TFL Eco Guidelines

Part 1/2008

Reduction of COD & BOD in tannery waste water

ECO SOLUTIONS

In harmony with the environment

TFL

Introduction

This publication is the first of a series that TFL is preparing in order to enhance the understanding of environmental and ecological aspects in leather manufacturing. Worldwide there is a lot of emphasis on operating in a manner that is compatible with the best ecological and environmental practices. This requires many tanneries and supply industries to have a better understanding of the whole ecological process of leather manufacturing from the start to the end. The tanning industry generates considerable amounts of solid, liquid and gaseous wastes. Well planned, clean technology practices, such as the efficient use of resources like chemicals and water, recycling and purification of process floats, allow tanners to reduce environmental costs and comply with regulations.

Since the production of leather from the raw hides and skins involves an intensive use of water it is logical to first focus on the waste water and ways of reducing the unwanted components. COD/BOD (Chemical Oxygen Demand / Biological Oxygen Demand) are the most commonly measured parameters when it comes to assessing the waste load of tannery effluent. The focus here will be to show in a clear and easy to understand manner, how much and at which process steps the COD/BOD levels can be reduced by means of modifications of the process and the chemicals being used.

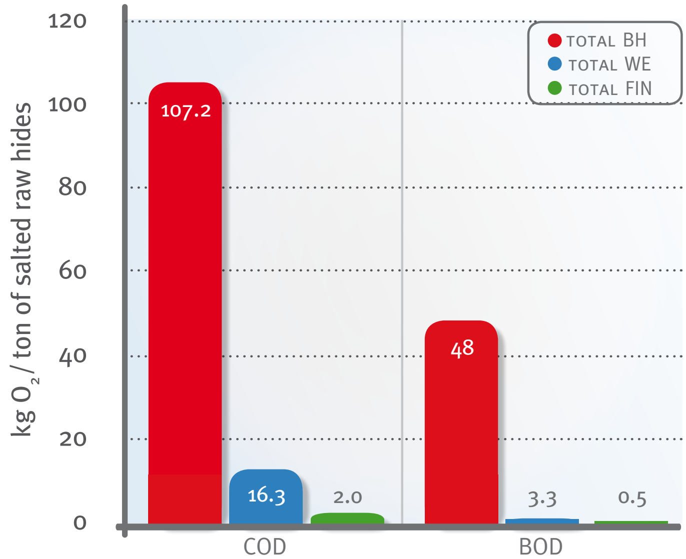


Fig. 1: Sources of COD & BOD_5 – Beamhouse (BH) compared with Wet-End (WE) and Finishing (FIN)

Water and its role in tanning leather.

The raw hide and chemicals used in the leather making process are the 2 key input factors in the overall ecological assessment of leather manufacturing. Water is the processing medium and acts as the carrier for many of the wastes that are generated. It transports the processing chemicals to the hide and skins and afterwards is the means for transporting the non-leather components and non used chemicals to the waste.

COD & BOD (Chemical Oxygen Demand / Biological Oxygen Demand).

In waste water treatment, organic chemicals and components removed from the hide are broken down by bacterial action into more simple components, which are in most cases less problematic for the environment. Oxygen is required for both the survival of these bacteria (aerobic bacteria) and the breakdown of the components. Depending on the composition of the organic chemicals, this breakdown can be quite rapid or may take a very long time. To measure the rate of this breakdown of the organic substances in the waste water, the oxygen demand is determined using the 2 world-wide accepted measurement parameters for organic pollutants:

- The Chemical Oxygen Demand (COD) is a practical way of measuring the total organic pollutants in the water.
- The Biological Oxygen Demand (BOD) is a practical way of measuring the biodegradable organic pollutants in the water.

Typically the BOD value is measured after 5 days and this is written as BOD5. The oxygen demand is an important parameter for assessing if an effluent can be put into rivers or sewers and to calculate the cost for treating the waste water. Also the ratio of the COD to BOD is used as an indicator of how much of the total pollutants can be broken down in a biological treatment of the water. A healthy river can tolerate some organic substances with low levels of oxygen demand. But the pollutant load created by tann eries is often excessive, so the effluent requires treatment prior to discharge. If effluent with a high oxygen demand is discharged directly into surface waters like rivers, the sensitive balance maintained in the water is lost.
The outcome is an environment overloaded with non-oxygen dependent (anaerobic) bacteria leading to toxic water conditions for aquatic life.

Chemical oxygen demand (COD).

This method measures the oxygen required to completely oxidise all the organic components of the effluent sample. So it gives a value for both the biodegradable and non-biodegradable organic contaminants, which includes:

- Biodegradable materials, e.g. from the BOD_5 analysis (within 5 days)
- Other biodegradable substances that need more time
- Non-biodegradable organic components

To measure the COD a filtered sample of effluent is heated with a strong oxidiser (potassium dichromate) and sulphuric acid for 2 hours. As the organic substances in the effluent are oxidised, they reduce the potassium dichromate, forming Cr3+. The amount of dichromate remaining is determined by titration and this is indirectly a measure of the organic components in the waste water. It should be noted that the COD does not measure the non-organic (inorganic) contaminants in waste water. So sulfur, ammonia nitrogen and inorganic salts in the water are not considered. Excess chloride ions in the water can interfere with the analysis but if this is known then the interference can be suppressed by adding a reagent during the analysis. Since the COD method gives reliable results in a very short time and uses relatively simple equipment, it has become the most commonly used parameter for measuring waste water pollution.

Biochemical oxygen demand (BOD_5) (organic material bio-degraded by bacteria within 5 days).

The BOD_5 measures the oxygen demand for the biodegradable pollutants only. This method is more complex. Essentially, the filtered effluent sample (without settable solids) is diluted in water, the pH is adjusted and it is seeded with bacteria (often settled sewage effluent). The samples are then incubated in the dark for 5 days at 20°C.
The bacteria use the oxygen dissolved in the water as they degrade the organic matter. The oxygen remaining after 5 days is determined and the BOD_5 can be calculated by comparison with the oxygen in the effluent-free reference sample.
The results of the BOD_5 can vary significantly depending on the bacteria used and a lot of care must be taken to get reliable results. The BOD_5 values are always lower than those obtained using the COD analysis. Generally, the ratio between COD : BOD_5 is in the range of 2 : 1 to 3 : 1 in untreated tannery effluent samples. The COD : BOD_5 ratio depends on the chemicals used in the leather making processes and their biodegradability.

If the ratio between COD : BOD_5 is high (high COD and low BOD value) it tells you that bacteria cannot easily break down the organic contaminants in the effluent.
This means that the biological part of the waste water treatment plant needs more time to break down the organic matter in the effluent. Or seen in another way; during the period the waste water stays in the biological part of the treatment plant less organic matter is broken down.

Units of measurement.

COD and BOD_5 values are measured in mg O_2 / litre waste water. Obviously this concentration value changes with the amount of water used; when less water is used, the values will be higher and vice versa. When looking at different processes, in order to have a fair comparison it is better to calculate COD and BOD_5 values in kg O_2 / ton of processed raw hides. The absolute COD load in the waste water from a tannery will depend on:

- Type of raw hides and leather processed;
- Type and amount of chemicals being used and their exhaustion from the processing floats.

Sources of COD & BOD_5.

Looking at the leather making process it is clear that the beamhouse waste water has the highest amount of organic wastes (see Fig. 1). The values for the wet-end processes are largely depending on the type of leather article being made and as such on the type and amount of retanning and fat liquoring chemicals.

When we consider the individual processes in each of the tannery areas (see Fig. 2, on the next page), we can conclude that the process generating the highest COD, as well as BOD, is the unhairing and liming process. Second is the soaking. When considering reducing the COD and BOD loads it is logical to concentrate on those processes where the highest reduction can be expected. So let's consider ways to reduce the COD /BOD, starting with the beamhouse.

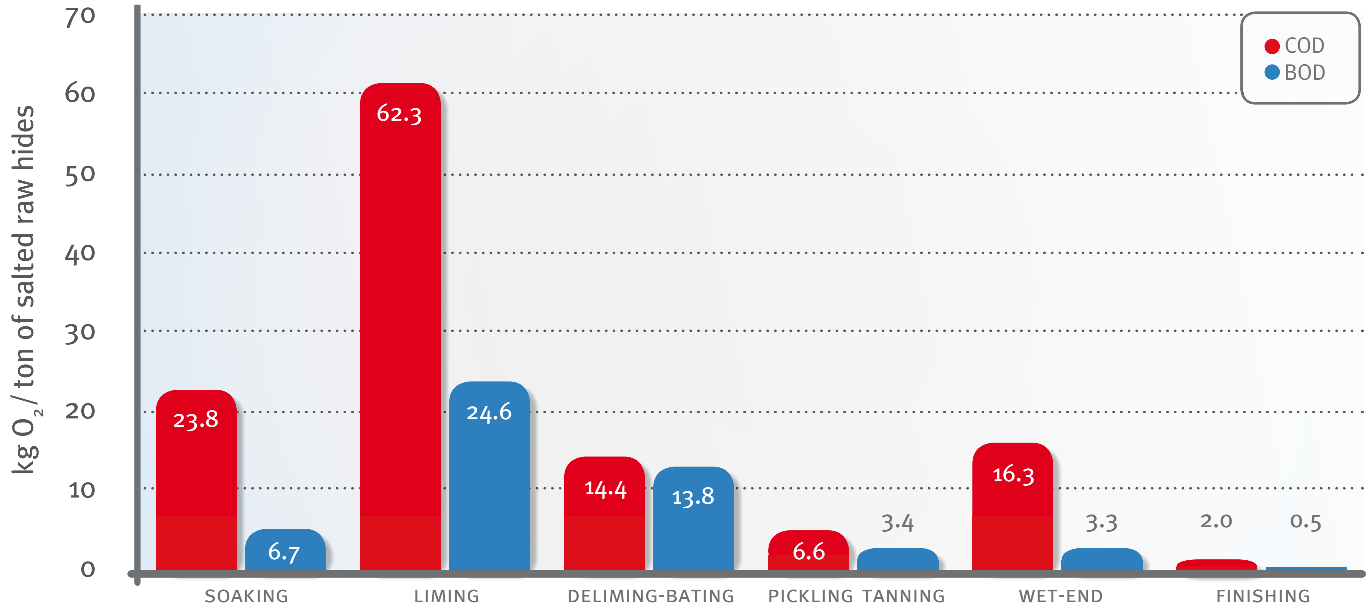


Fig. 2: *Sources of COD and BOD_5 in leather manufacture*

Soaking: Reduction of COD & BOD_5 by using modern lipase technology.

Soaking normally is performed with surfactants, soda ash and optionally proteolytic enzymes. The surfactants remove grease and dirt from the hide by emulsifying and dispersing it into the float. Soda ash breaks the grease partially down into self emulsifying soaps. The proteolytic enzymes start breaking down the non-leather proteins like the epidermis, interfibrilar substances and blood. They support the release of grease from the hide by breaking down the membranes of fat cells. The introduction of lipase (e.g. BORRON® DL) in soaking normally means that the amount of surfactant can be considerably reduced and in some cases even eliminated. A lipolytic enzyme catalyses the breaking down of grease into soaps. The effect is that in the available amount of time, more grease is broken down into soaps, provided sufficient soda is in the float.
Surfactants have a higher COD and BOD_5 than lipases; however the overall impact is negligible when considering the total COD/BOD effluent load. Interestingly, we observe a secondary effect in the spent float from individual process steps and in the final waste water when using lipases instead of surfactants. The natural grease separates much easier and can be readily skimmed off. This means less grease is emulsified, which would otherwise need to be degraded in the biological treatment part. In addition, the surface tension of the waste water is increased resulting in a better flocculation of the proteins and reduced foam formation. Rates of a 70% improvement of the efficiency of the biological waste water treatment have been found. In practice often a lipase is directly fed into biological treatment plants to improve the efficiency.

Other possibilities in soaking.

Reducing the COD and BOD_5 values of the soaking float by reducing the soaking intensity and with it the opening-up of the hide (e.g. by lowering the process temperature or reducing process time) is not advisable since this has a major impact on the quality of the final leather.

Liming: Reduction of COD & BOD_5 by using the TFL Hair Save process.

In the overall analysis of waste water from a tannery, the liming process is the one which creates the highest chemical oxygen demand. This is due to the fact that in liming most of the proteins such as hair and the non-structural hide proteins are being removed from the hide to provide a well opened-up hide with a clean grain. A substantial reduction in COD and BOD_5 can be achieved by using the patented TFL Hair Save (HS) System with ERHAVIT® HS2 or ERHAVIT® EF. In a standard unhairing process the hair is being pulped with sulphides and alkali, which means the proteins from the destroyed hair are entering the waste water in a fully solubilised or partially degraded form. In the effluent treatment plant these proteins have to be biodegraded. Whereas, in the TFL HS System hairs are not pulped but are saved (immunized), thus considerably reducing the amount of oxygen needed for biodegradation of the solubilised proteins (see Fig 3). The hair can be filtered from the bath during (or after) the liming process and disposed of separately (see Fig. 4). Even without filtering off the immunised hair during the process, still 80% of the saving potential of the TFL Hair Save liming system in COD and BOD_5 reduction can be achieved.

Hair removal from the liming float.

As mentioned before the saved hair can be removed during the process or after the liming float is drained.
In process: After removing the hair from the hide the liming float can be pumped through a special hair filter which should take about 40 min to max. 2 hours. When correctly dimensioned the total float of the drum should be able to pass the filter 5 times. About 90% of the hair is removed from the float this way. For the COD and BOD_5 this is the best option since the hair is not further pulped during the liming process.

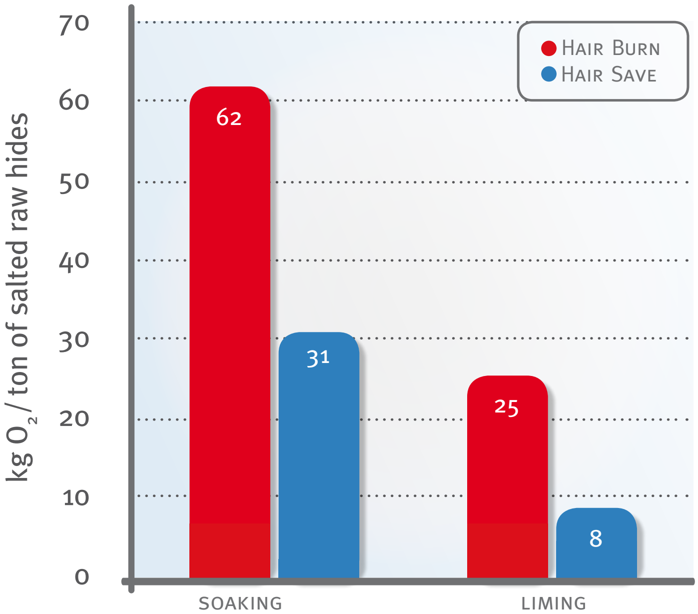


Fig. 3: *Impact of the TFL Hair Save System on the COD and BOD_5 in the liming process*

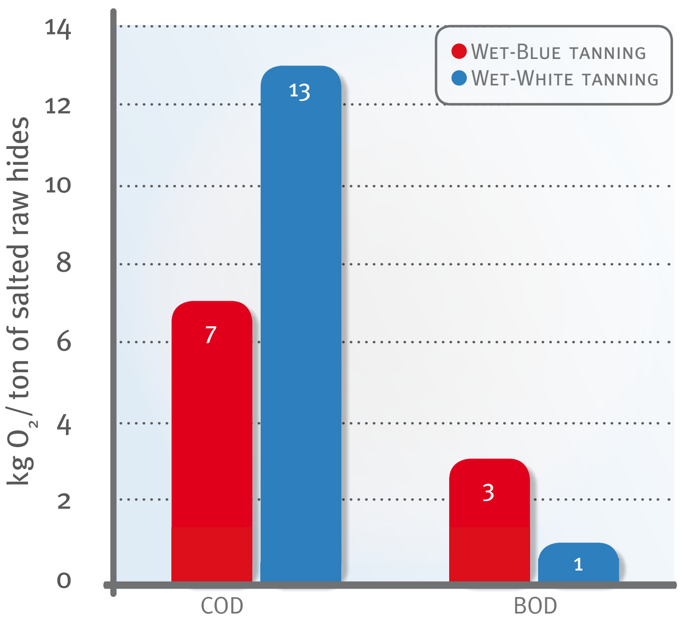


Fig. 4: *COD & BOD_5 – comparison of the pickling & tanning process for a standard Wet-blue and a Wet-white*

After process treatment.

Here the liming float is drained off completely either through a hair filter or it is drained into a holding tank. From there the float can be pumped through a hair filter into a second holding tank or returned back into the same tank. In both cases the filtered float can partially be used to start the next liming process together with fresh water or it can be send directly to the water treatment step. The advantages are that the float can be filtered whenever convenient and that less filter systems are needed. The downside is that when the hair is not removed from the float immediately it will be further broken down and thus increasing COD and BOD_5 again. But as said before still 80% of the possible saving potential is still achieved.

In a regular hair pulping process the hair is not completely solubilised, there is still enough partially broken down hair which can be removed after draining the float by filtering. Thus a reduction of sludge and COD can be achieved but of course not at the same extent as in a hair saving process.

In general it can be said that COD/BOD in the filtered floats directly correlates to the degree of immunization during the hair saving process.

In all cases where in process hair separation is done it is advisable to add a slip agent (e.g. ERHA® GM 3034, ERHA® GM 3995) to avoid scuffing the grain due to the intact hair structure.

Use of hair.

Since the hair obtained during the Hair Save liming process is almost intact the question arises what to do with it other than dumping. Actually the separated hair is highly suitable for further use. The three main possibilities are composting, the manufacturing of fertilisers and the production of biogas.

Whatever the end use, it is important that the hair is not stored and transported in closed containers. The protein containing residual water present in the hair should be allowed to drain off to prevent the risk of putrefaction. A solids content of at least 50 % should be aimed at.

Composting.

Trials at a commercial composting plant in Germany showed that a good compost was obtained by decaying a mixture of 2/3 organic household and garden refuse (supplying carbon and hydrogen) and 1/3 hair (supplying nitrogen). The hair can be used in the damp state (see note above). During the decaying process, fungi grew all around the hair so it contains no substances which impede the natural biodegradation process. It was noted that the nitrogen contained in the compost is bound and therefore is released to the plants over a prolonged period, therefore hair gives the compost a sustained release of nitrogen.

Fertilizer.

The same applies for fertiliser manufacture, the hair is dried out, ground and then made into granulates. The nitrogen release in this case is slower due to the fact that hair is more intact than in composted form.

Biogas.

The hair as well as other organic wastes can be used for the production of biogas. Because of its high protein content the hair often yields more gas. Very good results have been reported from Denmark where a combination of liquid manure together with bovine hair and fleshings is used in a continuous operation to generate biogas.

For all three above uses it is preferable to have a hair which is slightly pulped on the surface, for example, as is achieved with the TFL Hair Save process. Hair completely intact, as with an enzymatic unhairing, is less suitable as bio-degradation takes considerably longer.

Recycling (Re-using) the lime foat.

In practice various tanneries recycle the spent lime float to reduce the water consumption. Often people associate lime float recycling with the idea that the COD and BOD are reduced as well. However, this is not correct and also not possible providing that the goal is to make a good leather. The insoluble parts resulting from each liming process (saved or partially pulped hair, fat, dirt) are removed during recycling and only the solubilised proteins (and hydrolysed proteins, amines) remain in the liming float.

These dissolved organic substances are what contribute to the COD and BOD. If the liming float is reused, the proteins and other chemicals will accumulate until an equilibrium level is reached. The equilibrium level depends on how much fresh water is added each time to the float before starting the next liming. If the level of dissolved matter is too high in the float the liming effect, respectively the opening up of the hide, is not good enough. This is often seen in the following processes with poor penetration of the pickle and chrome tanning but also in crust leather showing a non-uniform grain break and temper.

It can happen that after a certain time bacteria might develop in the retained lime liquor used for recycling. These bacteria can get accustomed to the alkaline environment of liming and may lead to the damage of the hide grain.

For this reason it is advisable not to re-use the float indefinitely, but to start the processes with a fresh float regularly or to disinfect the float by treating it with hydrogen peroxide (H_2O_2).

Deliming and bating.

In deliming and bating normally highly polluting ammonium salts are being used. Ammonium salts are very problematic for the waste water treatment plant since they can only be broken down by intense aeration. For the same reason ammonium salts are very toxic to aquatic life since while breaking down they take oxygen out of the surface water needed for the fish to survive.

Consequently the removal of ammonium salts from the waste water has a high priority. Ammonia and in general nitrogenous compounds can be broken down by combining intensive aerobic and anaerobic (when the rate of oxidation of organic matter by bacteria is greater than the supply of oxygen) biological treatment. Since the oxygen demand for breaking down ammonia is very high (40% of the total oxygen demand of the waste water treatment plant) it leads to correspondingly high operational and energy costs.

Alternatively ammonium salts can be replaced in deliming and bating by other chemicals like carboxylic acids (special preparations are DERMASCAL® ASB new, DERMASCAL F and DERMASCAL® RBI/F) and organic esters (as in DERMASCAL® CD). Most of the alternative ammonia-free products are increasing the COD in the deliming process.

The magnitude of this increase can be bigger than the influence of the proteins released from the hide during deliming and bating. Replacement of ammonium salts is not made to reduce the COD, (note: the ammonia is not measured by the COD test), but because the ammonia-free products are much easier to degrade than ammonium salts. The waste water treatment plant actually works better regarding the removal of nitrogen when the BOD_5 in relation to the COD is quite high.

Pickle and chromium tanning - COD & BOD_5 issues.

In the standard chromium tanning process most of the chemicals used in the pickle and tanning steps are not organic. This means that compared with other processing steps the levels of COD and BOD_5 found in the floats are relatively low.

To reduce salt and chromium in the waste water the spent pickle and tanning floats can be recycled, which can result in a minor reduction in COD and BOD_5 through removing the fat. Devices for skimming off the fat during continuous recycling of the float (loop design) can be very efficient for lowering total fat content in wet blue. This has many advantages like a better saming of the wet blue. To reduce salt, which incidentally is a water contaminant that cannot be removed in a regular waste water treatment plant, it is possible to partially replace the pickle salt by non-swelling organic acids like SELLATAN® P liq. This can slightly increase the COD and BOD_5 but when considered overall it is not significant.

For masking purposes sometimes dicarboxylic acids (e.g. CROMENO® M and CROMENO® MFN/1) are added to the pickling and/or chrome tanning float leading to a minor increase of COD and BOD_5.

A pickle fatliquor (e.g. CORIPOL® GF) also has an effect on the COD and BOD_5 values, depending on the exhaustion and fixation of the product.

Wet-White.

The replacement of chrome tanning with a chromium-free (wet-white) process creates waste water with higher COD and lower BOD_5 (see Fig. 4). The wet-white pre-tanning process made with SELLATAN® CF new or SELLATAN® WL-G has an excellent exhaustion. The increase in COD for chromium-free leather comes from the higher quantities of vegetable tanning agents, syntans and fatliquors required to make this leather The low BOD is caused by the less easily biodegradable vegetable tannins and syntans of the tanning agents. So, in general the wet-white tanning increases the organic contamination of the waste water in terms of COD. However, the chrome load in the effluent (and in the leather) is drastically reduced or eliminated and this can have considerable advantages for the disposal of sludge and solid wastes.

Wet-end-retanning, fatliquoring and dyeing.

The COD and BOD_5 load in the Wet-end part of the leather making process is typically related to the chemicals used and how good they are exhausted and fixed in the leather. This means that the type of leather, chemicals used and the application process will normally be the determining factor in the COD and BOD_5 level.

The non-exhausted vegetable extracts and syntans can put a significant load on the waste water COD. Typically they are slow to bio-degrade (low BOD values) requiring longer biological treatment times, resulting in a high COD : BOD ratio. This is clear to see in Fig. 1, where the waste water from retanning processes have a high COD : BOD_5 ratio of 5 :1, compared with a more normal ratio in the beamhouse of about 2 : 1.

By optimising the application process to achieve good float exhaustion and fixation of the chemicals onto the leather, one can ensure that the COD levels of the waste water are kept quite low. Most retanning agents, as well as fatliquors, dyes and dye auxiliaries are anionic in nature. So a key part of the application is the correct use of acidification, to give the leather a cationic character, and cationic auxiliaries for fixation.

In the waste water treatment residues of these anionic organic products can be relatively easily removed by an efficient coagulation and flocculation process. This is readily confirmed by anionic dyes, which give coloured water at concentrations above 10 mg/l, but after treatment the waste water is normally clear of colour, indicating any dye residues have been removed. In the biological waste water treatment process even some of the difficult to biodegrade substances can develop bacteria to break them down. Important is that the waste water being treated has a relatively constant chemical composition and the balancing tank is large enough to level out daily fluctuations coming from the variations in leather production. Interestingly, the digestion of the more difficult organic components from the retanning process is often helped by mixing them with the wastewater coming from the beamhouse.

So in the Wet-end, rather than considering the individual biodegradability of each syntan, fatliquor and dye, the controlling factor for achieving low COD values is to achieve high exhaustion of the chemicals.

Reduction of COD and BOD_5 by using amphoteric polymers.

Products and auxiliaries which improve the exhaustion of the chemicals will lower the COD and BOD5 values. Therefore special amphoteric polymers, like MAGNOPAL®TGR, improve the exhaustion of fatliquors and retanning agents and help to reduce the COD and BOD5 values in the waste water. In the example shown in Fig. 5, MAGNOPAL® TGR was used to reduce the COD and BOD5 values by half. At pH values above 4.5 the amphoteric polymer is anionic and assists with the dispersion and penetration of fatliquors and retanning agents. After acidification, the polymer changes to become cationic and fixes the anionic components to the leather.
MAGNOPAL® TGR is electrolyte stable and can be used in most tanning processes from the pickle on.

Finishing.

In comparison to the other areas of leather manufacture, the Finishing processes have a minimal impact on the COD / BOD load of the waste water, see Fig. 1. Only the water-soluble components in the finishing chemicals will contribute to the waste water COD. Modern spray applications and roller coating technologies are designed to minimise the waste of expensive chemicals. In spray finishing some waste water can be created if water is being used for removing the spray mist. However, the polymer components will not dissolve in water and can be skimmed off. Cleaning of the machines and spray lines also contributes to the low COD load from Finishing.

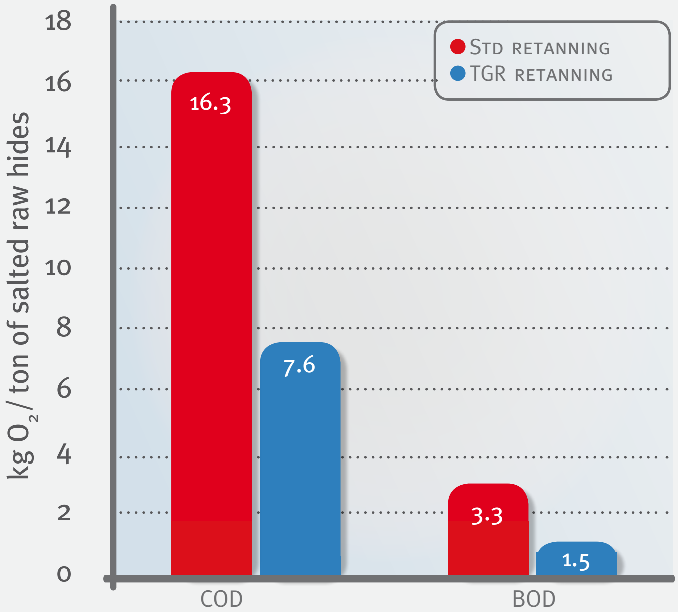


Fig. 5: *Comparison of COD & BOD5 for a shoe upper retanning process*

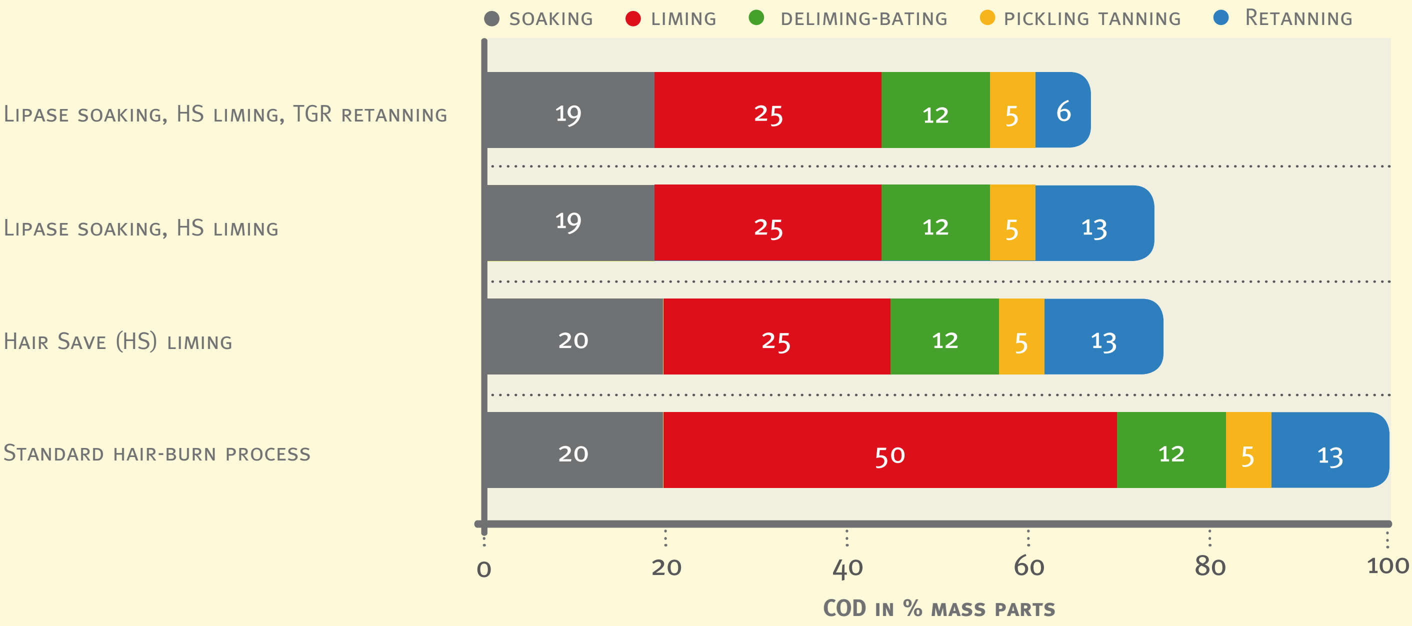


Fig. 6: *Impact on the COD from various processing options*

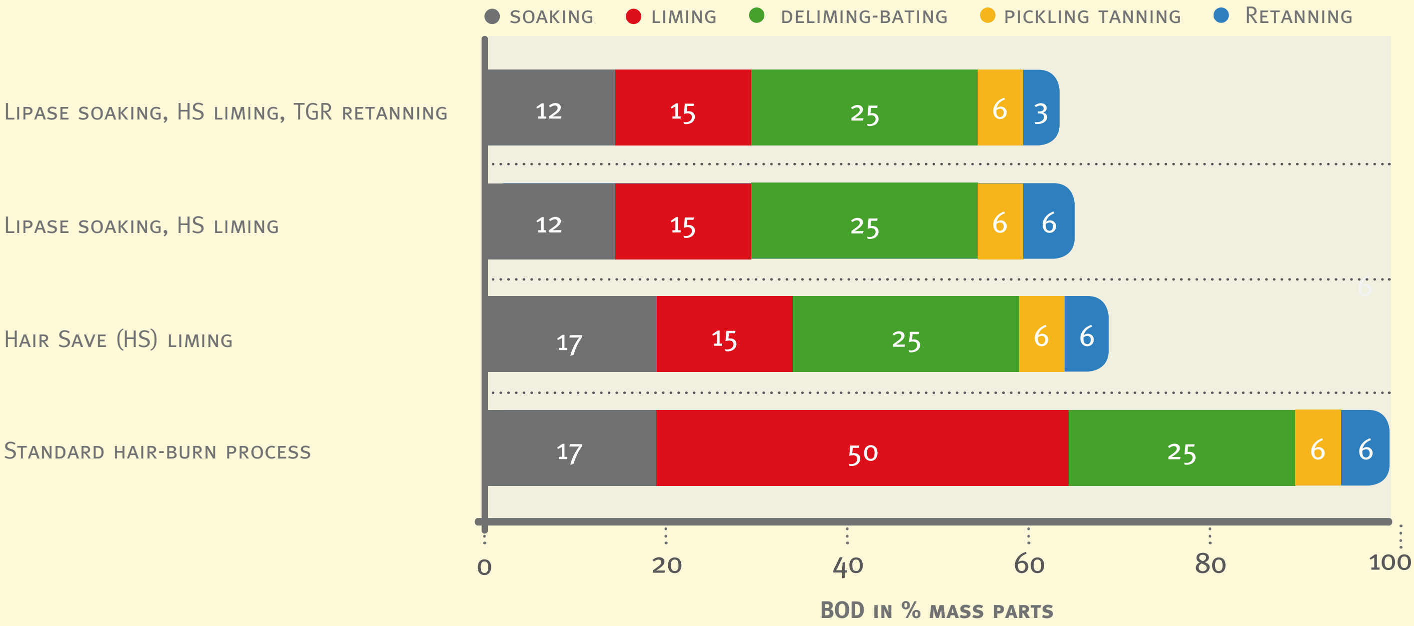


Fig. 7: *Impact on the BOD from various processing options*

Comparative overview of measures for COD/ BOD reduction .

In the above guidelines, the various optimising steps have been discussed individually. What if one takes the whole leather manufacturing process, how do these optimising steps look when compared side by side?
In Fig. 6 and Fig. 7 the impact on the total COD and BOD values are compared for 4 different leather manufacturing processes. The standard hair-burn leather making process is used as the reference.

- The biggest impact on COD and BOD_5 reduction is achieved with the patented TFL Hair Save (HS) System.

- The second biggest impact and the easiest to implement is the lipase soaking technology with the more efficient grease removal from floats.

Waste water treatment and practical impacts.

As seen in Fig. 7 and Fig. 8, an overall reduction of COD and BOD of some 30 – 40% can be achieved in leather manufacturing when applying the guidelines discussed here. However, the typical COD values of such a tannery waste water are still much too high to be discharged directly into surface waters and in most cases not even to municipal sewerage plants without further treatment.

So it is necessary that the tanneries undertake some waste water treatment either on-site or in a collective treatment plant. Normally this first step is a chemical / physical process, often referred to as a primary treatment. Here the water is aerated and stirred together with coagulating and flocculating agents. The solids formed are then either sedimented out or by use of flotation skimmed off.
Some 50 – 80% of the COD and 50 -70% of the BOD_5 can be removed in an efficient primary treatment.

The secondary waste water treatment process is normally a biological degradation step. The remaining organic components are broken down by bacteria, important here is to give the process enough time and to maintain a continuous, stable through-put of effluent.
A very efficiently run secondary treatment plant achieving › 95% reduction in the pollution parameters is required to meet the relatively stringent limits for COD and BOD_5 required to allow effluent discharge to surface waters. Such a treatment plant is often only possible as a collective or municipal waste water plant.

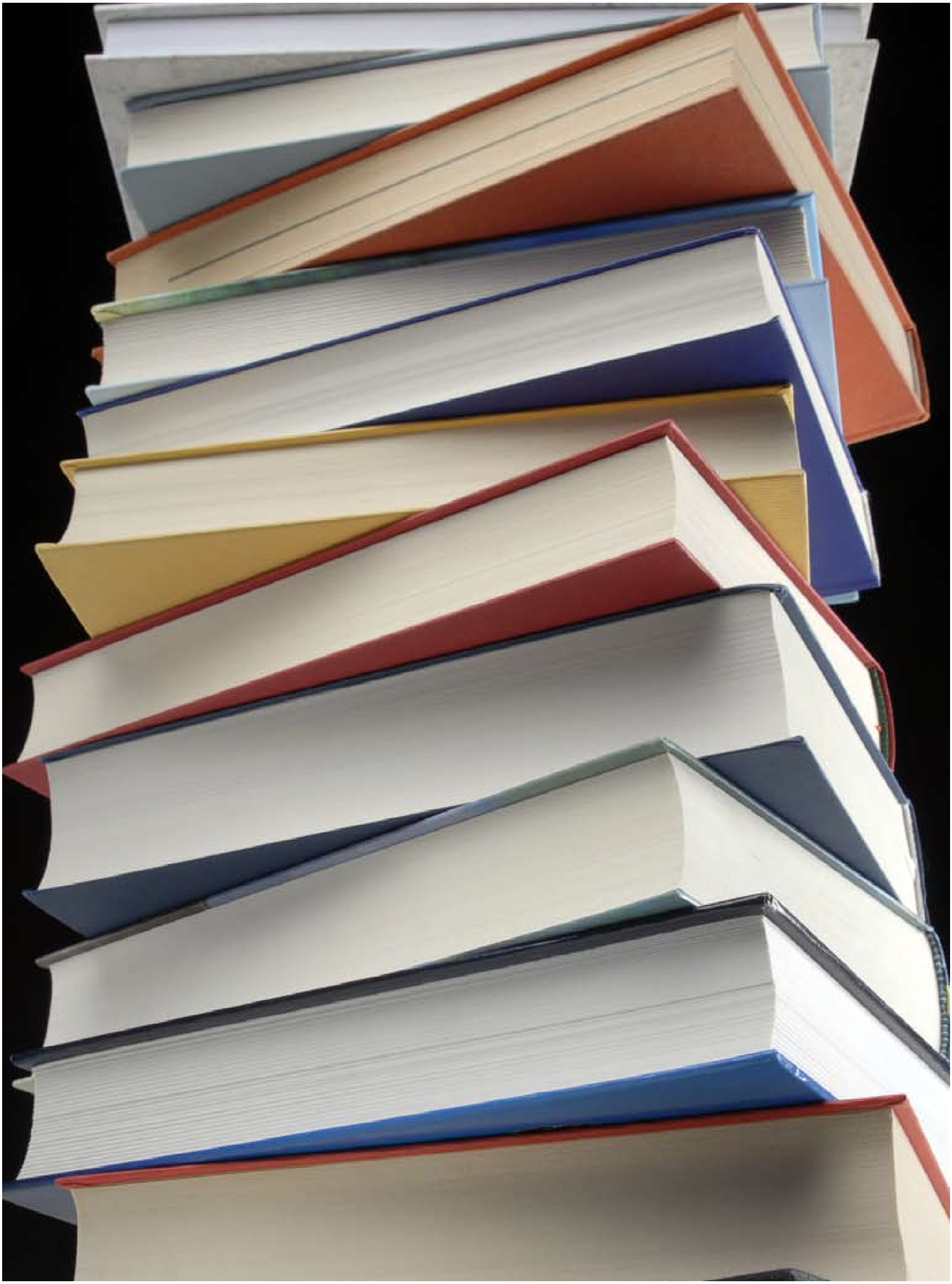
Typical pollution reductions after primary and secondary (biological) treatment are 85 - 95% for the COD and 90 - 97% for the BOD_5.

Fig. 8 gives some dimensions of the typical COD and BOD waste water values for a bovine chrome tannery with a beamhouse.
(Note: the values can vary considerably depending on the local situation)

Depending on the specific local regulations in Europe, the values achieved after primary and secondary treatment would often be sufficient for discharge into surface waters.
However, in China the limit for COD is currently set at a low 100 mg O2/l for direct discharge into surface waters.This low value can only be reached by extending the stay of the float in the secondary treatment plant or by introducing a tertiary treatment with techniques such as advanced biological treatment, sand filtration, membrane filtration, reverse osmosis and special adsorption procedures.

Fig. 8

Pollution parameter	Raw tannery waste water mixed effluent, before treatment (mg O2/l)	Tannery waste water after primary treatment (mg O2/l)	Discharge to surface waters after primary & secondary treatment (mg O2/l)
COD	4000 – 10´000	500 - 2000	100 - 300
BOD_5	2000 - 5000	200 - 800	20 - 100



Product glossary

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BORRON® DL

lipase based degreaser for alkaline processes	special lipolytic formulation active in the alkaline pH range, from 7 – 13; enhances fat removal; supports grain cleaning, hair removal and scutt loosening; improved waste water treatment; quantity applied: 0.05 - 0.3% depending on rawstock

CORIPOL® GF

anionic fatliquor	based on a combination of selected natural and synthetic fatty substances; highly suitable for pre-fatliquoring in the pickling and tanning steps of chrome tanning; can also be used for wetting back crust leather; quantity applied: 1 - 3% in pickling or tanning

CROMENO® M

complexing and masking agent	equilibrated compound of masking and complexing agents; improves chrome exhaustion and fixation; promotes a fine grain, good fullness of the flanks, a round handle and very good dyeing properties; quantity applied: 0.4 - 0.7%

CROMENO® MFN/1

basifying agent with masking & complexing properties	safety basifying agent with masking properties; very slow, uniform rise in pH; clear improvement in chrome exhaustion and distribution; positive effect on leather fullness and fineness of grain; very low iron contend for brilliant wet-blue; suitable for chrome recycling processes; quantity applied: 0.6 - 0.9%

DERMASCAL® ASB NEW

general deliming agent	mixture of dicarboxylic acids and ammonium salts; has a buffering effect without the risk of swelling; prevents the pH from dropping below the critical limit of 5 (fixation of scud and residual hair!); provides a fine, clean grain; quantity applied: 2 - 4% (depending on rawstock and thickness).

DERMASCAL® CD

eco-friendly deliming agent	based on functional esters, highly concentrated and free of acids and nitrogen; delimes gently and homogeneously and buffers the pH around 8.5; effectively reduces growth and neck wrinkles; imparts very good grain cleaning, less hair roots and short hair; quantity applied: 1 - 2%.

DERMASCAL® F

low-ammonium containing deliming agent	based on a mix of organic components with masking ability; delimes gently and homogeneously without big pH drops; enhances chrome uptake and exhaustion; quantity applied: 0.6 - 2.5% .

DERMASCAL® RBI/F

masking and complexing agent with deliming properties	based on dicarboxylic acids; used in deliming in combination with reduced ammonium salts offer; improves the grain pattern and smoothness; lowers end pH of the process; improves lime removal; used in pickling to mask and complex chrome; quantity applied; quantity applied: 0.5 - 1%

ERHA® GM 3034

powder slip agent	based on modified polysaccharides; can be used in all process steps, particularly short float processes; prevents knotting and folding thus avoiding abrasion and grain damage; quantity applied: 0.1 - 0.3%

ERHA® GM 3995

liquid slip agent	based on copolymers; can be used in liming, deliming/bating and in pickling/tanning; quantity applied: 0.03 - 0.15%

ERHAVIT® EF

enzymatic liming agent with reductive-effect	free of amines, nitrogen and sulphides; accelerates the diffusion of liming chemicals, regulates swelling, loosens scud, increases yield and quality, permits reduced offer of sulphide; quantity applied: 0.6 - 1%

ERHAVIT® HS2

liming agent with reductive-effect for hair saving	sulphide-free; has a swell-regulating and grain-cleansing effect; suitable for the hair-save (HS) process; attacks the hair-root area; provides very smooth and clean pelts; improves area yield; quantity applied: 0.7 - 1.5%

MAGNOPAL® TGR

amphoteric polymeric retanning agent	based on an acrylic copolymer; improves the tightness of the fibre structure; noticeably improves the float exhaustion; quantity applied: 1 - 5% at the end of dyeing and fatliquoring with subsequent slow acidification

SELLATAN® CF NEW

wet white tanning agent	based on aliphatic polyaldehydes; non-ionic; highly suitable for manufacturing wet-white leather; can also be used for producing shrunk leather; quantity applied: 2 - 3%

SELLATAN® P LIQ.

non-swelling pickle acid for dynamic tanning process	based on modified polysulphonic acids; anionic; suitable for combining with wet-white tanning; reduced offer of salt and acid, and short running time in the pickle. Chrome-tanning auxiliary to improve the fullness of hides; quantity applied: 1 - 2%

SELLATAN® WL-G

wet white tanning agent with extra masking ability	based on aliphatic polyaldehydes; non-ionic; highly suitable for manufacturing wet-white leather; can also be used for producing shrunk leather; quantity applied: 1.5 - 3%

For further information have a look at **www.tfl.com** or contact **ecology@tfl.com**