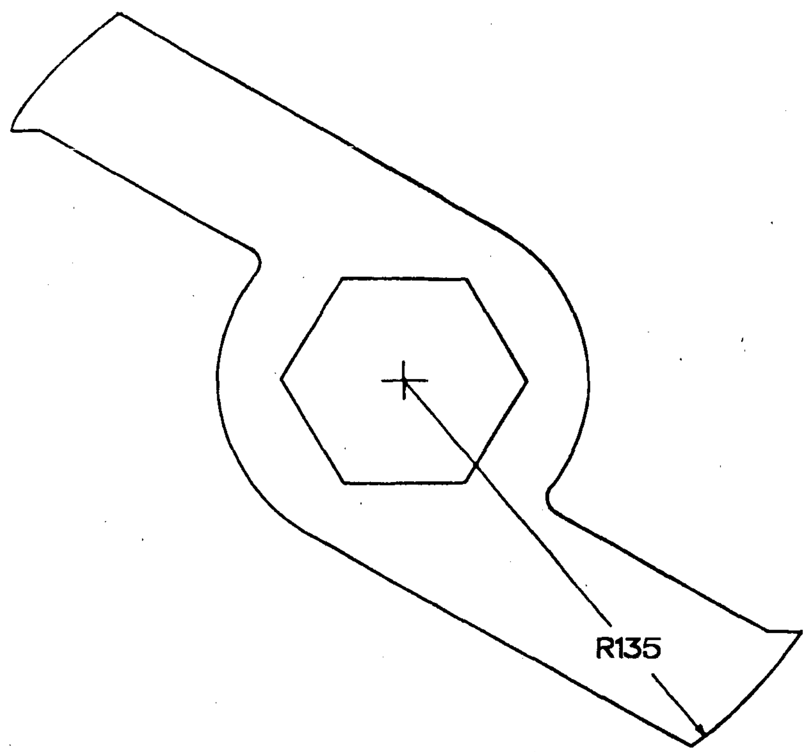

Figure 1. Cutter design.

mounted on the shafts scissoring against fixed cutters mounted on either side of the cutting chamber. Backing plates which bolt onto the channels on the sides of the machine would give mounting points for the adjustable stationary cutters. The sets of cutters would need close tolerances for optimum results.

These stationary cutters (or anvils) (Fig. 2) were designed so they could be easily replaced if damaged or worn, without the need to dismantle the main shafts. The backing plates have a 6 mm ridge running along their length and these mate with a groove in the back of each anvil to ensure positive location. Two through bolts which ride in slots in the backing plates and side channels of the machine provide adjustable fastening for each anvil.

The criteria for the design of the cutters included the height of the cutting plane relative to the shafts and the mode of cutting i.e. the cutting surfaces should first interact at the extremity of the rotating cutter with the contact point moving towards the shaft centre. The height of the cutting plane should be such that the cutters have the best attack angle on the material. The mode of cutting suggested would ensure that the material is 'trapped' by the cutters and not squeezed out. A design width of 28 mm was decided for the cutters. A clearance of 0.2 mm between the cutting surfaces was allowed.

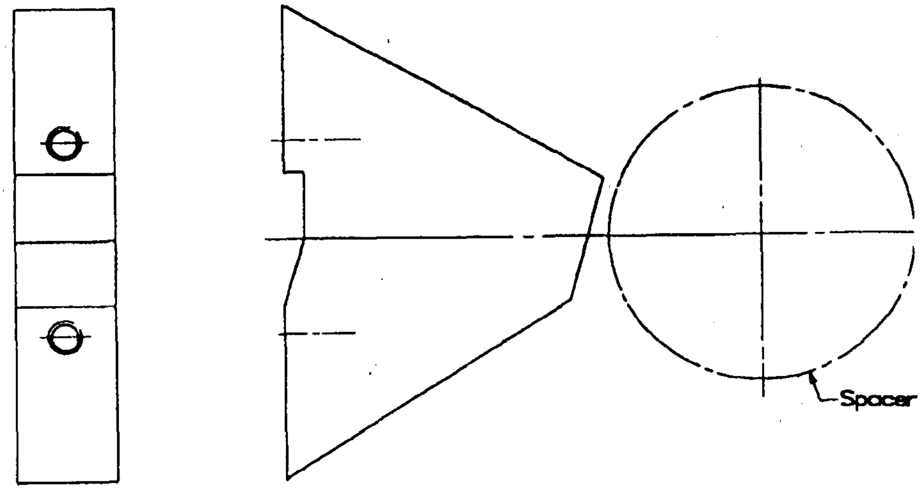

Figure 2. Stationary cutter design.

Suitable cutters (rotating knives), anvils and backing plates were designed at the laboratory, manufactured and installed in the Brentwood Shredder. The motor was rewired to run in the opposite direction. The speed of this first prototype was 12 r.p.m. for each shaft. Figure 3 diagrammatically shows the mode of operation.

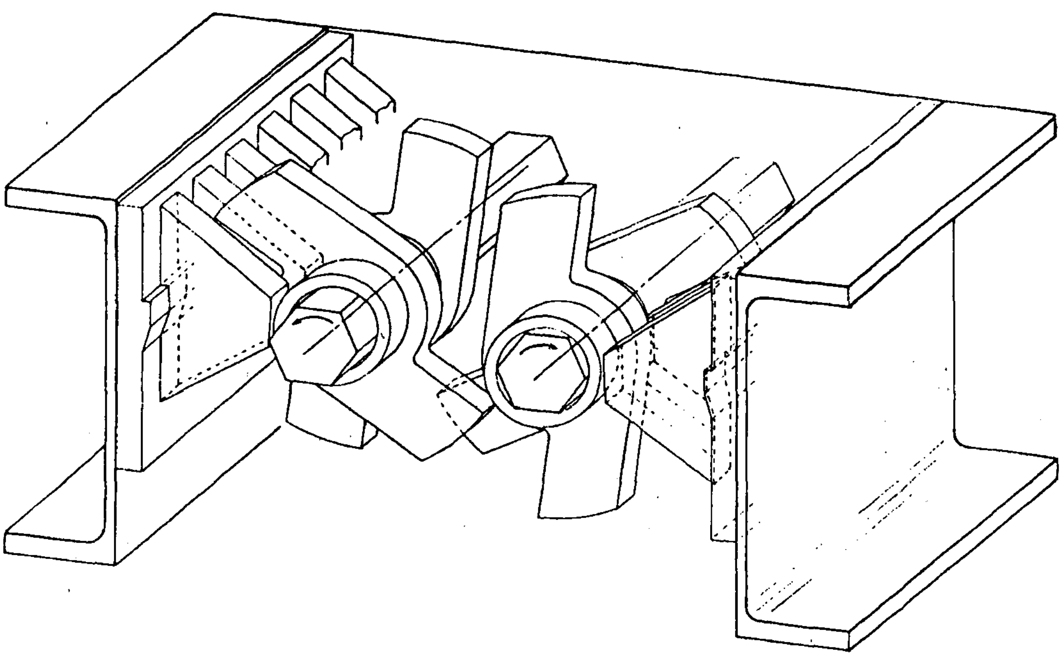

Figure 3. Mode of operation of the first prototype.

2.1.2 Preliminary evaluation

Several trials were performed with the cutters arranged in both 'chorus line' and 'staggered' formation. The materials used included beef omasums (bibles), and lower intestinal tracts (runners). Actual cutting was satisfactory with discrete pieces approx. 100 mm by 50 mm being produced. The throughput rate, however, was not as high as necessary, and was improved through further development. The cutters appeared to rotate too slowly and material tended to roll up the tapered sides of the feed hopper, away from the cutting area.

2.1.3 Further modification

The problem of the cutters not grabbing the material adequately had to be overcome. It was decided to redesign both the cutters and the anvils. These were machined accordingly and refitted to the Brentwood. The speed of the shafts was increased to 50 r.p.m. with the installation of a new gearbox. To aid in fluidising the material, a centrally located spray bar, operating from mains pressure, was fitted directly above the centre of the two rows of cutters. This was drilled so as to deliver a jet of water onto each cutter.

The feed hopper supplied by Brentwood had one vertical side and three tapered at about 20°. To reduce the tendency for material to roll up the side of the feed hopper as the cutters made contact, a vertically sided insert was added. This, it was hoped, would improve throughput. At this stage of development, the machine was transported to an abattoir for extended trials.

2.1.4 Secondary evaluation

These tests showed that improvements had been made. Throughput was greatly increased and there was less tendency for the material to ride on top of the cutters. Particle size was similar to that of the first evaluation, although occasionally some longer strips were produced. Residence time for an opened paunch, bible or intestinal tract was around 20 seconds, with all three together being processed in 25 to 30 seconds per set.

During this evaluation, several other minor modifications were made to the equipment. These included changes to the feed hopper, alteration to the anvils and variations to the water spray arrangements. The most significant of these was the change to the anvils. These were re-machined to give a straighter cutting edge with a slightly steeper angle. The result was a material output of more consistent size.

2.2 Washing and dewatering system

2.2.1 Washing unit

The type of washing system selected utilised a series of high pressure spray nozzles situated directly below the Brentwood Shredder. It was decided to enclose these in an acrylic, four sided cabinet, and to arrange them in a staggered formation for best efficiency (Fig.4).

Twenty spray nozzles were used, each of which delivers approximately 5 litres per minute at 7 bar. To obtain this pressure and flow rate, a suitable pump was required. A Pacific, T2-6 series was selected for these trials. A pressure gauge was fitted to the system so that water usage could be measured. Various nozzles were evaluated to test their ability to produce the highest pressure for the lowest flow rate without mist production.

The most efficient nozzles trialed were: 'Spraying Systems'-'TG3', 'GG3009', 'GG6.5' and 'TP2508'. Table 1 gives the flow rate and spray angles of these jets at various pressures. TP2508 is a fan type jet and the other three are 'full cone' types.

Table 1. Flow rate and spray angles of nozzles trialed.

Nozzle	Pressure (bar) 4	7	10	Spray angle at 7 bar
	Litres per minute			
GG 6.5	5.5	7.1	8.4	45°
GG 3009	4.1	5.4	6.5	30°
TG 3	2.5	3.3	3.9	60°
TP 2508	3.6	4.8	5.8	32°

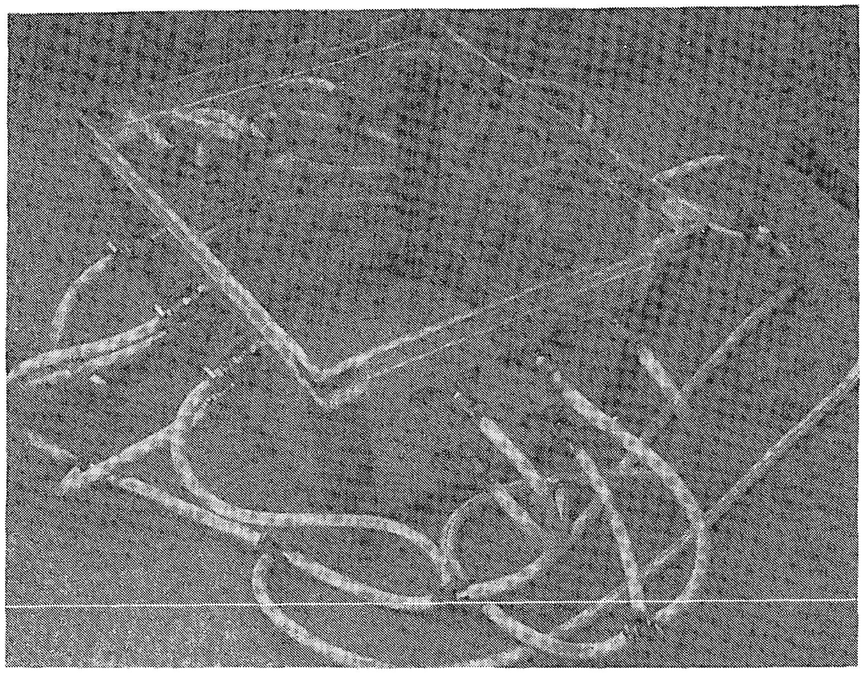

Figure 4. Washing unit design.

2.2.2 Dewatering

Three types of dewatering unit were selected for trialing. Two of these were constructed at the Laboratory, and the other was a Contra-Shear Pilot Plant on loan from Contra-Shear Technology. The former two were designed to be situated below the washing chute, directly under the Brentwood. The "Contra-Shear" required a separate connecting chute as it was too bulky to be placed in a similar position.

(a) Type A

This was a semi-immersion type unit which, it was hoped, would also act as a secondary washer (Fig.5). It was designed basically as a sheet metal trough, 2000 mm long, 600 mm

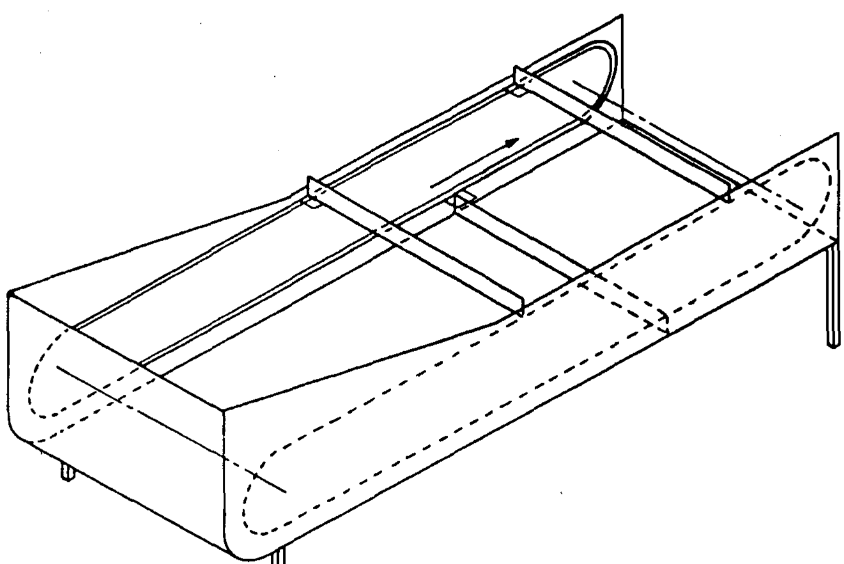

Figure 5. Dewatering unit type A.

wide and 500 mm deep. The base was angled at about 15° with adjustable outlet valves at the lower end so that the depth of water could be varied. Two motor driven chains and sprockets were mounted inside the trough running lengthways, with 12 connecting 'paddles' or 'doctor arms' attached so that they would move material up along the base. The product is thus pushed out of the water and allowed to drain as it moves up the 'beach' section of the base. The arms were raised 5 mm above the base by nylon rubbing strips to provide a gap for drainage. The main drawback with this type of system is that the material, after spraying, falls back into the wash water, thus tending to re-soil it. The addition of copious amounts of fresh water could have alleviated the effect, but would be uneconomical. In addition, it was difficult to achieve a reasonable amount of dewatering in the space provided. Inserting a mesh screen in this part of the base was considered, but clogging would be impossible to avoid.

(b) Type B

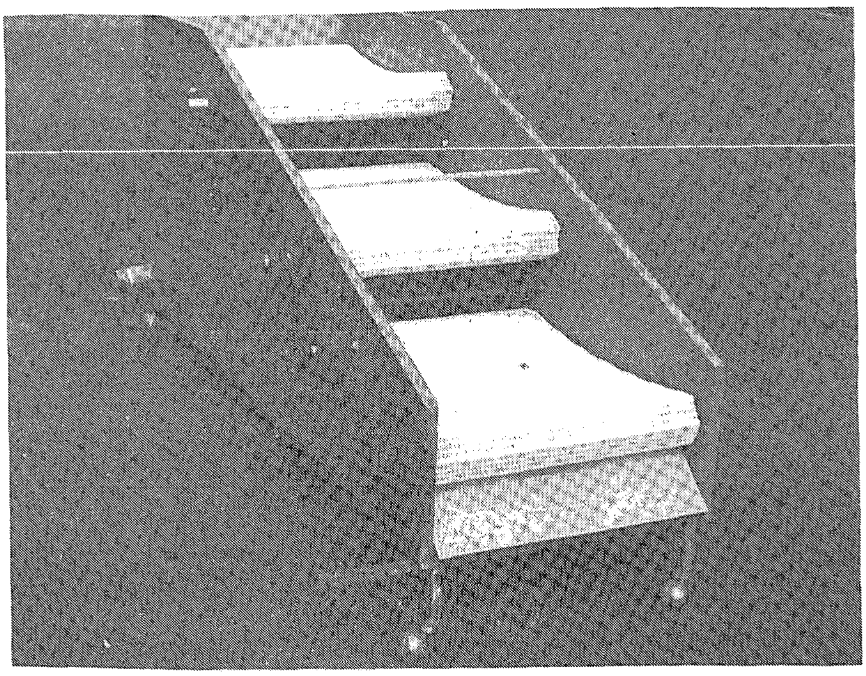

Figure 6. Dewatering unit type B.

This unit was designed to allow drainage of the material with the use of perforated conveyor matting. The unit consists of the sheet metal trough, similar to Type A, inside which three tiers of rotating belts are fitted. 'Intralox' (T.M.) open hinge plastic belting was selected for this application. These conveyor belts are mounted on sprockets and pairs of shafts (see Fig.6). The shafts are chain driven and powered by a single electric motor. Washed material drops onto the first and highest belt, is transported along by it, reaches the end and falls down onto the next belt where the process is repeated. This has the effect of rolling the material over, thus providing better drainage through the matting. Two outlets are provided at the lowest point of the base for drainage of wash water.

This process is much gentler on the material than a rotating trommel, thus the incidence of pea fat formation is greatly reduced. The fat content of the wash water was measured at approximately 30% of the amount produced in the trommel system used at the Metropolitan Regional Abattoir (MRA) (0.4% c.f. 1.5%).

Extra spray bars were added above the second tier of matting and although this improved the washing of the material slightly, it also increased the moisture content of the end product.

Dewatering by this method was found to be much improved over the Type 'A' unit. The amount of ingesta remaining in the output material was less than that found with the use of the first model, indicating that the overall washing effect is quite good.

(c) Type C

The New Zealand firm 'Contra-Shear Technology', manufacture a range of rotating wedge-wire screens for dewatering diverse materials. It was decided to trial a suitable Contra-Shear unit as a comparison to the Type 'A' and 'B' dewatering units. Contra Shear supplied the laboratory with a small pilot plant (Type 600) with 3 mm gap wedge wire screen.

This piece of equipment was duly set up next to the Brentwood and spray washing system at the MRA for evaluation. A connecting piece was added so that material, after passing through the washer, transfered directly into the Contra Shear. Materials used included bibles, opened paunches and runners. These were put into the Brentwood at a rate of one every 40-50 seconds. This was about the limit of the pilot plant's capacity.

The end product was visually inspected and found to be very well dewatered. Small amounts of manure were imbedded in the tissue, but virtually none was found in a free state in the output. As expected, the longer the residence time in the screen, the drier the material became. This process time can be altered by using different numbers and profiles of flutes inside the screen. A compromise is then reached between throughput and dewatering efficiency.

Fat composition tests were done on samples of effluent water from the "Contra-Shear". These results were similar to those achieved from the Laboratory designed type 'B' dewatering unit i.e. approx. one third of the level measured from the hasher washer.

3. DISCUSSION

3.1 Cutters

The results of trials with the modified Brentwood prove that the basis of the design for cutting is a sound one. After alterations to the original prototype, the machine met all the size reduction requirements of a dry rendering system. With the experimental 27 mm wide cutters, particle size is perhaps too small for the situation where the product is to be mixed with bone-in material before cooking. Here the longer cook time required for the hard material can result in the softs being overcooked. This can cause an increase in the amount of fines, and consequently in the F.F.A. of the tallow produced. Hence, 30 or 40 mm wide cutters will be recommended for production models. An added advantage with wider cutters is that the rate of throughput should increase. At present, there are a very few problems with throughput, except that the very largest bibles sometimes bridge across the cutters for a short period of time.

This model Brentwood has not been designed for the reduction of bone material, and therefore it is not recommended for this purpose. However, during trials, several beef hocks and shin bones were processed without any apparent damage to the machine.

There has been no observable wear on any of the cutters or anvils during these trials. Some time does need to be spent, however, on resetting the anvils should they be removed for any reason. The shafts need to be manually rotated slowly and the clearance between all the cutters and anvils checked as the securing bolts are tightened.

The control box for all Brentwood machines has an 'Electronic Shear-pin' overload device which can stop and reverse the motion in the case of jamming caused by an item such as a roller. With the gut cutter, this reversing cycle must be adjusted so as to operate for only half of a revolution and then stop the machine to prevent further damage by the item and to stop uncut material being carried down between the shafts in the centre of the cutting chamber. A warning device should be fitted so an operator can find and remove the offending article.

Following the success of this trial unit, Brentwood Engineering produced a commercial prototype gut cutter which is of very similar design. The major difference is that the length of the cutting chamber is 700 mm compared with 450 mm for the experimental prototype. The width of the cutters used is 40 mm. This unit is cutting soft raw material for the dry renderer in a public abattoir in NSW. A visit was made to the plant to observe the operation of the gut cutter. The unit was found to be performing quite satisfactorily and the particle size and the throughput rate were meeting all expectations.

3.2 Washer

Visual appraisal of material passing through the washer unit indicates that this method of washing is successful. The actual level of washing is an improvement over that achieved by the hasher/ washer trommel unit. There are other advantages. Residence time is very short. Hot water is not required, therefore less fat is lost to the effluent system. The unit, in conjunction with a dewatering unit, occupies much less space than a trommel washer.

On a commercial level, the washer unit would be inexpensive to manufacture and set up. The sprays themselves would simply be mounted on a stainless steel square-sided chute arrangement. A separate pump with an approximate capacity of 100 litres per minute at 7 bar delivery pressure would be required to supply the sprays through a series of connecting pipes or hoses.

The number of spray nozzles used can be varied to suit the amount of product and is limited by the capacity of the pump. Generally, the higher the pressure, the better is the washing action. This has a greater effect than increasing the total flow rate.

As the water consumption is high at 6000 litres per hour, it is suggested that works consider recycling waste water from slaughter floor viscera conveyors, washbasins, carcass washes, etc., for this duty. Water from such sources would require screening to prevent blockage of nozzles.

3.3. De-watering devices

The Type A dewatering unit did not do an acceptable job of lowering the moisture content of the cut and washed material. There were many inherent problems in the design and therefore further development was abandoned.

The Type B unit showed more promising results. The overall component cost is low, with the major expense being for the motor and the "Intralox" matting. The entire assembly could be constructed for less than $5,000.

During several hours of trials, the matting material showed very little sign of clogging. Some small pieces of tissue did manage to find their way through and end up on the shafts and sprockets. This did not cause any problems, although thorough cleaning may be difficult. Extra sprays, facing down on the underside of the matting on its return journey, could be employed intermittently if excessive build-up was noticed in the spacings.

One test involved adding a spray bar which directed water onto the product as it fell from the first tier to the second, and this trial indicated that extra washing could be achieved. The moisture content of the end product increased only marginally so this ancillary wash may be considered if further washing is required.

The design of this unit is such that another tier of matting could be included to dewater the product further. The overall length could also be increased if floor space is available.

The motor used in the trials was a 1 horsepower variable speed unit which gave the prototype a belt speed of 7 to 20 m/s. A smaller motor would be sufficient for this application. Slower belt speeds could be obtained with different gearing and this should aid dewatering.

The 'Contra-Shear' rotating screen is an excellent dewatering device for this type of material. The design of wedge wire screen material and the continuous tumbling action ensure that virtually all of the free water is removed from the product. These units are bulkier than the two prototype units and, as such, cannot fit directly under the Brentwood. However. they are only approximately 1/3 rd the length of an average trommel washer.

Residence time in the drum is much less than a trommel and the agitation is less severe. This, plus the fact that no hot water is added, ensures that much less 'pea' fat is generated. Also, as the screen gap is much smaller than the trommel holes, there is less chance of any free fat escaping with the waste water. Despite the small gaps in the screen, there was no noticeable clogging during any of the trials.

As with the 'Type B' dewatering unit, extra sprays can be set up inside the unit for added washing or outside for intermittent screen cleaning. The motor used is very small (about ⅓ rd horsepower) and the power consumption is low. The unit is virtually maintenance free, except for periodic greasing and inspection.

4. CONCLUSION

The modified Brentwood gut cutter is an ideal replacement for existing soft waste offal size reduction equipment. The unit in commercial use at present is meeting all expectations for cutting and throughput rate. Brentwood Shredders in general have proved to be reliable, low maintenance machines in the meat industry, and have the advantage of being Australian made.

The spray washing system does an acceptable job of cleaning dirty material intended for dry rendering. There is an advantage in that the sprays can be easily turned off while clean material such as washed paunches or condemned clean offal are being processed. The unit is very inexpensive to make.

The type of dewatering unit to be used in conjunction with the Brentwood cutter and washer mainly depends on available finances and the type of rendering system the product is intended for. With a dry rendering system, good dewatering means a substantial energy saving with the cookers. In a wet rendering system, this is not so critical. A rotating screen such as the Contra Shear unit evaluated in this trial will do an excellent job, but is expensive at approx. $15,000 to $25,000 (November 1988) dependent on size. At a much lower cost, the CSIRO design type 'B' unit performs almost as well. An existing trommel could also be used, but some of the advantages of the other systems would be lost.

The system can be 'fine tuned' to the required throughput and type of material which is expected to be processed.

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Brentwood Size Reduction machines are manufactured by:

Brentwood Engineering Pty Ltd,
Berkely Road,
UNANDERRA NSW 2526

and are available from:

Shred Tech Pty Ltd,
PO Box 59,
REGENTS PARK NSW 2143

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