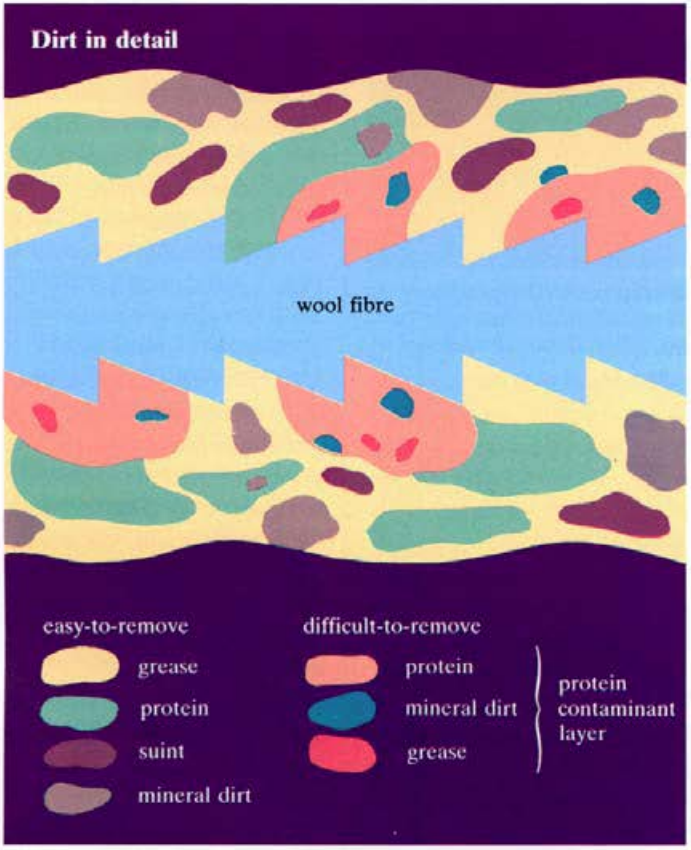
Better scouring, cleaner effluent

If you've ever had to wash a heavily soiled wool jumper, you can appreciate the task facing our scouring mills. Their job is to turn the shorn fleece, laden with grease and dirt, into clean white fibre.



What makes scouring such a difficult job is the protein contaminant layer (PCL). The PCL swells in water to a sticky gelatinous mass covering the fibre.

That's not easy when you consider that a typical Merino fleece contains 14% grease, 11% dirt, and 5% suint (as the sticky remains of sheep's sweat is called). Imagine the result of not shampooing your own locks for a year...

Scourers wash the fleece in a series of up to six 'bowls', using plenty of hot and cold water and detergent. A single 'train' may scour 10 million kg of greasy wool a year, but in so doing creates 80 million litres or more of waste water containing more than 2000 tonnes of impurities — a pollution load exceeding that carried by the sewerage from a township of 30 000 people.

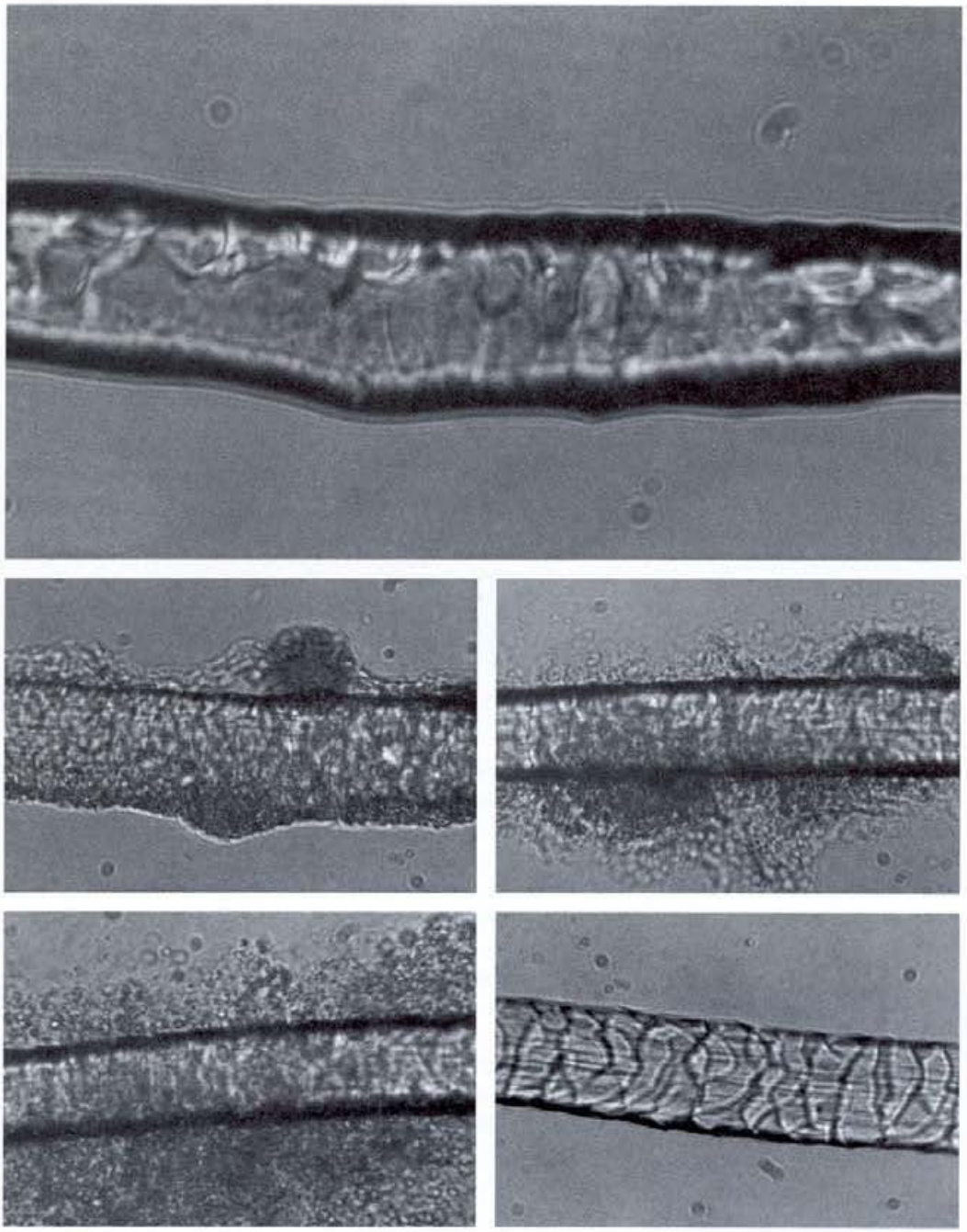
Scouring waste doesn't easily degrade biologically, since micro-organisms find wool grease particularly hard to digest.

The cost of disposal is correspondingly high: either for installing treatment plants that can reduce pollutants to levels low enough for discharge to the environment — typically 20 mg per L biological oxygen demand (B.O.D.) and 30 mg per L suspended solids — or for payment of the high charges for disposal to the sewer. (For example, the Melbourne and Metropolitan Board of Works charges 18·5 cents per kg of B.O.D. and 9·2 cents per kg of suspended solids; in Perth and Brisbane, the charges are higher still.)

Typically, it costs an urban scouring mill in Melbourne about 3 cents to dispose of the effluent from scouring each kg of Merino wool — about 10% of its total costs. That can add up to $300 000 a year, including more than $50 000 for collection and disposal of the wet sludge that accumulates in settling pits ahead of the sewer.

The CSIRO has now come to the aid of financially burdened scouring mills. After years of research into the physical and chemical mechanisms of the scouring process, the Division of Textile Industry has licensed a chemical engineering firm to market SIROSCOUR, a much more efficient method.

Although the basic equipment and techniques involved are the same as before, SIROSCOUR uses them in the best possible arrangement. It brings



The scouring of a single greasy Merino fibre immersed in water and detergent. The protein contaminant layer progressively swells and disperses, carrying grease and dirt particles with it.

scientific understanding to a process that had essentially relied on long experience among mill operators. Not only does the wool end up whiter and cleaner, but improved recovery of grease and dirt can reduce the amount of contaminants in the effluent by more than half.

The key to improved scouring performance and cleaner effluent lies with two important discoveries made by the Division's scientists over the last decade.

The first was Dr Bert Anderson's discovery that, besides grease, suint, and dirt, raw wool fibres carry a fourth type of contaminant, previously overlooked (because it is almost invisible and only comprises less than 5% of the wool's weight). He called it the proteinaceous contaminant layer (PCL) because analysis showed it to consist of two high-protein fractions: peptides of suint and cellular debris (sweat-stained dandruff, if you like).

The importance of the PCL is that, like baked-on cheese, some is hard to remove without a lot of soaking and scrubbing; furthermore, it forms a matrix that traps quantities of dirt and grease within it. The PCL completely changes what we think scouring is doing.

For a start, contaminants can no longer be seen as a uniform mixture that is progressively removed in each bowl of the scouring line. The old picture was that scouring emulsified the grease, dissolved the suint, and took the adhering dirt particles into suspension.

Dr Anderson's micrographs showed that, when it was immersed in water, PCL slowly swelled into a sticky gelatinous mass, completely enveloping the fibre. Depending on the concentration of detergent and other reagents, the PCL might finally disperse, or stay attached. Most importantly, it markedly influenced the rate at which grease, suint, and dirt escaped into solution. Under some conditions, contaminants could be redeposited onto the wool.

When we look at how much contaminant remains in each scouring bowl, we find that the old process easily removes 90% of the contaminants. They comprise most of the grease, suint, and loosely held dirt, and some PCL. However, the remaining 10% takes a long time to shift; these hard-to-remove contaminants comprise the remaining PCL along with other material complexed, or attached, within it.

Since time is needed to let the PCL swell and eventually come adrift, CSIRO scientists modified the usual scouring process to include a soaking (or intermediate rinse) stage — an approach hitherto unknown to scourers anxious to improve their production rates. Moreover, they modified the later 'rinse' bowls to act as scouring bowls for PCL; special reagents are added for this purpose.

The final result is that SIROSCOUR achieved, in one comparative trial, a whiteness index of 40 compared with the standard technique's 36 (a difference that can be readily discerned by eye) and a residual ash level (a measure of remaining dirt) of 2·2% compared with the other's 3·1%.

The second major CSIRO discovery forms the basis of greatly improving effluent quality. Dr John Warner and Dr Brett Bateup found that dirt settled out of suspension much better if there wasn't much grease around to coat

the dirt particles. Whereas at 3% grease concentration, settling efficiency is only 10–25%, at 0·5% grease the corresponding figure is 60–80%.

In other words, if dirt and grease are removed at separate stages of the scouring process, more dirt can settle out before the waste water is discharged to the sewer. The SIROSCOUR process does this by introducing another bowl at the beginning of the scour train, raising the number of bowls from five (standard in the industry) to six.

The additional bowl uses cold water and chemical additives to selectively scour dirt and suint, but not grease, from the wool. Some 40–50% of the dirt can be removed and, with grease levels much less than 1%, more than half of this dirt can settle out.

Another waste stream high in dirt and low in grease is the liquor remaining from bowl 3 after wool grease has been separated out by a grease centrifuge. (The grease is a valuable by-product that ends up as pure lanolin.)

While a high dirt recovery is attractive, the wet sludge produced in normal settling pits is sloppy and difficult to handle. As alluded to earlier, a mill may have to pay $200 a tonne for the sludge to be collected and dumped in a special liquid-waste facility.

The SIROSCOUR process uses a de-watering device known as a decanter centrifuge to recover the dirt from these streams. This makes the residual muck dry enough (less than 50% water) to dig with a spade and use as landfill.

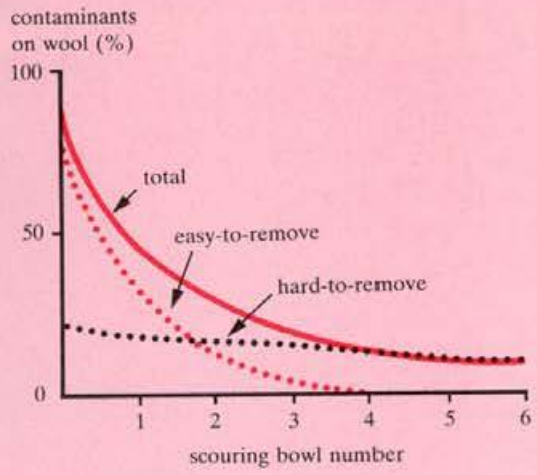
More than 60% of the dirt on the wool is recoverable as a spadable sludge, the CSIRO scientists find. Savings on sewerage and other disposal costs should easily pay for the cost of the centrifuge.

In one industrial-scale trial, they measured the composition of the sludge as 53% dirt, 1·3% grease, and 0·4% suint. If left undisturbed, no water separated and no smell developed. The Victorian E.P.A. classified the sludge as a non-hazardous solid that would be acceptable at any tip licensed to accept solid putrescible waste. The sludge from the trial was disposed of in this way at a cost of about $10 a tonne.

At present only 20–25% of Australia's wool clip is scoured in this country. With our dollar now cheaper, and the obvious attractions of the SIROSCOUR process, it looks as though that figure is bound to increase.

Andrew Bell

Hard and easy components



Using conventional scouring methods, most of the wool dirt is easy to remove; it's the remaining 10–20%, for which the PCL is largely responsible, that makes life difficult for scourers.

New concepts in the removal of contaminants from raw wool. C.A. Anderson, B.O. Bateup, J.R. Christoe, and J.J. Warner. *Proceedings of the 7th International Wool Textile Research Conference, Tokyo, 1985.*

Dirt: better recovery techniques from scour effluent and selective dirt removal from the wool fibre. C.A. Anderson, B.O. Bateup, J.R. Christoe, and J.J. Warner. *Proceedings of the 7th International Wool Textile Research Conference, Tokyo, 1985.*

To recover the most dirt, the idea is to keep the scouring liquor low in grease. This can be done with a low-temperature liquid in the first scouring bowl (grease is removed in later bowls).

Aim for low grease