



How to make perfect patent leather

Peter Jessop, Stahl International bv

Patent leathers are currently fashionable. When demand is strong, as is the case today, tanners and finishing units that have the expertise to produce leather finished with a well proven patent coating system will have experienced and overcome the many application and performance difficulties that are associated with this type of finish.

The original patent leather finishing process that was developed and introduced into commercial manufacture during the latter part of the nineteenth century used a linseed oil based lacquer coating. This process produced finished leather having the desired high gloss, "plastic" surface. Physical performance was adequate initially but the finish hardened on ageing, resulting in a tendency to crack. Technology has moved since those days but the so-called "genuine patent leather" produced today is finished using solvent dilutable polyurethane solutions that are cured using isocyanate based cross linkers.

Water based products are now available that will produce what are termed "wet look" finishes. These products are relatively easy and safe to apply and overcome many of the difficulties and hazards associated with the well-tried solvent based systems. However, they still fall slightly short on the depth of transparency and lustrous gloss level when compared with that of the solvent based systems.

Whilst it is the final top coat applied to the leather that determines its gloss level, there are many additional factors that determine the quality, physical performance, consistency and look of the finished leather.

Making patent leather

The traditional patent of the past was a high gloss, very smooth, almost plastic black leather created with early solvent based finishing systems. Much of the leather was made into smart children's sandals for special occasions; these are still produced today. Occasionally ladies chose to wear white and of course there were the men's black "evening-wear" shoes traditionally worn to a dance.

With an increasing fashion demand for high gloss leathers came the explosion of colour. Ladies patent leather footwear became available in the fashion colours of the day. Finishing systems were developed that provided two-tone, metallic and even pull-up effects visible beneath the top coat.

The vast majority of patent leathers are produced on corrected grain crust. The reason for this is that to produce a totally smooth "plastic" surface, the grain has to be completely removed. The high level of gloss also means that any defect in the leather surface needs to be minimised by buffing the leather prior to



Patent leather used for clothing

finishing. The surface then needs to be heavily impregnated and covered with pigmented base coats prior to the application of the final gloss coat.

Obtaining a high level of physical performance of the finished leather is essential to avoid cracking or peeling of the film in wear. Good adhesion of the finish—and even more importantly—between the various layers of individually applied finish coats needs to be achieved, together with good film flexibility and rub fastness. Well-prepared crust leather and robust finishing formulation and application procedures are essential requirements for the manufacture of a high quality product.

Creating a clear, smooth, glossy and glass-like look

PREPARATION OF THE CRUST LEATHER

The fundamental properties required of crust leather to be used for patent leather is that it needs to have very good buffing properties, have a tight grain, and be presented and remain flat during the finishing process. The degree of stretch should also be carefully controlled and be kept to a minimum to enable good lasting properties in footwear manufacture.

Today's requirement for the finished leather is for a mellow handle and high resistance to grain cracking. Retannages can be kept relatively simple using modern compact systems that also reduce process times and product inventory. Following light neutralisation, a combination of replacement and acrylic syntans should be incorporated in the retannage. For fatliquoring a combination of sulfated natural oils, neatsfoot and mineral oils that have excellent dispersing properties would be a good choice. The addition of natural vegetable extracts and fatliquors that do not deposit on the surface will allow deep buffing and good penetration of the impregnation system. Through dyeing is not essential. The introduction of drum impregnation using a suitable acid stable acrylic resin after dye fixation will enhance the grain tightness.

Prior to finishing, the leather should be sprayed on the flesh side with a resin and protein preparation to seal any loose dust. This is to avoid subsequent transfer, which might cause contamination of the finished surface during subsequent processing operations.

IMPREGNATION

The impregnation formula should always be calculated to suit the individual crust leather.

To ensure that the surface of the leather is properly wetted and penetrated, the impregnation formula must overcome the ►



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surface tension of the leather. The size of the polymer particles is therefore very important, and so the most suitable polymer must be selected for the leather being processed. Not only must the particle size be considered, but the hardness rating, mechanical stability, pH and penetrating properties are all key factors. Many polymers are not able to wet the leather fully and in these cases the addition of surfactants and solvents (*penetrators*), or a mixture of both, is necessary. A well-formulated patent leather impregnation system should take into account the following:

- The resin should have suitable particle size and properties.
- The penetrator system should help to reduce the surface tension of the leather and should sufficiently enable the wetting process without producing side effects, such as, poor wet adhesion and excessive wetting of subsequent finishing coats.
- An optimal balance of the proportional concentration of resin and penetrator should be determined.
- The quantity of resin solids that needs to be deposited inside the grain corium needs to be determined according to the type of leather selected, and should be at least 3 - 5 g/ft².

The addition of a penetrator to the impregnation system reduces the time it takes for the resin to wet into the leather. The optimum quantity is usually around 10% by total volume. Above this, the wetting time often increases and penetration is therefore reduced.

BASE COAT

The base coat will be fully pigmented (*approximately 20% on total volume of finish mix*) and bound with a combination of acrylic, polyurethane, butadiene resins and synthetic casein. This is usually formulated and compounded into a ready to use, purpose designed compact resin product. The important properties required when selecting the individual components is that:

- the formula provides an adequate degree of resistance to cold flex cracking;
- is sufficiently solvent resistant;
- has good plating performance;
- good filling;
- high wet and dry adhesion to the leather;
- excellent application properties.

To avoid adhesion difficulties, care must be taken to avoid waxes, oils and silicone based hand modifiers.

To achieve a completely uniform finish, the base coat needs to

be applied by reverse roller coating machine using the latest roller technology. This is to avoid coating lines that would be emphasised by the high gloss, transparent top coat. Multiple applications will be necessary to apply the total of 15 g/ft² required, and there will be intermediate smooth plating operations. This is to ensure that the surface is completely smooth and well-filled and that there is sufficient material to support the heavy top coat without risk of absorption through or into the dried film: this is because this would inhibit the flow performance and detract from the final gloss and depth of lustre of the finished product.

THE INTERMEDIATE COAT

A generous coat of nitrocellulose lacquer on top of the base coats and prior to the patent top coat application is essential, especially when making colours and effects. The reason for this is that it provides a stronger bond between the base and top coat, and eliminates the risk of poor adhesion and subsequent peeling of the top coat film after curing. Dyestuff or pigment may be added to this mix to produce a special effect or to provide an opportunity for colour correction. This coat is applied by conventional spray methods. A heavy application should be made to ensure complete flow-out across the surface of the leather.

PATENT TOP COAT

The formula includes a polyurethane solution, cross-linking mechanism and solvent. The choice of solvent is critical, the most common being butyl acetate. This can be combined with compatible faster or slower boiling solvents, such as ethyl acetate, toluene, MIBK and cyclohexanone, to obtain optimum flow-out properties depending upon application conditions. For example, when applying the prepared mix in high temperature conditions, the coating must be heavily applied and flow easily without distortion of the film. The coating must also have good "hold" properties to ensure that the applied mix does not continue to flow and "run" whilst the leather is being transferred into the drying and curing chamber. Changing the solvent blend to suit the prevailing conditions and achieve the desired results is quite normal. Solvents that contain water must not be used, otherwise blooming or whitening of the top coat film will occur. This results in a lack of transparency and low gloss and the physical performance of the film will degenerate.

Application is normally by either airless spray or flow coater





Panel 3: Finish cracking on lasting

(curtain coater), normally at a rate of 15 - 20 g/ft² (wet) depending upon the end results required. The most efficient method is flow coater because there is less risk of air bubbles being introduced into the film to cause pinholes in the finish film and the applied film is more consistent. On softer leathers a lower amount is recommended. Application is carried out in dust-free conditions (see section: *Drying and Curing Conditions*).

Control of the viscosity of the mix is also important. This is determined by the quantity and type of solvents chosen in the blend. Care must be taken not to reduce the solids of the mix unduly otherwise film thickness and resulting gloss level will be reduced. The viscosity of the mix is normally controlled using the Ford 4 Cup method; the starting point should be 20 - 22 seconds and adjusted to suit local application conditions.

DRYING AND CURING CONDITIONS

A separate space is required for the specialised application of patent top coats, and this must be sealed off and isolated from the general production area. The reason for isolation is to ensure that there is no risk of surface contamination during the application and curing cycle of the heavily applied top coat. This can take between twelve and twenty hours depending upon the local conditions, with the finish remaining sticky up until the time when the curing cycle is completed.

The problem is that once the Patent finish has been applied, any dust particle which falls onto the surface is impossible to remove and at the same time is visible to the naked eye. To avoid this, a dust-proof area has to be constructed and has to be closed off from all other areas for as much of the time as possible.

The design of a dust-proof area is fairly standard. Entry is through an airlock with doors at either end, sufficiently far apart to avoid both doors being open at the same time. Inlet air is drawn into the area by fans operating inside the chamber and passes through inlet filters that remove all traces of dust particles. The interior area is maintained at a slightly positive pressure in relation to areas outside by controlling the velocity of the airflow.

When the leather pieces have been coated they are normally transferred to a horizontal mesh tray and placed in mobile racks in which they are transported to the drying ovens. In ideal operating conditions the oven temperature and humidity may be controlled to enable a lower starting temperature and humidity—approximately 25°C for the first two to four hours, then increasing to 45 - 50°C for around eight to ten hours, with increased humidity for the last period to complete the curing cycle.

HANDLING

Avoid direct finish to flesh contact when the leather is piled ►

Panel 4:

Troubleshooting and solutions

Problem	Cause and solution
Poor adhesion of top coat to base coat.	Insufficient quantity of nitrocellulose intermediate lacquer applied.
Poor cold flex of finished leather.	Increase polyurethane content in base coat. Reduce cross linker content in top coat.
Poor wet adhesion.	Increase proportion of water resistant acrylic resin in base coat.
Poor solvent resistance of base coat.	Increase quantity of butadiene resin and synthetic casein in base coat.
Tackiness of top coats remains after thorough curing.	Check ratio of cross linker to polymer. Apply compatible silicone based cleaner by wiping the complete leather surface with impregnated cloth.
Cloudy matt appearance of top coat after curing.	Check if top coat is contaminated with water. Check and remove wax in base coat.
Pinholes in top coat film.	Air bubbles in top coat mix. Dirt contamination of surface prior to top coat. Top coat viscosity needs to be adjusted. Check for silicone contamination of mix.
Insufficient gloss.	Solids content of top coat too low. Insufficient quantity of top coat applied. Contamination of top coat with moisture, waxes or silicone.
Gritty feel of finished leather surface.	Check dust filters in top coat application chamber and replace as necessary.
Finish peeling off on ageing, Panels 1 and 2.	Check from which layer the finish is peeling. When inter-coat failure is between base coats check the formulation for ageing and re-coatability (especially following the plating operation) and adjust accordingly. When peeling completely from the leather, check and adjust the base coat formula to improve total finish adhesion. Check leather prior to base coating for over sealing of impregnation and adjust vacuum drying, rebuffing as necessary.
Orange peel appearance of finish when stretched.	Insufficient impregnation. Excessive buffing. Crust leather preparation too stretchy.
Finish cracking on lasting, Panel 3.	Reduce quantity of cross linker in top coat.
Poor flex resistance, Panel 5.	Check the point of failure of the film. Reduce cross linker in top coat.



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after completing the finish application. For final inspection the leather should be piled grain up with intermediate layers of tissue paper placed between each piece to prevent flesh contact with the finished surface. When rolling the leather, the grain should be rolled outside to avoid creasing the finish film, which causes ripples to form in the film.

Troubleshooting problems

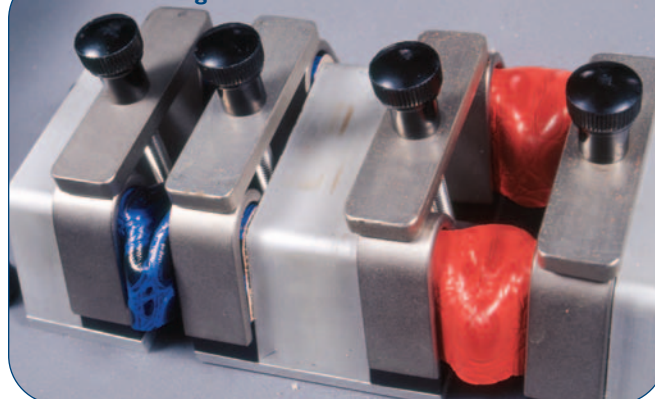
There are many and varied difficulties that the patent leather finisher is likely to face. Some of these have already been explained and others are outlined in *Panel 4: Troubleshooting and solutions*.

The problems outlined in *Panel 4* represent barriers to the entry into this market of the less experienced, "would be" suppliers of patent leathers coated using modern products. However, a basic understanding of the issues involved can enhance the confidence level of those willing and bold enough to invest in a patent leather finishing line. Provided they understand the disciplines involved and are prepared to implement them, then a high level of success should be achievable.

Overall

Given that the various finishing formulations are well developed and the application procedures documented and adhered to, the resultant high gloss finish still requires every

Panel 5: Testing Patent leather for flex resistance



possible means to avoid contaminating the finish and its surface with dust particles, residual chemicals or finishes that may be in the nearby vicinity. When producing patent leather it really does pay to remember the old English adage: "Cleanliness is next to Godliness!"

Acknowledgement

Stahl would like to thank SATRA for the kind permission to use the illustrations used in Panels 1, 2, 3 and 5.

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