Winds over the salt

We're all familiar with how the interaction between land and ocean drives the circulation not only of water but also of air. Australians spend sweltering summer evenings waiting for the arrival of cooling winds — the 'Fremantle doctor' in Western Australia and the 'southerly buster' on the east coast — without considering that these life-saving breezes are created by differences in temperature between water and land. Distinctive weather patterns hundreds of kilometres inland are also linked to the ocean: for example, western Queensland's spectacular 'morning glory' clouds are generated by the collision of sea breezes from opposite sides of a 150-km-wide peninsula (see *Ecos* No. 56).

Dr Bill Physick of CSIRO's Division of Atmospheric Research and Dr Nigel Tapper of Monash University have discovered that similar processes also operate (albeit on a more modest scale) above salt lakes thousands of kilometres from the sea.

In fact, the circulation above salinas can create breezes as strong as their better-known coastal counterparts. Dr Physick and Dr Tapper found that temperature differences across salinas are sufficient to drive a medium-scale circulation.

Applying earlier measurements obtained by Dr Tapper at a small salt lake in New South Wales to numerical modelling of a typical large salina (about 7000 sq. km), they suggest that the albedo or reflectivity of the lake's dry surface, which is higher than that of surrounding soils, combines with heat storage within the lake to generate winds by creating a horizontal gradient in temperature, since heat flows out of salt and sand at different rates. This in turn generates a pressure gradient, which generates wind flows. Salinas also absorb and store heat during the day for release at night, generating differences in surface temperatures of up to 15°C between salt and sand.

The flow of heat into and out from salinas sets up a regular 24-hour circulation pattern, with onshore flow in the daytime and offshore breezes at night.

Inland aviation may benefit from Dr Physick's and Dr Tapper's research. Wind-shear is a significant danger to low-level aviation in many parts of inland Australia, but zones of clear-air disturbances have not been 'mapped'. Further observation and modelling should enable aviation authorities to identify hazardous regions and assign flight paths accordingly.

The scientists' findings may also have implications for drought research. Their results suggest that albedo-induced medium-scale circulations on the margins of desert areas play an important role in the long-term droughts that lead to desertification; greater understanding of the mechanisms involved in this process could provide ways of countering the growth of deserts.

Carson Creagh

Better leather, less pollution

The tanning industry is rich in terms — fellmongering, wet blue, bating, scud — that reflect the traditions developed during its 5000-year history. The techniques used to transform hides and skins into leather remained virtually unchanged for most of those 5000 years, until the introduction of chrome tanning 100-odd years ago. Recent developments have revolutionised the efficiency, economics and environmental acceptability of the industry.

The popular perception of a tannery remains, however, straight out of Dickens: a dark, malodorous place full of noxious vapours and foul pollution. That may be true enough of history, but it is quite inaccurate today: it is simply cost-effective to recycle tanning liquors and to dispose of wastes as profitably as possible.

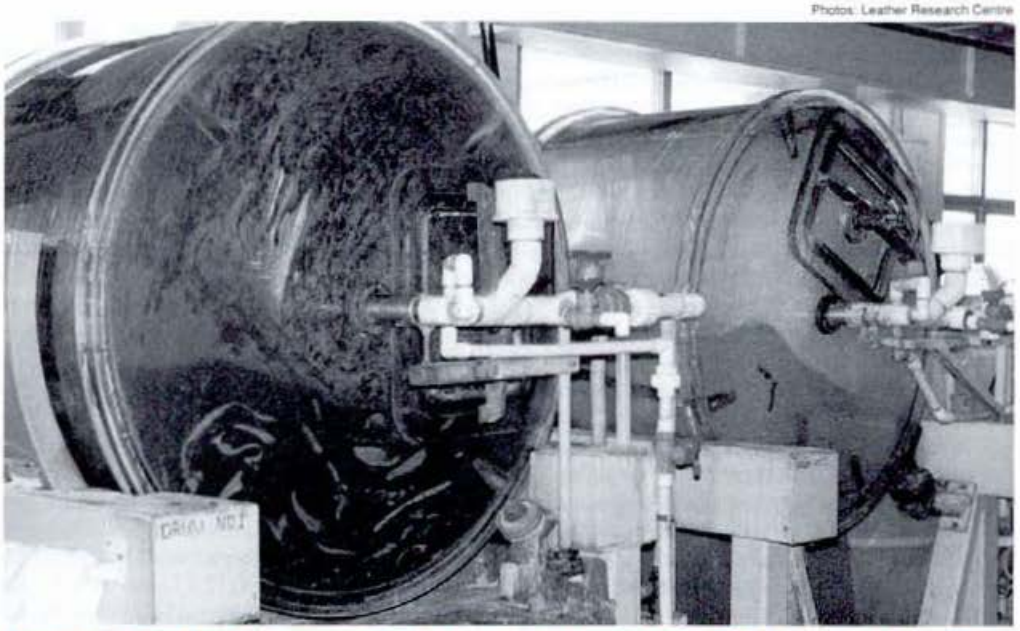
Cost-effectiveness is important to Australia's tanneries, which form the basis of an industry worth $680 million a year. The industry encompasses far more than the production of shoes and handbags — the Melbourne-based firm of Joshua Pitt Ltd, for example, manufactures leather for 3200 different products from fine clothing and cricket balls to saddle leather and washers for high-pressure, high-tech machinery.

But despite the industry's value, Australia remains a net importer of leather. Most exports are of unprocessed hides, which are often re-imported into Australia; indeed, fashionable European leather shoes are sometimes made from Australian hides.

One of the factors in that imbalance is the cost to tanneries of treating the effluent produced during tanning. Since the late 1970s Ms Catherine Money, Mr Robin Cranston, Dr Jim Scroggie and Ms Margaret Davies, of the CSIRO Division of Wool Technology's Leather Research Centre in Melbourne, have been looking at ways of reducing the amount of effluent produced by hair removal ('unhairing') from hides prior to tanning.

The Sirolime process they have developed offers significant environmental and economic benefits, has the potential to help increase the amount of hide-processing

Photos: Leather Research Centre



Degraded hair produced by conventional unhairing (left) leaves a sludge that is difficult to dispose of, while the Sirolime process (right) results in far less pollution.

Recirculating tanning drums of the kind suited to the Sirolime process.

carried out in Australia and, because it uses conventional chemicals and techniques, albeit in novel ways, can involve relatively little outlay. While the process requires specially designed tanning drums, potential savings are significant, and two Australian tanneries are already using the process.

Leather Research Centre scientists have also been active in improving the recycling of unhairing liquors.

In a hurry

Until World War II, hides were unhaired using lime plus low levels of sodium sulfide. This process stripped the hides while preserving the hair intact, for conversion into felt for carpet underlay and other uses. However, it took several days.

The war effort required large amounts of leather — for everything from boots, belts and flying jackets to washers for artillery pieces — in a hurry, so more rapid unhairing and tanning processes became a priority. The simple and effective solution was to increase the amount of sodium sulfide, which unhairs hides overnight... but does so by degrading hair chemically into soluble proteins, leaving a sludge that forms the major pollution load in a typical tannery and that is expensive to treat.

This rapid-unhairing process has become the norm in the tanning industry (although firms such as Joshua Pitt use the older hair-saving process to produce leather for shoe soles), but there is increasing pressure to reduce levels of degraded hair in tannery effluent.

Sirolime is essentially a modification of the conventional process. Hides are first impregnated with hydrosulfide, then washed and the hydrosulfide on the outer surface of the hides is oxidised (the impregnation and wash liquors are re-used). Five minutes later, lime is added and the hair begins to loosen as sulfide ions attack its roots.

Leather Research Centre scientists examine a hide, split down the middle and processed using the conventional technique and Sirolime. The side on the right of the photograph, unhaired using Sirolime, is noticeably cleaner.

After 30 minutes the loosened hair is removed by filtration. This part of the process continues for half an hour, then any residual hair is destroyed in a secondary liming stage by the addition of sulfide and lime. Again, the used liquor is recycled directly back into the process.

The Sirolime unhairing process offers several advantages over alternative techniques. It can treat both green and salted hides, and successful trials have been carried out with kangaroo, calf and goat skins as well as cattle skins. The sulfide ions attack the hair at the follicles, resulting in a greater degree of hair root removal.

Sirolime processing involves a gradual increase in pH, which aids the smoothing or 'letting out' of areas of wrinkled skin, such as around the neck. Similarly, it reduces puckering or 'draw' because the sulfide liquor acts slowly, preventing contraction within the hides. It requires no special chemicals, keeping the cost of reagents to a minimum, and it can be delayed at any time if there is an equipment failure.

Sirolime achieves significant reductions in unhairing-effluent loads; for example, it reduces the total dissolved solids in effluent from 6000 milligrams per litre with conventional unhairing to 2000 mg per L, and suspended solids from 1900 mg to 240 mg per L.

Recycling

As a result of earlier Leather Research Centre work, the recycling of tanning (as distinct from unhairing) liquors has been widely adopted by the Australian industry. The conventional tanning process first pickles unhaired hides using sulfuric acid and salt, then adds chromium salts, and the hides are tanned in rotating drums to ensure thorough treatment. Tanning is completed in about 10 hours. Sirolime with recycling reduces the effluent load by about two-thirds, but additional reductions are possible when chrome tanning liquors are recycled — for example, when spent tanning liquor is used to pickle hides prior to tanning.

Much attention has been paid not only to how much effluent tanneries produce but also to what kind of effluent. For example, concern has been raised about the possible health hazards of chromium pollution; but as Catherine Money points out, the type of chromium present in effluent is more important than the presence of chromium *per se*.

Chromium-3 — trivalent chromium, or ^{3}Cr — is naturally present in the environment, often in soils at a level of 100 parts per million (p.p.m.). It has low toxicity and is actually an essential trace element, vital to carbohydrate and lipid metabolism. Tannery effluent contains only ^{3}Cr, and not the more toxic hexavalent ^{6}Cr.

Courtesy of Bernard Hammerman Furs, Sydney

Research has shown that ^{3}Cr becomes insoluble, immobile and unreactive in soils, and that conversion to ^{6}Cr is rarely measurable in the field, but environmental authorities have taken a conservative attitude to the possibility of chromium pollution and have set extremely low discharge standards... which can best be met by aggressive recycling of chrome tanning liquors.

As well as the direct recycling of chrome liquors for use in pickling wet-blue hides, any excess liquors are collected for chromium recovery by precipitation, further reducing levels in tannery effluent. This chromium can be redissolved and re-used. Reduction of salt and sulfate levels is an additional benefit of direct chrome recycling.

Reducing the amount of pollutants in tannery effluent addresses important environmental concerns, but leaves unresolved the equally important question of disposing of recovered hair. To date, disposal of hair has been largely a matter of flushing sludge into sewers (which is no longer acceptable).

Leather Research Centre scientists are looking at two methods of utilising degraded hair. The first has the advantage of simple processing that makes the hair easier to handle and to transport: compressing it into fertiliser pellets for farm or home garden use.

The second (albeit at this stage purely experimental) idea is more imaginative: forming the hair into plant pots that can be put into the ground together with the plant they contain — providing a wholly recycled source of fertiliser.

Carson Creagh

'The Sirolime Process and Effluent Minimisation.' C. A. Money and R. W. Cranston. (CSIRO Division of Wool Technology Hides, Skins and Leather Group: Melbourne 1990.)

'Meeting Reasonable Environmental Requirements.' C. A. Money. (CSIRO Division of Wool Technology Hides, Skins and Leather Group: Melbourne 1990.)