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URGENT ASSISTANCE TO THE ARGENTINE WOOL INDUSTRY

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THE ARGENTINE REPUBLIC

Technical report: Survey of Argentine wool scouring methods*

Prepared for the Government of the Argentine Republic
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of R.G. Stewart
Wool scouring expert

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United Nations Industrial Development Organization
Vienna

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* This document has not been edited.

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GENERAL COMMENTS

All plants visited could be improved by a few basic control and operating elements, now fundamental to modern scouring plants. These elements are

a) Weigh belts

b) WRONZ liquor circulation loop and grease recovery

c) Moisture meter and associated energy control on the wool outlet from the dryer.

However, even with these elements, productivity would be limited by the very nature of the old design which was not intended to operate nonstop for 160 hours or more. In most cases inadequate or inefficient dryers would also be a bottleneck to increasing productivity.

One other major inhibition to upgrading is the firmly held but erroneous belief by many scourers that they are already operating at levels of efficiency comparable with what can be obtained with modern plants, or that they could get a local manufacturer to copy the latest technology and so attain this status. In regard to the last point, I have already seen imported dryers rendered obviously inefficient by having modules added locally without the manufacturer appreciating the basics of dryer operation.

In these cases, the cheapest option is proving very costly in the long term by causing lost production.

It is appreciated that investing in new imported machinery is a difficult decision to make in Argentina today and that plant management need to have the benefits clearly pointed out so that they can make a good case for such investment. Accordingly, I believe INTI should work with scourers to isolate such benefits and quantify them for the individual cases concerned. The notes which follow indicate what might be done.

1) GREASE RECOVERY. The following is the percentage recovery of grease to be expected from the FIRST BOWL SCOURING WATER (i.e. no spillages or losses of liquor, otherwise the percentage is reduced). Estimates are conservative.

WRONZ loop on conventional plant - 40%

WRONZ loop with mini bowls - 50%

Obtain from the scourer his estimate of the quantities of wool and the grease content. As a first approximation, most of this will be removed in Bowl 1. Estimate quantities recoverable in one year. The problem with most plants seen is that it is quite difficult to capture all the grease laden wash water because of limitations imposed by the bowl design.

2) WATER USAGE AND ASSOCIATED ENERGY LOSS. Conventional scourers must discharge Bowl 1 after 8-12 hours of operation and also release dirt and water during normal operation. In New Zealand we have found this to be as much as 15 l/kg greasy wool being scoured. (Note this refers to heavy scouring effluent from Bowl 1 and not the rinse water.) A mini bowl plant with a WRONZ loop will, by contrast, need to discharge only about 1.5-2 l/kg greasy wool and is designed for continuous operation. 80% of the heat can be recovered from this steady discharge --none can be recovered from the discontinuous discharge in conventional plants.

Measure, by installing suitable flumes, the amount being discharged by an individual scourer. The water and energy savings from installing mini bowls can then be estimated.

3) TOTAL ENERGY SAVINGS. The amount of energy used in scouring with the best practical technology can be calculated and is known as a bogy fuel co-efficient. In different cases these coefficients may be assumed as follows:-

	MJ per kg of greasy wool scoured
Conventional plant	8.0 or more (each plant must be measured)
Conventional plant + WRONZ loop	4.1
Mini bowls + WRONZ loop	3.7
Mini bowls, WRONZ loop, direct firing in dryer	3.3

An energy audit must be done to calculate what each individual scourer is using. The benefits from installing the various improvements can then be calculated.

4) PRODUCTIVITY. An increase in the amount of wool being scoured is especially profitable since it is achieved at little cost. Improvements such as installing weigh belts, cleaning and recycling washing water via a WRONZ loop, and using plants such as mini bowls designed for continuous running, and installation of a moisture meter with dryer control, all increase throughput and hence profitability. An increase of 20% due to these changes would not be unreasonable. Often the increase is far greater.

Calculate the benefits after discussion with the scourer to ascertain present level of productivity. Remember to set down clearly the assumptions being made.

5) IMPROVEMENTS IN EFFLUENT QUALITY. Industry will only set a value on this if it ameliorates a pollution problem which is threatening to cost them money or good will at their production site.

The major contribution to pollution in the effluent is from the recoverable fraction of the wool grease. Operation of a WRONZ loop therefore reduces the pollution load by about 45%. With additional primary treatment, still profitable in that the returns pay for the equipment in two years, can reduce the load overall 55-60% or better, depending on the wools being scoured.

6) DETERGENT USAGE. Once again, individual mill data is required, but it is common experience that reuse of wash water can result in detergent savings, as can a metering system which operates only when the wool is being fed into the train. A dribble of detergent from a can mounted alongside the bowlbowl is not detergent metering. We would anticipate usage for fine and crossbred wools not to exceed 0.5% (5 1/1000 kg greasy wool being scoured) when correctly deployed and it will be frequently less than this.

7) PRODUCTIVITY SURVEYS. These can be invaluable in allowing individuals to assess their own position in a confidential way. Energy surveys are a special case of productivity surveys. Suggest a simpler approach, seeking the following ratios. All wool quantities are expressed as greasy kg.

kg/metre width/year kg/metre width/hour worked	production
Heat energy in A/kg Electrical energy in A/kg Detergent costs in A /kg	material costs
Labour costs in A/kg	- Labour
Repairs and Maintenance in A/kg	- R & M
Administrative costs in A/kg	- Admin.

Ratios when calculated are then supplied to ALL participating scourers in a simple table, from the highest to the lowest. Individual scourers are only given their own ratios and can see where they are placed in this table.

The concept can be greatly sophisticated once the value is appreciated and the confidence of the scourers obtained.

PEHUAJO S.A. Osvaldo OTERO. 2 trains, 1.8 m and .8 m. 6 bowls, mini, double hopper and 4 Charpentier types. Hunter and French rotary drum on small plant. Mainly swing rakes. Harrow a first mini, used as suint bowl. Much of plant locally made and designed. Sharples grease recovery. Commission scourer.

Recommendations: Cott opener, autoclean type dusting of greasy wool, weigh feeding and WRONZ loop could help plant efficiency. Dryer survey needs to be done to ascertain efficiency and so direct advice to be given.

POLE S.A. José ISAAK and Oscar CAFFERATA. All types of wool from 18 to 40^{+} µm scoured. Dusting, feed hopper, 4 drum opener/feed hopper and 1.8 m 6 bowl swing rake Charpentier type followed by Hunter. No. 1 suint bowl and last 2 stainless bowls for bleaching. Dirt removal good, but combing wools would be disadvantaged. Lincoln top produced as a substitute for mohair. 800 kg greasy/h should go to 1000 kg/h with weigh feeding, but drying could be the bottleneck. Not possible to process fine wools without some degree of entanglement in this plant.

Recommendations: Wool dusting (autoclean), cott opener, weigh feeding, WRONZ loop with grease recovery, moisture meter and control on wool outlet, and a dryer survey to be done. All would increase efficiency and productivity.

CALIA S.A. Juan ROCHA. 5 bowl 1.8 m Charpentier Harrow, gentle action Sargent brattice dryer. Autodumping on Bowl 1, Sharples recovery, approx. 1.8% on greasy weight. Total water usage claimed 5 l/kg, 800 kg/h greasy scoured. Wool oiled after dryer, binned and carded for top making. Slightly ropy but possibly in preparation. Detergent surfactant c. 90.

Recommendations: Weigh belt, WRONZ loop, dryer survey and bowl replacement could improve operating efficiency. Grease recovery should be at least 3-4% on greasy wool weight.

MALENKY E HIJOS S.A. Jean CONTRAIN, Juan KEHM (from LANICO S.A.), Aldo ALVAREZ, Osvaldo SPOTORNO, Pedro PETRCCCHI and Miss MALENKY. Keen interest in improving. Good attitude. Two x bowl, 1.6 m. Charpentier type swing rake trains, 4 drum Fleissner and Hunter dryers, and one 1.? m wide Hunter harrow stainless steel plant, gentle action for combing, erected above floor. Sought to reduce entanglement in fine wools and feed directly to dryer. Staff had the basics of technical methods. Suggest this plant be used for any technical transfer operations by INTI locally.

Recommendations: Weigh feeding, autoclean, dryer survey, WRONZ loop for existing plant. Nucleus mini bowl plant (3 mini bowls and WRONZ loop) for early replacement to give maximum benefits.

EL TRIUNFO. Robert FANTON, Juan FANTON, Mr. SACO. 6 bowl stainless steel Charpentier copy (Reilo), swing rakes, hopper, 4 drum opener with dirt removal with flowdown. Screens, very large (10 mm) perforations, only cleaned in pairs to reduce wool loss. Bowls 2 x 35°C, 2 x 60°C, 2 x 20°C. Double squeeze at exits of 1 and 6. Studded bottom, rubber top rollers. Hunter copy, very long, appeared ineffficent. Moist air exiting at wool exit. 28,000 kg/24 h, bowls dropped every 8-10 hours. Scoured wool dusted, double drum but fed between the drums. No dust separation. Louvre screens.

Recommendations: Use air flow to assist dust removal. Autoclean, WRONZ loop, dryer survey to improve air flow and moisture meter with dryer control.

ITUZAINGO. Néstor A. ARGENTINO. Five bowl Fleissner, 2 compact, 3 short. Scours 24-30 μm wools. 3 drum Fleissner dryer. 700 kg/h greasy. Combing 170 tons/month.

Recommendations: WRONZ loop which would recover 4% of the grease and 6-7 tons/month. Heat recovery on flowdown stream. Moisture meter on wool outlet. Autoclean and weigh belt.

LAHUSEN S.A. VIEDMA. Mario KULLOK, Carlos GARZONI, Oscar ZEBAL. Four lines A and B. 1.2 m Charpentier type swing rakes, dryers 3 drum Fleissner being installed plus old brattice. Line C - 5 bowl Fleissner with P & M dryer. Line D - modified (slow) swing rake with 6 drum Fleissner (all dryers gas-fired). Two problems: productivity and dust in Fleissner scoured wool. After discussions, the following steps were recommended:

Recommendations: - for increasing productivity:

1) Weigh belt on D line
2) Log down time and pinpoint for preventative R & M.
3) Install nucleus of modern high production plant (3 mini bowls/WRONZ loop/centrifuges to replace A and B lines)

- for improved quality of Fleissner scoured wool:

1) Autoclean on greasy wool feed
2) Autoclean or Andar deduster on scoured wool.

Urgent recommendations: -Energy survey to ascertain overall and dryer costs in MJ/kg greasy.

- Survey of 6 drum Fleissner dryer to improve performance (Initial suggestions: bigger exhaust vent, smaller burners and all to fire). Once dryer had operated properly, moisture meter with some form of control on the outlet.

UNILAN S.A. CHUBUT. Eng. Pier CIERUTI, Hernán CASTELLANOS. 1.8 m 5 bowl, 2 swing rakes and 3 harrow. 12 draw off points, bowls 1 and 2. P & M sloping sides in last 3. Dryer being converted to gas firing. Gas-fired boiler for bowls. Plant to scour for modern top mill. Problems likely with operating a WRONZ loop in such plant. Dirt holdup still likely.

Recommendations: To support such an extensive further processing investment, a new nucleus mini bowl scour would be preferred with weight belt feeding.

HART S.A. TRELEW. Manager Mr. CASARTELLI and Peter SIMPSON. 5 bowl Charpentier hybrid plant with harrow mechanism in late bowls. WRONZ liquor handling to be installed and grease recovery plant not yet present.

Recommendations: Weigh belt, variable speed control on heavy solids pump. Alter conditions so as to scour more grease off in bowl 1.

LAN-MAR S.A. 600 mm wide 4 bowl plant. 300 kg/h which scales up well. Swing rakes and 2 drum Reilo dryer.

PUNILLA S.A. Mr. SARTORI AND Mr. GARCIA. Gentle jet before bowl 1. 5 bowl swing rake and harrow. 70°C. old F & M brattice limiting throughput. 750 kg/h probably limit. Good product.

LANERA AUSTRAL S.A. Ing. G. J. LEFEBVRE. Combing and scouring to support this plant. All Sargent 5 bowl and brattice dryer, all gas-fired. Very tidy, very gentle. Harrow action. Rubber rollers. No grease recovery. No data on performance. Corrosion, probably because of water softening.

Recommendations: Grease recovery, WRONZ loop, weigh belt and dryer survey. Operate plant on different detergent regime and without water softening. Moisture meter and energy control to dryer.

NEW SCOURING TECHNOLOGIES - THEIR ADVANTAGES AND DISADVANTAGES

by R. G. Stewart

1. INTRODUCTION

The principle reason for scouring greasy wool is to prepare it for further processing. However, the wool type, the nature and extent of the contaminants and the processing route the wool is to follow after scouring will all determine to some extent the way in which the washing step is carried out. In addition, the particular location of the plant with respect to environmental pollution will also dictate conditions at the scouring stage. It may be necessary to chose a technology which enables easy and effective primary treatment either as part of the scouring step or closely associated with it. Further effluent treatment to secondary or tertiary standards may also be required and this relates to the total water used (or perhaps no water used at all) and hence the scouring process chosen.

Taken overall, the scouring operation contains many elements or processing steps. These are:

greasy wool opening and dusting
greasy wool flow control and blending
the scouring or washing process
wool drying and general energy management
scoured wool dusting
control and instrumentation
quality assurance
packaging
by-product recovery and often associated effluent treatment.

Management of such a process must also include wool flow to and from the factory in a cost-effective way: thus the management skills of good communication and people interaction are also needed if the most efficient overall operation is to be carried out.

Finally, the subsequent processing of the scoured wool must also be considered, both in the context of the greasy wool blend to be scoured and in the specification required for the scoured wool. For a vertical company scouring its own wool for subsequent processing, the interaction is relatively simple and the scouring process can be straightforward. For a commission scourer, often having little or no control over the input wools but frequently clear and unambiguous instructions as to what specifications the scoured blend must have, the performance of minor or major miracles is a regular expectation.

2. PREPARATION

Pre-scour preparation of the greasy wool will involve opening, dusting and blending.

2.1 Greasy Wool Opening and Dusting

These are most important steps with the treatment needing to be tailored to the condition of the greasy wool, its dirt content, degree of openness (cotted or matted fleeces may need tearing apart), and fineness (excessively opened fine wool will felt readily in the scour). Dirt removal at this stage ameliorates the load needed to be carried by the wash water. In addition, dirt is much easier to dispose if it is dry rather than suspended in water.

Opening and dusting can take place in one machine or in two purpose-built machines and a wide range of units of varying intensity of treatment are available. These range from single drum pickers (opening, no dirt removal) to Fearnoughts which open excessively and also have dirt removal capabilities. All suffer from build-up of dirt during operation which impairs their performance. Frequent cleaning is essential to maintain uniformity in the opened and dusted wool but this is frequently not given.

The only major development in recent years has been Taylor's Autoclean Opener Duster.

This unit has self-cleaning teeth on the opening section, a self-cleaning screen on the dusting section, and a dust removal cyclone on the air exhaust. Although expensive it gives reproducible opening and dusting over long periods of operation with a wide variety of wools of various types.

(Figure 1)
(Figure 2)

2.2 Blending Greasy Wool

Scouring does represent an opportunity for greasy wool blending which is seldom realised. Blending systems for greasy wool are usually quite rudimentary and comprise placing all the components in a heap or a bin before feeding into the scour or loading the components onto a moving belt which terminates in a feed hopper to the scour. Part of the reason why conventional blending systems have not been used is the difficulty of transporting greasy wool pneumatically. The trunking of the conveying system tends to block with grease and dirt.

One plant in New Zealand has recently installed a blending system utilising weighbelts, bin layering mechanisms, belt conveying and automatic bin unloading.

(Figure 3)

This is a tremendous advance on what is traditionally used in the wool industry and owes much to practices employed in blending in the cotton and synthetic fibre plants.

Good blending at the processing stage is essential if a scoured blend of uniform composition is to be produced. If objective measurements are used to specify the scoured blend uniformity at this stage improves the precision of the sampling.

Wool flow to the scour should be uniform and measurable. Strategies to obtain this will be discussed under Control, Section 5.

3. SCOURING SYSTEMS

Scouring systems are selected for only a few paramount reasons which are usually:

(a) ability to avoid entanglement:
(b) ability to scour dirty wools:
(c) ability to avoid an effluent treatment problem: and
(d) the price.

Usually any potential client will have a certain preconceived rating to apply to each of the above reasons and this determines the final decision on what plant or system to buy.

To these reasons must be added a major inhibition - no-one is anxious to buy a prototype. This means new systems must be launched with a fair degree of risk-sharing from the developer. In spite of the large sums involves in such venture capital there have been a number of new systems launched in recent years but with only a few being successful. Success in this context is taken to be the securing of a follow-up order once the commercial pilot plant has been commissioned.

If we restrict the list of technologies to successful plants by this criterion we have the following systems with their generally acknowledged advantages and disadvantages

3.1 Fleissner Drum Scour

This is an aqueous scour which utilises the suction drum concept to move wool through the scouring liquor. These plants are produced in long bowl, short bowl, and compact bowl (mini?) versions to suit customers requirements. The action is very gentle and probably produces the minimum of entanglement for an aqueous system. However, the same gentle action also means that dirty wools may not be scoured as clean as a system which allows a greater degree of agitation. Although there is no specific data to confirm this, trade opinion is that water usage (expressed as litres of water/kg of greasy wool scoured) tends to be higher than conventional systems. This could be involved with the wool tending to filter out dirt if the liquors are allowed to become too concentrated. However, the fact remains that a substantial number of these systems have been installed over the years.

3.2 Solvent Scouring

The initial rationale for solvent scouring was avoidance of entanglement, but in latter years the emphasis has shifted to highlighting the avoidance of pollution. The process has made painstakingly slow commercial penetration since the first Sover plant was commissioned in 1968. The process involves degreasing with hexane, a brief water spray to assist in removing the hexane and then jetting with isopropanol to remove the suint components. The initial prototype ran in Belgium for five years. Plants were then sold to Russia (two), Japan (one) in 1973, and to Taiwan in 1985 where only the solvent degreasing section was used for commercial reasons. A further plant will be commissioned in Western Australia this year and a second plant has been sold to Taiwan for installation in 1989. This will give a total of seven plants worldwide.

Installations are costly but include a lanolin refining step and evaporation of the small (1 l/kg of greasy wool scoured) amount of aqueous effluent produced. Economics depend heavily on the current value of the recovered woolgrease. This is a somewhat shaky foundation for such large investment. The question must be asked, are you buying the plant for woolscouring or for woolgrease production?

The other commercial solvent plant is Toa YS process presently operating in Japan. This uses 111 trichloroethylene. Solvent losses are said to be 2% on scoured wool throughput. The wool is given an aqueous scour after the solvent wash.

3.3 Aqueous Scouring in Conventional or Mini-bowls

Aqueous scouring has received considerable attention in recent years to make it more efficient, controllable and to incorporate as much by-product recovery and primary effluent treatment as possible because of the environmental considerations. A number of competing versions are commercially available.

3.3.1 The WRONZ Comprehensive Scouring System with Mini-bowls

This has benefited technically from widespread commercialisation since it was first introduced in 1972 (the WRONZ System) and complimented with mini-bowls (1978). For example, the number of mini-bowls installed in New Zealand and overseas since the first introduction is approximately 200. This means that a considerable degree of improvement has occurred over this period and the process is still going on. The total package involves improved opening, weighfeeding, process control, by-product and heat recovery, and maintaining at a low level of heavy effluent discharge (in the vicinity of 1 l/kg of greasy crossbred wool scoured). A full description of the complete system needs to be the subject of a separate presentation. It utilises Alfa-Laval centrifuges but this is not a mandatory aspect. Other manufacturers machines are equally suitable (e.g., Westfalia, Garap, Sharples or Humboldt).

3.3.2 Garap System

This appears to resemble the WRONZ Comprehensive Scouring System but utilising Garap instead of Alfa-Laval centrifuges.

3.3.3 SIROSCOUR Process

Full details have not been published but it appears to be a process utilising multi-stage scouring in a combination on mini- and multi-hopper bowls. Complete process control using the latest computer technology is understood to be incorporated with the added aspect of liquor handling loops which maximise dirt and grease removal (Fig. 4). The first commercial prototype is presently (August 4) being commissioned. More data will be presented at the seminar in September as information comes forward on this new process.

(Figure 4)

3.3.4 Petrie & McNaught Mini-bowl Scour

The WRONZ mini-bowl system has also been commercialised in at least one location in the U.K. by the firm of Petrie & McNaught.

In summary, there is no scouring system which has clear advantages over all others in all situations. Purchasers must look at the first four points of entanglement, dirt removal, effluent treatment and price and decide from a consideration of the competing processes just which one suits them best.

4. WOOL DRYING

Thirty percent or more of a scours energy requirements is in wool drying. The points to observe here are:

(i) that as much water as possible should be removed mechanically;
(ii) that the feed to the dryer is uniform;
(iii) observe the many aspects of efficient dryer operation which have been well documented elsewhere;
(iv) make sure that the process can be controlled, i.e., that some extra drying capacity is available; and then
(v) make use of the current technology available to monitor and control the dryer.

Expanding on some of these points, water removal can be enhanced by increasing the temperature of the final rinse bowl or increasing the squeeze pressure. In some cases a double squeezing can be cost-effective. A feedhopper before the dryer is essential if a uniform feed is to be obtained and attention to uniform greasy wool feeding via a weighbelt feeder at the beginning of the scour will also have benefits in producing uniformly fed scoured wool to the dryer. In dryer operation we must also consider aspects such as the temperature and humidity of the drying air, its flowrate through the wool, the steam supply, the types of steam traps employed, condition and design of the steam coils, and the existence of good control systems.

(Figure 5)
(Figure 6)

5. WOOLGREASE RECOVERY

This operation is essential to any of the high concentration scouring systems mentioned under 3.3. It is also essential if effluent disposal is a problem since the major contribution to be BOD and COD arise from the woolgrease present. The equipment for recovery is commercially available but expensive.

There is no clear agreement between various authorities as to what constitutes the best system from a scours point of view (as distinct from a machinery supplier or woolgrease purchasers point of view). The choice is between:

(a) the two-stage system used in New Zealand and elsewhere comprising a primary centrifuge and a secondary refiner with initial grease emulsion of 60-80% being refined to less than 0.5%; and
(b) a three-stage recovery system is advocated by Australian workers: primary centrifuge, grease emulsion 20%, total solids; secondary centrifuge grease emulsion 60-80%, and a tertiary centrifuge.

A number on in-process and out-of-process loops for optimum recovery of grease and dirt are promoted currently and these are usually promoted as part of the scouring process. One exception to this is the Lemar Process Stage I (Fig. 7).

(Figure 7)

6. ENERGY CONSIDERATIONS

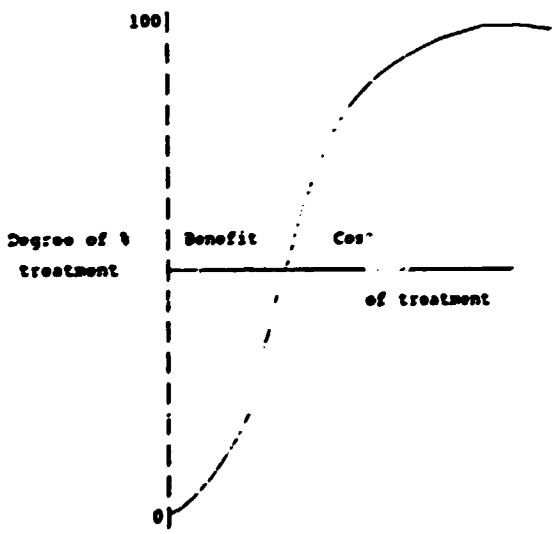
Scouring is energy-intensive. The major areas for expenditure and conservation are:

(i) the primary energy generation plant;
(ii) the scour bowls;
(iii) recovery from the effluent; and
(iv) efficient operation of the wool dryer and recovery from the wool dryer exhausts.

Technologies have been developed to the stage of commercialisation and much experiences exists on the various aspects of energy conservation. The driving force for all the measures used must be the present cost of energy. At the moment worldwide prices for energy are comparatively low but this situation will probably change in the 1990s.

7. EFFLUENT TREATMENT

The level of treatment usually varies from plant to plant. The relationship of cost to degree of treatment usually follows the standard curve.



Primary treatment are usually profitable. Beyond that, any other treatment costs money and sometimes large amounts. Many systems have been tried with no clear contenders as to the best and least expensive treatment.

8. PACKAGING

Dense packaging of scoured wool to densities of greater than 500 kg/m^3 is now accepted as a commercial and cost-effective way to package wool for transport. The different aspects of possible damage, covering materials, sampling for objective measurement, etc. need to be considered in this context.

9. GENERAL

Quality assurance, analysis, and testing are essential for a soundly based scouring industry and should not be neglected.

Efficient scouring of greasy wool enables the fibre to be marketed on equal terms with its synthetic competitors, i.e., as a clean fibre able to be specified with parameters of processing significance. Wool producers should avail themselves of this marketing opportunity.

8 August 1988

Encl.

Figure 1: caption as noted.
Figure 2: caption as noted.
Figure 3: Layout of greasy wool blending.
Figure 4: Contaminant recovery loops for SIROSCOUR® system.
Figure 5: Temperature control loop for a dryer.
Figure 6: Humidity control loop for a dryer.
Figure 7: Lemar Stage I system.

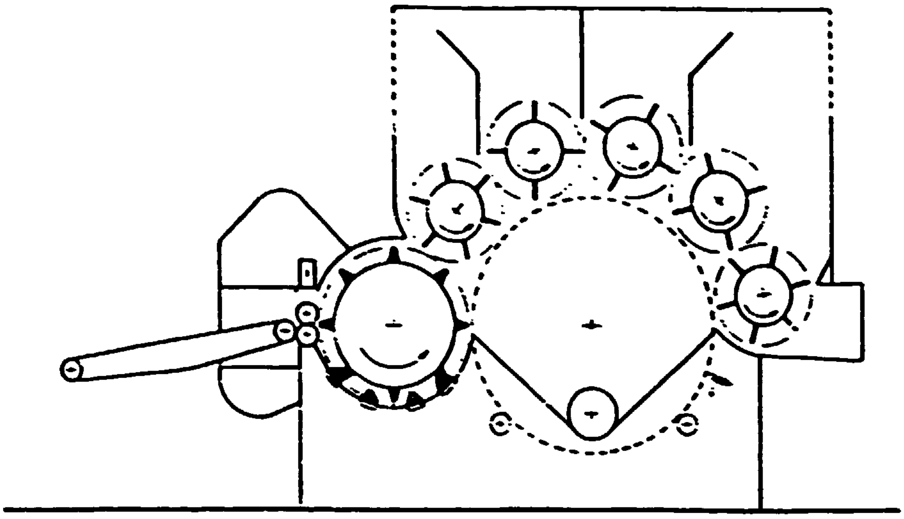


Fig. 1. Schematic diagram of the prototype opener

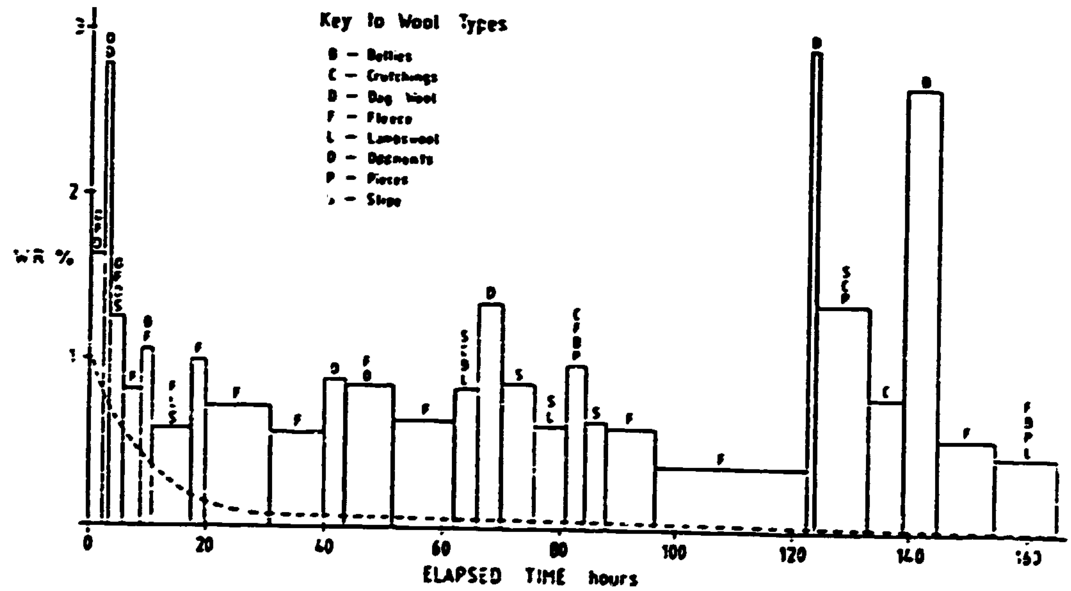


Fig. 2. Histogram of waste removal with time

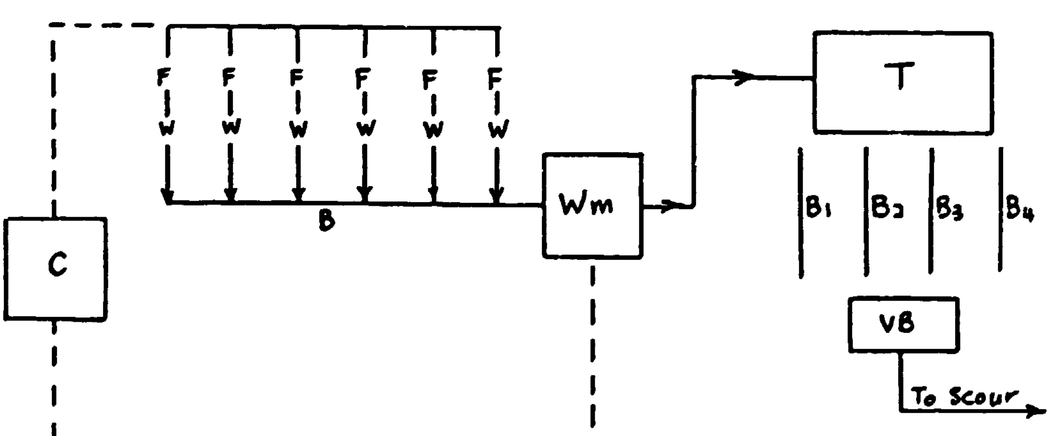


Fig. 3. Blending schematic

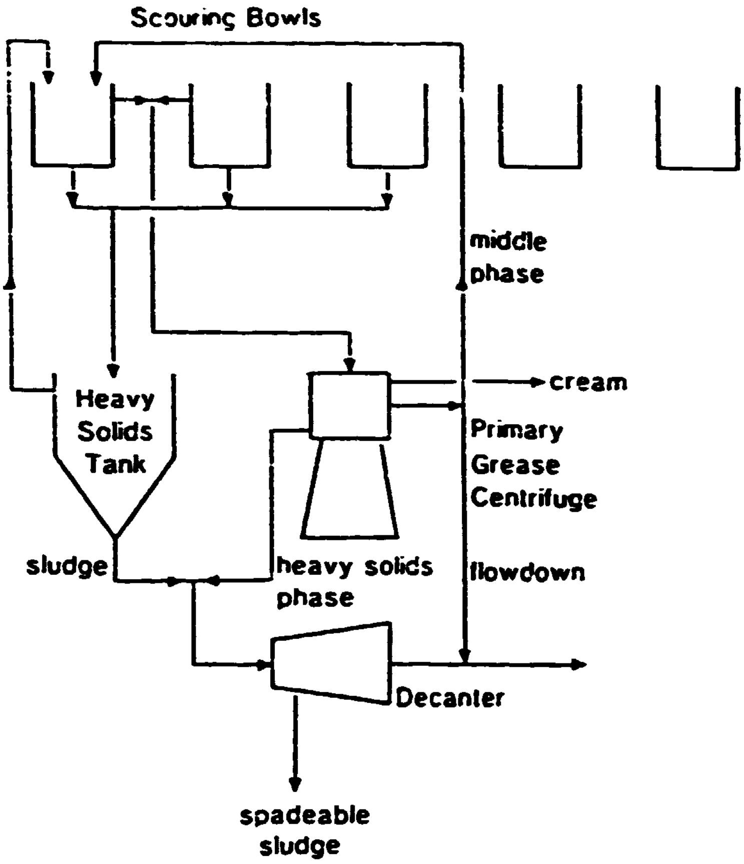


Fig. 4. SIROSCOUR Liquor Handling Loop

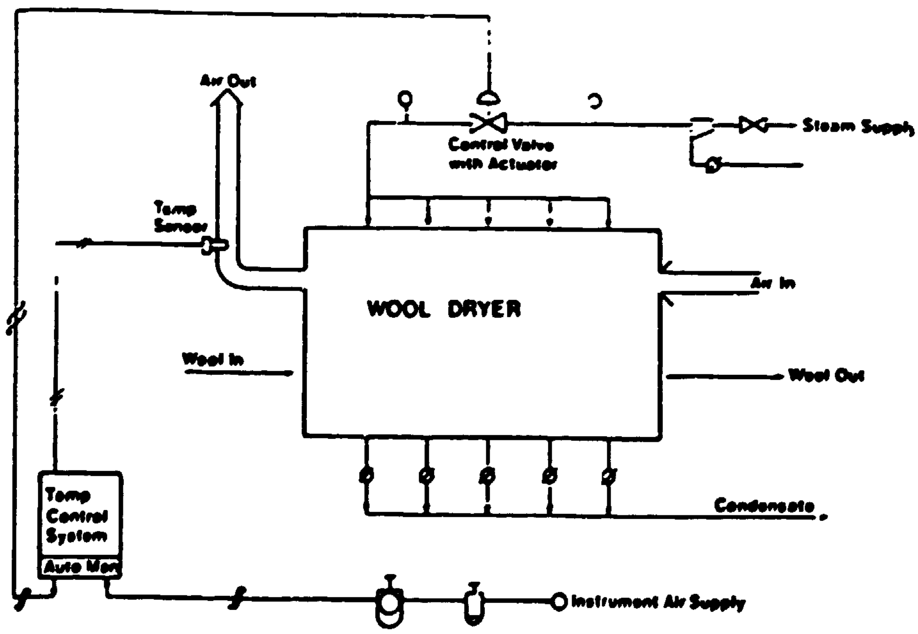


Fig. 5. Temperature control in a wooldryer

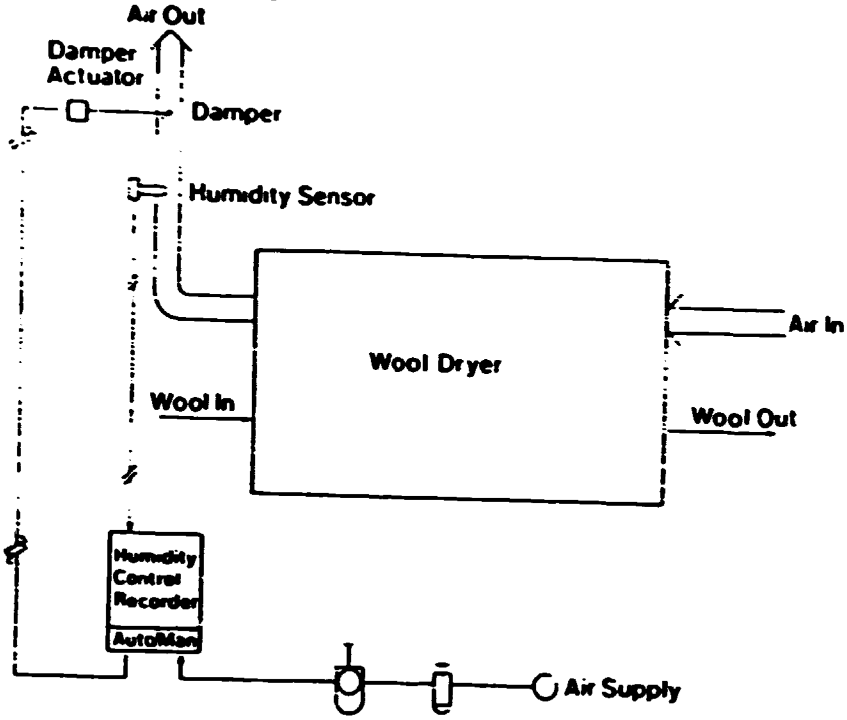


Fig. 6. Humidity control in a wooldryer

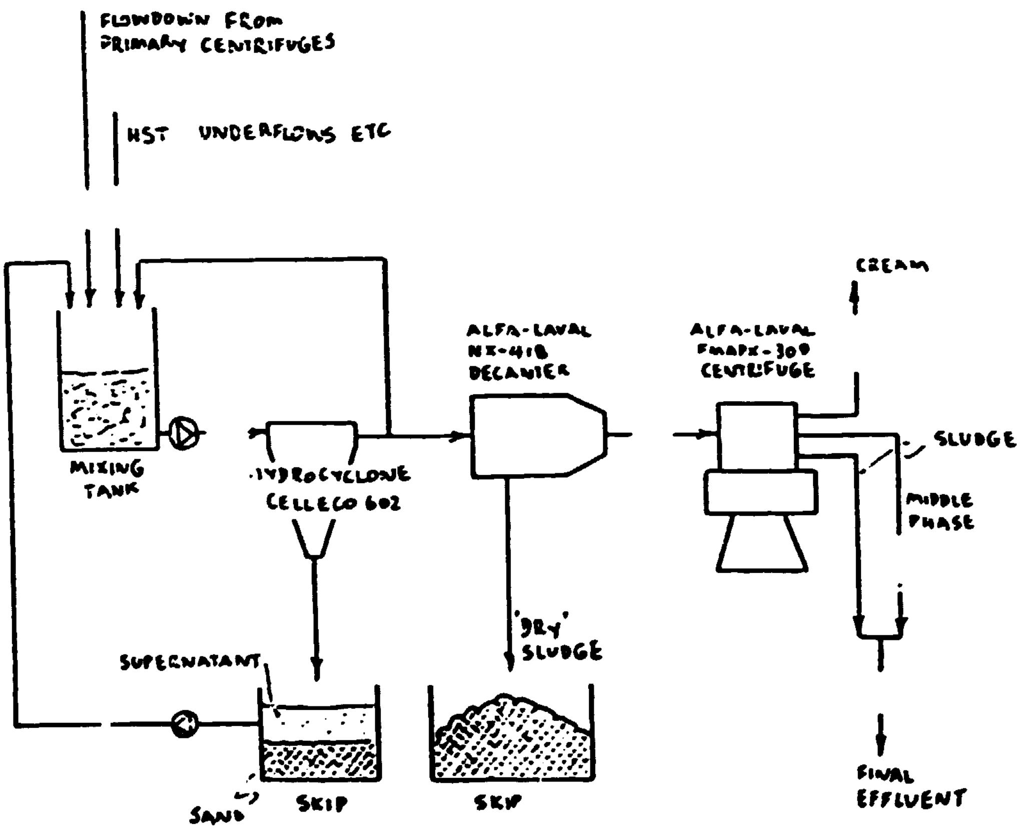
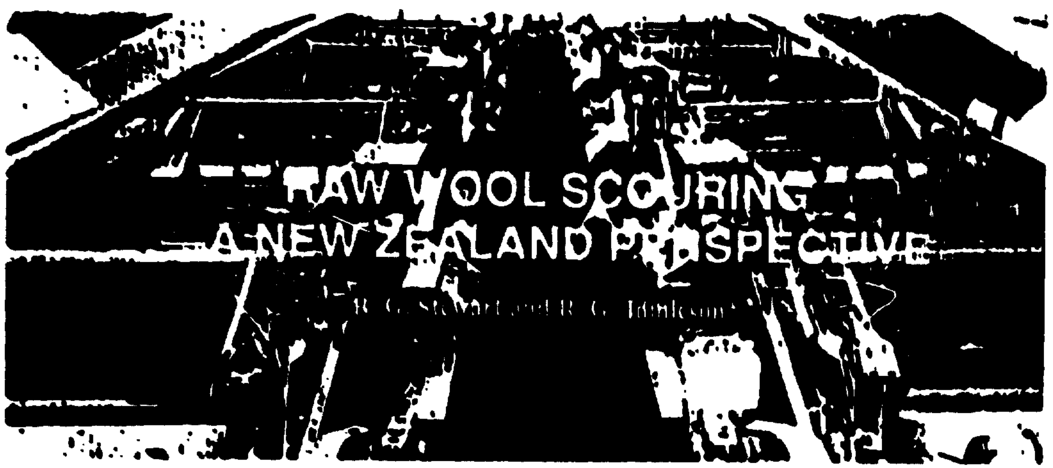


Fig. 7. Lemar Process, Stage I



R. G. Stewart and R. G. [illegible]*

1. INTRODUCTION

The last 20 years has seen considerable changes take place worldwide in the raw woolscouring industry. Prior to this, most emphasis had been placed on modifying the various existing processes or introducing new ones with one principal aim – that of improving the combing tear by reducing entanglement.

This situation has now changed significantly in New Zealand. The main concern for both producers of scoured blends and the users worldwide are colour and effluent disposal problems. Colour determines the shades available to be dyed on the wool and the lightfastness of the resultant dyeings, especially with pastel shades where the stability of the wool base is the dominating factor. Effluent disposal problems arising mainly from the scouring of greasy wool, are an overwhelming disincentive to wool users in many parts of the developed and industrialised world. Ironically these are just the places where we aim to sell wool as a high priced and quality product. Supplying these countries with clean scoured blends, merely shifts the effluent problem back to the producer countries.

Consequently, those raw wool scouring practices which give the prospect of enhanced colour in the scoured product together with the ability to reduce or avoid the effluent problem have been preferred in recent years. It is perhaps significant that one of the few raw wool scouring techniques developed over 20 years ago and now receiving commercial endorsement is the Sover process/1/ which offers the prospect of an in-house effluent abatement step.

2. MECHANICAL DEVELOPMENTS

The major recent developments in mechanical innovation have centred round the introduction of the WRONZ Comprehensive Scouring System/2/ and its later embodiment in the mini-bowl scouring technology/3/.

Although the WRONZ system was basically a simple process, initial acceptance was not immediate in this conservative industry. The prototype was observed closely in New Zealand for almost a year before the second plant was commissioned. Thereafter uptake was rapid both within New Zealand and overseas. The value of the development stemmed not so much from the improvements in scouring as in the concomitant economies associated with by-product recovery, energy usage, water consumption, and continuous plant operation. The industry had already accepted the need to run plants for 24 h/day and 7 days/week for high productivity and maximum use of resources. This technology enabled them to do so.

In the field of opening and dusting greasy wool new developments have been sparse until comparatively recently. Short slipe wool produced by painting skins with lime sulphide depilatory and later removing the wool mechanically, has been opened very effectively and cleaned by making use of a Fehrer washer/4/ which has a hammer-mill type of action carried out in a flushing stream of water which carries away the impurities.

The opening of greasy wool has been the targeted market of machine makers producing Trademarked machines such as Truegrip/5/ and Piranha/6/, when cotted fleeces were to be handled, and the WRONZ Autoclean/7/ for fleece and oddments in blends. The latter machine has introduced novel aspects such as self-cleaning teeth and a self-cleaning screen for maximum dirt removal at all times. A commercial prototype has operated successfully for 18 months, dusting a variety of New Zealand greasy and slipe wools.

Lightweight opener screens/8/ easily accessible for removal have also been a useful development, enabling operators to change them more frequently since it has been shown that conventional bar screens can block and clog within 30-60 min of starting to process wool, with considerable impairment of dust and dirt removal.

It is anticipated that further rapid development in the opening and dusting of both greasy and scoured wool will occur. This will be associated with the introduction of blending systems for greasy wool, to take greater advantage of the opportunities the wool scour offers for mixing blend components.

3. ENERGY

A principal area of cost in raw wool scouring is energy/9/. The proper operation of a WRONZ Comprehensive Scouring System with mini-bowls enables many energy saving strategies to be used and in fact has stimulated the consideration by management of many energy related aspects of scouring which were previously ignored/10-14/. The NZ industry is now energy-conscious, and has a variety of conservation techniques open to it, e.g. covers for hot scour bowls/15/, waste heat recovery from air/13/ and water/10/ streams. We will see more use being made of these when energy costs increase as they surely must in the 1990's.

4. LABOUR AND PRODUCTIVITY

The high labour component of scouring has stimulated a fresh look at productivity. It is a fact that in most plants throughout the world, throughput is retrospective. In other words most managers could only estimate in advance what their throughput might be but would have to rely on the ability of the individual operators to approach this figure. Weigh feeding, applicable to a wide range of materials which are continuously processed, was introduced to the New Zealand industry in 1974 and has since been re-exported with most new plants installed worldwide since that time. Previously weigh feeding had been used in at least one mill in the United States and was also offered on at least one European scour manufacturer's line. It needed only the documented evidence of benefits to a woolscouring operation/16/ for it to become more widely

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accepted.

Weighbelt feeding, now well established, allows managers to nominate in advance what throughput is required, to incrementally increase or decrease this as circumstances dictate, to query production records when operation is continuous and to identify problems due to machine inefficiencies or production bottlenecks. It also contributes to uniform throughput which in turn is important for the production of evenly dried wool.

One other strategy of great value to pinpointing production problems has been the increasing use of confidential productivity surveys. These, when conducted by an independent and professional organisation/17/, tell scourers how they are performing in relation to their competitors in their own industry. It is a powerful incentive for a company to improve, say, its energy usage if it is informed that in the annual productivity survey it ranked bottom, even though it may have ranked in the upper quartile say for sorting or administration costs. The net effect in an industry group is an all-over lift in productivity and the elimination of inefficient practices.

5. CONTROL AND QUALITY ASSURANCE

It is in these two areas that the greatest advances have been made in recent years and where the greatest potential for improvement still remains. Various control techniques have been introduced to complement new mechanical developments and the requirements of increasingly stringent specification for scoured wool blends. Widespread use of weigh feeding has already been mentioned. Taking the scour process in logical order from the feeding of the greasy wool, we have the following items of control commonly available and widely used:

—Hoppermatic/18/ control of greasy wool level in a feed hopper (this helps the weighbelt feeder to optimise throughput control)

—bowl temperatures with suitable hardware to allow for steam heating, high temperature hot water heating or direct gas-fired heating

—flowdown controlled by variable speed pumps rather than by opening or closing a control valve

—level controls in tanks or bowls using proven equipment which can operate reliably in the hostile environment

—sludge discharge. (IWS developed Trimwaste/19/)

—rinse water deployment as in multistage scouring

—control of flowdown and liquor quality in the main scour bowl (FLOCOM/20/)

—control of rinse water by turbidity measurement/21/

Feed to the primary centrifuges is one of the remaining areas not yet amenable to automatic control. WRONZ is concluding proving trials in a commercial plant with a new development called Centricom which automatically maintains the optimum feed flow rate to the primary centrifuges in a WRONZ loop.

Detergent, insect-resist chemicals, acid, hydrogen peroxide and bisulphite solutions are now metered into the appropriate bowls with the sophistication required for materials where dosage is determined by the clean wool throughput. Using the new computer technology which monitors and records all that is going on in the scour, management need only log in the estimate of yield. The weighbelt then records the throughput and the computer calculates the amount of chemical required and automatically controls the metering system. Such gathering together of essential operating information for management has been demonstrated in the WRONZ SCOURCOM concept where the scour is under complete surveillance and control by its own computer. The status of each part of the plant is displayed on a colour graphics terminal and various control parameters can be called up or changed using a simple five-key pad. This system is currently controlling the WRONZ pilot plant scour and is available for demonstration purposes.

The control of both peroxide and bisulphite bleaching still depends upon manual titration although automatic titration is available if required/22/.

The quality of the scoured product has classically been assessed by the level of extractables and regain, both determinations being somewhat time-consuming. Near infrared spectroscopy (NIRA) now provides these data with speed and reliability/23/. It is also possible to link the InfraAlyzer with a VDU in the scour hall so that the scour attendants can see results displayed of the extractables and regain of wool which has been processed through the plant as recently as 20 min ago. In this usage, the technique serves the dual purpose of both quality control and quality assurance.

Much effort has centred on control of wool drying/24/ and this has required monitoring of absolute and relative humidity in the dryer exhaust. Although direct reading sensors of humidity have been examined/25/, they have tended to be susceptible to over-temperature and recourse has been made to the more reliable wet and dry bulb sensors when humidity measurements have been required for control purposes. A new development, Humicon/26/, has used this basic approach with programmed psychrometric data enabling a direct read-out of relative humidity to be displayed from wet and dry bulb temperature sensing.

One of the most significant recent developments in drying control technology for the scouring industry has been the new concept called DRYCOM/27/. This unit receives various inputs such as the wet- and dry-bulb temperatures in the dryer, the regain of the dried wool, the weighbelt flowrate signal, and any other data relevant to the scour that management keys into the instrument. Management also keys in the desired regain and on the basis of these inputs DRYCOM continuously makes adjustments to the dryer exhaust damper setting, the wool flowrate and the dryer's energy supply so as to produce:

(i) wool dried to the required regain;
(ii) with maximum efficiency of energy usage; and
(iii) change the plant throughput to a preset maximum if instructed.

DRYCOM also has indicating facilities and will print out a status report on request or at intervals and plot again as a function of time.

Of prime importance to DRYCOM is the continuous and accurate on-line measurement of the regain of the wool emerging from the dryer. A specially designed regain meter has been developed which supplies this information. Its principle of operation is conductivity measurement but it is microprocessor based and utilises techniques of conductivity from four channels employing a special signal technique rather than one continuous DC signal. The system is software programmed to convert its 6000 conductivity measurements per second into a mean regain value and updated every 0.13 s.

The most notable recent development in commercial wool dryers has been the production of the Mark II version of the Unidryer, a design concept from the

University of New South Wales/28/. The first of the new units were manufactured for specific use in a continuous scouring and setting process for carpet yarn called Chemset/29/ and they have proved to be very successful in this duty. An assessment of their performance in drying hanks of carpet yarn/30/ has confirmed the principle of high intensity drying that they embody and which gives the most obvious benefit, a 30% saving in space over drum dryers of the same capacity.

An assessment of Unidryer performance in dry loose dyed stock has also confirmed the initial specifications and will be published shortly/31/.

Once the wool has been scoured and dried there is often the requirement to sample for fibre length, strength and other data of processing significance. This requires drawing both a full length "grab" sample and a representative core sample. In New Zealand a special sampling head has been developed for grab sampling from a conventional bale (density less than 250 g/m³) and from the low density pre-press box of a dense press.

Core samples can be taken using pressure coring or handheld mechanically driven units for conventional bales and hydraulic coring assemblies for dense packages.

Having obtained samples of cores and of full length wool, determinations can then be made of the various textile parameters important to subsequent processing. These include: 'as is' and 'base' colour, residual grease, length (after carding), bulk, degree of medullation, vegetable matter content and fibre diameter/32/.

The measurement of colour is a New Zealand Standard suitable for use with both greasy or scoured wools/33/. After suitable sample preparation and colorimeter calibration, the tristimulus values X, Y and Z are determined. The use of these to arrive at an "index" for colour is avoided because of the known ambiguity to which this can give rise/34/. Instead, because of the good correlation between X and Y for wools, the tristimulus data are utilised commercially to describe wool colour in terms of brightness (Y) and yellowness (Y-Z).

The selection of greasy blend components by computer/35/ utilising objective measurement, raises special problems if sale of the scoured blend by specification/32/ is contemplated. The basic scouring problems apart, the additional constraint on the scourer is not to bring about any colour changes by washing or drying since this has probably already been calculated as part of the blend parameters. The practice of bleaching during scouring has potential for disturbing this concept since the calculation of the predicted colour in the scoured blend has been negated. In the case of peroxide bleaching, this colour may be substantially better than was calculated from the blend components. The same situation holds, though to a lesser extent, if some other type of bleaching during scouring, such as bisulphite in bowl 3, is employed.

The question of fibre damage also arises since, as is well known, a minor degree of damage is unescapable with peroxide bleaching. The generally accepted quality assurance test is that of alkali solubility, where a value of 20% for scoured loose wool is regarded as the maximum acceptable to the end user/36/.

If peroxide bleaching is to be carried out, then this fact should also be tagged to the blend to advise the end user. This will avoid the potentially dangerous situation developing where the latter was unaware of previous bleaching and decided to do this again with concomitant enhanced damage.

Mention must be made of a new technique which makes use of image analysis to yield fibre diameter results without the usual caveats which surround airflow measurement for coarse medullated wools or lambs wool. This new measurement technique is called FIDAM/37/. It has been developed by the Australian Wool Testing Authority for initial use in AWTA test houses throughout Australia.

6. PACKAGING

Freight can [illegible]bstantial item in the total cost of getting wool from the sheep's back to the mill. Consequently, in some countries investigations into packaging densities higher than those usual in farm-packed bales (i.e., greater than 250 kg/m³) have been made. From this work emerged the facts that although some greasy wool may need heating to aid subsequent opening and sorting, scoured wools can be packaged to substantially higher densities than normal without these opening problems and with concomitant freight savings, especially in containers where a box rate has been negotiated. The only proviso shown to be necessary is to ensure that the freshly opened package of scoured wool is passed through an opening machine operated so as to give a light degree of opening, sprayed with water to raise the regain of the whole mass to about 20% and then allowed to stand 18-24 h before carding. If this procedure is followed then subsequent processing is the same as would be obtained with wool shipped at the lower farm-packed densities/38/. Although this result was obtained for Australian combing wools it is likely that strong wools would behave at least similarly.

Because of the rapid growth of containerisation in sea and road transport and the benefit of having these loaded up to 18 tonnes, the trade acceptance of dense packages (up to 650 kg/m³ and with bale weights up to 500 kg) has been rapid. There has been some consumer reaction because of both the weight, which makes manual handling difficult, and the density, which prevents sampling without opening unless the mill has special sampling equipment. These objections can be met by packaging to lower and more acceptable densities albeit at greater cost. Consumers can then make a decision as to how much they are prepared to pay for the convenience of the lower density packages.

Dense packaging of scoured wool as a separate operation after scouring has also enabled clean covering material to be used instead of the often much branded and repaired farm bale, as is usually the case when dumping (compressing already packaged wool) is done/39/. This has the benefit of easier identification for each package and intangible benefits for the image of scoured wool as a textile raw material of high quality.

7. POLLUTION ABATEMENT

For many woolscours, a policy of zero discharge of pollution is either essential or of high priority. Some have approached this by way of solvent scouring, others by investing in a wide range of very expensive treatment processes. From an economic and pragmatic point of view there is no substitute for examining the scouring process, rationalising flows and carrying out good housekeeping so as to produce the lowest amount of effluent to be treated in the first place. This can then be followed by rigorous primary treatment such as recovering the most woolgrease possible and removing solids as spadeable sludge for easy disposal using decanter centrifuge or hydrocyclone techniques. Work along these lines has amply confirmed the usefulness of this approach which can also be integrated into alternative scouring procedures such as using a cold first bowl/40/.

Only when these possibilities have been fully exhausted should scourers contemplate costly and complex secondary or tertiary treatment of effluent.

An account of most of the secondary and tertiary treatment processes which have been employed for woolscouring effluent have been given in recent publications/41/. It is probably true to say that, because of the urgency which has preceded the installation of these processes, attention to completely rationalising the initial scouring and by-product aspects have been meagre.

One exception to this has been the in-house development of an evaporation process for strong wastes at a woolscouring plant in Canterbury, New Zealand. This was done only after comprehensive primary treatment of all heavy liquor flows was accomplished. It should be added that, far from being an expensive option, this primary treatment has been most cost-effective.

The use of flocculant to assist solids removal at the primary treatment stage has also been confirmed as a valuable technique in recent years/42/.

Secondary treatment plants which have been built and operated commercially in the last 15 years have included Hot Acid Cracking/43/, Alcohol Destabilisation/44/, Bitterns Destabilisation/45/, Aerobic Digestion (UNISAS Process)/46/, Anaerobic Digestion/47/, Ultrafiltration/48/, Evaporation/49/ and Centrifugation/50/.

Tertiary treatment have included incineration (combined with evaporation in some cases/49/ and solvent scouring/51/ in others) and land irrigation/52/. Many of these options have associated problems, all involve substantial costs, and all have their protagonists.

At the present stage of our knowledge, the area of specialised techniques in anaerobic digestion/47/ warrants further investigation as a way of reducing the solids and strengths of the woolscouring wastes. Other options like irrigation then become viable as tertiary treatments if the solids content of the feedstock can be reduced and high grease levels avoided.

8. NEW DIRECTIONS

The main emphasis in improved woolscouring is now clearly on the following:

the production of scoured wool with the best possible colour and free from non-wool contaminants and keratin fragments;

— production of scoured wool with minimal entanglement; and

— carrying out the scouring process with the production of minimum or zero effluent.

How these goals are most economically achieved is not yet entirely clear. What is clear, however, is that management can expect to operate a scour with an increasing amount of data and control to enable them to make the most cost-effective decisions when changing blends or scouring to different specifications.

Multi-stage scouring/53/ using mini-bowls or multi-hopper bowls will probably contribute to the goals [illegible] the production of scoured wool of optimum colour and freedom from entangle[illegible]t together with the minimum amount of effluent. It is within the capability of p[illegible]ent technology to have a continuous display of operating parameters such as wool dryer efficiency and flowdown ratios, or to formulate blends using the concept of 'dial-a-blend' using computer controlled weighbelts and feed hoppers. These must improve the economics of scouring and benefit the end user by providing blends of optimum characteristics for the processes and products desired.

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1. INTRODUCTION

Wool processing, the wet processing steps in particular, has always been regarded as an art. Over the last forty years, researchers around the world have tried to make wool processing more of a science than an art to help the industry remain competitive. The articles published in Wool Science Review since its inception reflect the progress made in this direction.

Of all the wet processes, wool scouring should be most amenable to the scientific approach because the process is basically an extraction system for removing fibre contaminants. In chemical engineering terms it would be described as a multi-stage extraction.

The aim of this review is to discuss the changes that have occurred in wool scouring over the last forty years. In recent years a number of excellent reviews and books/1-6/ have been published on wool scouring and related topics. Consequently, this review is not intended to be a comprehensive treatise. For example, solvent scouring will not be discussed in depth as the technology has been fully described in some of the above reviews and in a previous issue of Wool Science Review/7/.

The review is in two parts. In the first part, the developments that have contributed in the transition of scouring from an art to a science will be considered. In the second part, the changes that have occurred in related areas such as opening and wastewater treatment will be discussed briefly.

2. WOOL SCOURING AS A SCIENCE

In making the transition from an art to a science a process must satisfy a number of criteria. With wool scouring the more important criteria are:

(i) The mechanism of the scouring process must be understood;
(ii) The optimum way of operating the process must be known;
(iii) The process must be capable of being controlled;
(iv) The equipment must be satisfactory;
(v) The effects of scouring on subsequent processing should be understood.

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