final report

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Process mapping for lamb ears

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1 Background

CRF would like a process that is fully automated and uses no, or minimal, labour
RM had earlier written up a report using three workers per shift processing ears from 5,000 head per day on one shift. All initial knowledge for trialling this process is based on that report and Rick's personal input during the trials.
MLA had initially requested that the job was mainly looking at an automated drying system to remove labour from the process.
The following process is based on all of the above, discussion with RM and thoughts from CRF and uses information given in an earlier report by the author.

2 Process steps

1. Ear removal
2. Caustic soak
3. Drain
4. Tumble
5. Drain
6. Rinse
7. Drain
8. Bleach
9. Dry
10. Cool
11. Waste Handling
12. Scheduling

3 Process description

Introduction

1. The basis is 7,000 head per day based on a 2 shift system approximately 6am to 3pm then 3pm to 1am, 5 days per week.
2. The factory gate price for ears is expected to be $30 to $40 per kg of dried ears (ie 30 to 40 cents each dried ear).
3. The annual dried ear production allowing for seasonal variation is
   7,000 head x 2 ears x 5 days x 48 weeks x 0.01 kg x0.95
   = 31,920 kg per yr allowing a 5% loss on QA inspection.
4. The factory gate sale price is $957,600 to $1,276,800 per yr.
5. A labour unit is $1,100 per week including on cost
6. Caustic costs are

Product name	%w/w	Density	$/kg	Freezing Point ^{0}C	$/kg dry weight
Caustic soda NaOH	46	1.49	0.57	5.5	1.24
Caustic soda NaOH	30	1.33	0.48	0	1.60
Caustic potash KOH	49	1.5	1.20	0	2.45
Concept C20 KOH/NaOH	40	1.45	0.95	4.5	2.38
Caustic soda NaOH	?	?	1.40	?	
Caustic soda NaOH	100	n/a	1.15	not a liquid	1.15

Note 1. All liquids supplied in 1000 litre IBCs
Note 2. First four prices from Orica direct
Note 3. Last two prices from CRF

7. Hydrogen Peroxide is $4.00 per litre in 200 litre containers
8. The extra headings of Waste Handling and Scheduling have been added to the Process steps compared to the earlier "Notes on Processing Lambs Ears at CRF 2007 06 14&15 Rev A rbb.doc"

4 Process steps

1. *Ear removal*
    a. There are two distinct operations
        i. ear removal
        ii. tag removal from half the number of ears
    b. Preliminary discussions with knowledgeable people in the field of automation would suggest a lead time of 12 months and a cost of $500,000 to $750,000 to develop a system that may remove ears satisfactorily.
    c. To locate and remove the tags first would be an extra exercise which could add 6 months and $250,000
    d. Identifying and discarding unsatisfactory ears ie diseased or torn ears would be a further complexity of unknown cost and development time
    e. One operator could do both of these jobs with a lead time of a few hours to develop the skills while automatically rejecting unsatisfactory ears.
    f. It is envisaged that as the ears are manually removed the ones with tags could be dragged over an air operated cutter and as the tag drops one way, the ear falls into a chute and is delivered into a stainless steel wire basket which is hanging on an overhead rail on the floor below. When the requisite weight is delivered, it triggers a switch to move the basket to the caustic soak stage. A 50kg basket ie 2 hrs production, would be 0.86m diameter by 0.86m high. A 25kg basket ie 1 hr production, would be 0.68m diameter by 0.68m high.
    g. The alternative talked about method of a moving belt taking each ear individually through the entire process to a finished dried ear is possible at this stage.
2. *Caustic soak*
    a. This process is very time / temperature dependent. A change of 1-2^{0}C can make a difference of 30 secs in the 4 mins processing time.
    b. As the caustic is used during the day, the 4 minutes could increase slowly to 6 minutes. This is a process that needs constant observation and would be difficult to automate. The time / temperature variables depend on the feel of how the wool is coming off the ears and whether the dehaired ears stay smooth or go ribbed.
    c. An automated system could be the basket on the overhead rail lowering into a temperature controlled bath of caustic and lifted back out under the control/observation of an operator
    d. The alternative continuous moving belt system would have problems as if the time of exposure and or temperature is not optimum then the belt speed would need to be changed or temperature changed and the ears already in process would not be satisfactory until the new settings are optimum again. This would take more operator intervention and result in poor quality product.
    e. The caustic should not be made up by dissolving solid caustic in 75^{0}C water. This is a safety hazard due to the heat of solution of caustic and weighing out the

solid which should not be inhaled. Caustic can be bought as a liquid in 1000 litre IBCs from which the 6% solution can be made by volume dilution. The IBC should be stored inside in a small bunded area to ensure the temperature stays above 5.5^0C (the freezing point). Using liquid caustic will cost $1,500 per annum more than using solid caustic in purchase price but it is much easier and safer to use, and will use less labour.

3. *Drain*
    a. The wire basket is lifted and drains back into the caustic solution
    b. A drainage belt could be used in a continuous belt scenario
4. *Tumble*
    a. Tumbling needs the presence of other ears and acts like a rotating cement mixer. It uses the other ears to rub the hair off. Rick described a tumbler in his report. The tumbling is a 5-15 min task which can be varied depending on how well the caustic has released the hair. A moving basket on an overhead rail could be arranged to automatically rotate and tip into this tumbler. If an operator is present, the degree of hair release can be observed and acted on. There can be operator feedback to the caustic wash system. It is difficult to see this as a fully automated / no operator system as the feedback loop has no detection/measuring method.
    b. Unsure how a continuous moving belt system could have a hair rubbing removal method incorporated. Certainly, any proposed methods would need lengthy trial work.
5. *Drain*
    a. As the drainage waste and rinse are going to the same drain this step is not necessary.
6. *Rinse*
    a. A water spray inside the tumbler could rinse the ears as the tumbler rotates with wastewater running to drain.
7. *Drain*
    a. See item 6
8. *Bleach*
    a. Each 25 or 50 kg batch of tumbled and rinsed ears could be tipped into a basket suspended on the same rail as before and lifted then lowered into a bath of hydrogen peroxide. This could all be automated.
    b. Rick suggested approximately 6 hrs of soaking in bleach. The attached two shift schedule allows for 4 hrs minimum (9 hrs maximum) on the morning shift and 6 hrs minimum (11 hrs maximum) on the afternoon shift. The bleach concentration could be altered if required to cope with a slightly shortened residence time of that no. 4 batch.
    c. The two shift operation indicates that there would need to be two peroxide baths (see schedule) because batches 5 and 6 are ready to be bleached before the bath is emptied of batches 1-4. However, there is the possibility of holding batches 5 and 6 at the rinse stage (item 6 above) until the peroxide bath is emptied. This is simple to do in a batching operation.
    d. If movement was required within the bleaching bath a circulating pump could be used though Rick has not indicated the need for any fluid circulation
    e. There seems no point in using a moving belt system to hold 6 hrs of ear production in a bleach bath.
    f. When the baskets are lifted out of the bleach it would save valuable drying time if free draining water was removed. This could happen if a conscious effort was made to allow baskets to drain when lifted from the bleach and then when ears are poured into the drying trays before being loaded into the oven.

9. *Dry*
    a. During the trials 5 kg of wet ears occupied one square metre. The oven needs to have 40 m^2 of drying trays for the 200 kgs of ears produced each shift. There is a 12 hr period for drying the ears in the schedule though this includes loading and emptying 40 trays of 1 m^2. A specification of a maximum of 10 hrs drying time would need to be given to an oven manufacturer. It is essential that drying oven manufacturers are given samples to test before quoting on the manufacture and supply of an oven. The trays would each have about 5 kgs of wet product and 1.6 kgs of dry product.
10. *Cool*
    a. The ears need to be cooled prior to packaging.
11. *Waste Handling*
    a. This is a vital step in the process. At present, CRF waste is only charged on volume as long as certain limits are not exceeded. The combined cost of incoming water and out going trade waste is $1.98 per klitre as long as limits for various parameters are not exceeded. These are listed below together with the calculated equivalent kgs per month based on 22,000 klitres per month.

Parameter	mg/litre	kgs/month
COD	1,200	26,400
Kjeldahl-N	170	3,740
TDS	515	11,330

    b. Three batches of ears were processed sequentially in the same caustic solution on each of the trial days and the residual caustic was analysed for COD and Kj-N. The TDS was calculated based on the caustic being neutralised by HCl (hydrochloric acid). An estimate was then made of what the caustic would be like if eight (8) batches were processed using one batch of caustic. The tumbler sludge was also analysed on both trial days. The table below gives the result how the ear waste process would affect the monthly discharge in the future when the ears waste is combined with the present waste assuming the present waste is close to the allowable maximum.

	Now		Ears waste	Future	Future	increase
Parameter	mg/litre	kgs/month	kgs/month	mg/litre	kgs/month	%
COD	1,200	26,400	2,606	1,317	29,006	10
Kj-N	170	3,740	150	177	3,890	4
TDS	515	11,330	1,018	561	12,348	9

    c. The discharge volume is estimated to rise by 25 klitres per month from 22,000 klitres per month to 22,025 klitres per month ie 1.1%.
    d. An alternative solution is to dispose of the highly caustic ear waste as a prescribed waste and not mix it with the present trade waste.
12. *Scheduling*
    a. A schedule is attached.
    b. The schedule suggests a few hours work on Saturday to complete processing of Friday's material.
    c. The last two hours of ears each day are kept from 1am until 6am before processing while the last two hours of ears on Fridays is kept chilled until Monday.
    d. The ear removal task would need one (1) labour unit each shift and the ear processing could be done with two (2) labour units per shift.
13. Costs

Running cost/year	Labour	4 labour units/shift	$464,000
	Caustic	$0.48/kg of 30%	$12,284
	Peroxide	$4.00/litre	$9,600
	Water	300 klitres/yr @$2.20/kl	$660
	Rendering loss	96 tonne/yr fresh wt protein	$864
	Ears purchase	21 tonne/yr fresh weight	$192
	Waste disposal		$17,000
	Electric power	Oven $25/day + 10,120kWh	$7,200
	Maintenance		$3,000
	Total		**$514,800**
Income/year	**Total**	**@ $25/kg dry**	**$706,800**
Capital cost	Oven drier	500kg batch unit	$160,000
	Tumbler	Rick said $5,000-$10,000	$20,000
	Winch	Rick said $1,000 (100kg lift)	$3,000
	Caustic tanks	1,000 litre stainless, heated	$5,000
	Peroxide tank	2 x 1000 litre stainless	$4,000
	Fresh ear transport	Motorised chain	$5,000
	Scales		$1,500
	Ancilliaries		$5,000
	Tag removal unit	Developed by MLA	$20,000
	Building		$100,000
	Total		**$323,500**