Role of Machineries for Film Forming in Leather Finishing

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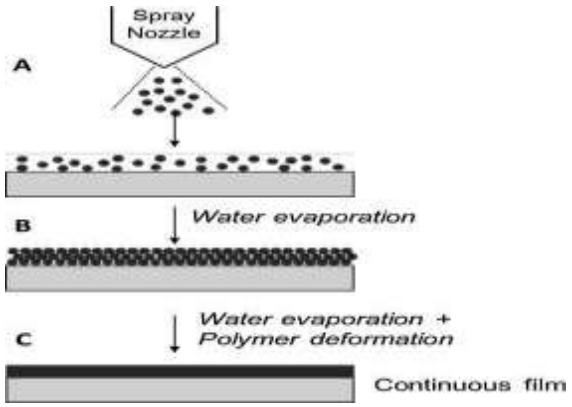
I. INTRODUCTION

Leather processing is broadly classified into Pre tanning, Tanning, Post tanning and finishing. In the Pre tanning unwanted matters are removed (like hairs and flesh etc...) and in the post tanning we can achieve the required properties of leather. Any Industry requires machines for their production. Role of leather machinery in production of finished leathers play major task, without modern machinery production of present day leather are impossible. Origin of machinery in leather industry starts from simple fleshing and shaving knife, hand padding which is the initial form of machinery. Development of leather machinery starts 100 years back. In early days most of the machines are mechanically operated and driven with steam power. With the invention of electrical power, developments in leather machinery took a new shape. More advanced machinery is developed with the help of electrical, pneumatic and hydraulic power. Due to the arrival of CNC (Computer Numerical Control), PLC (Programme Logic Control) and PC(Personal computer) more modernization was carried out. Today's leather machinery is more accurate and it requires less maintenance and less human inference. In the near future use of robotics technology in the tanning sector is not ruled out.

Leather machineries are broadly classified into two types they are helical bladed two-pass machines which is used in fleshing, setting etc and another type is referred as jack type they are shaking, glazing etc.Tanning drums acquires major attraction in tanning industry without drums it is impossible to make a leathers. Finishing machineries plays an important role to develop quality leather in a big way. To make perfect leather one has to understand the process in a good sense. The success of the perfect leather lies with balanced control of machinery operation. Balanced control in machinery operation not only improves the quality of the final leather at the same time it reduce the cost significantly. So it is a moral for each and every technologist to understand the functions of machinery in details.

Film formation refers to a process of forming a thin film on surfaces when film forming materials such as surface coatings are applied on that surface in the fill formation process a low viscosity liquid surface coating is applied to a solid substrate.



II. THE IMPORTANT MECHANISM OF FILM FORMATION ARE

PHYSICAL FILM FORMATION:

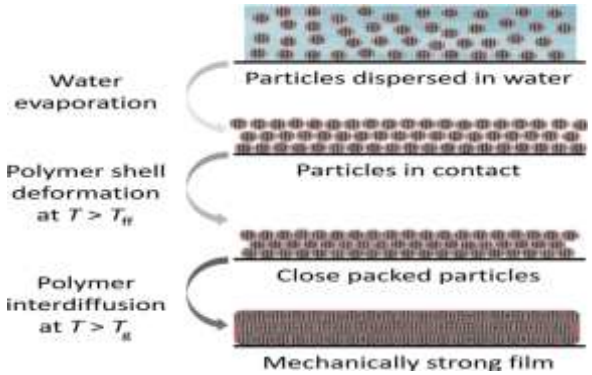
Binding agents' molecules are mostly elongated. They exhibit a strong mutual binding which can be broken by the much smaller molecules of a suitable solvent. In solution binding agent molecule can move freely.

CHEMICAL FILM FORMATION:

In chemical film formation a chemical reaction takes place in which the binding agent is involved and which causes the solidification. In chemical film formation the binding agent molecules often polymers by themselves grow to gather into larger units so that finally the whole paint can be considered as a huge macromolecule.

The coatings materials should

1. Capable of forming a film that is cohesive with the core material.
2. Chemically compatible and non-reactive with the core material.
3. Provide the desired coating properties, such as strength flexibility, impermeability, optical properties, and strength.



The finishing operation acquires prominent position and it is like a cosmetic work, which added beauty to the leather and increase the product value. Applying finishing material onto the leather surface is skilful job because one has to cover the surface defects without improving the grain value. Modern finishing equipment can able to do the job in a greater way. The objective of this paper is to study various machineries available for finishing film formation on the leather.

The modern film formation machines used in leather industries

1. Curtain Coating
2. Roller Coating
3. Hand –spraying machine
4. Auto-Spraying machine
5. Transfer Coating
6. Padding Machine
7. Foam finishing

The technical details of the above machineries are respective companies either through collected from the email and internet. Details of the machineries are compiled and then brought into print form. Above work is more literature survey.

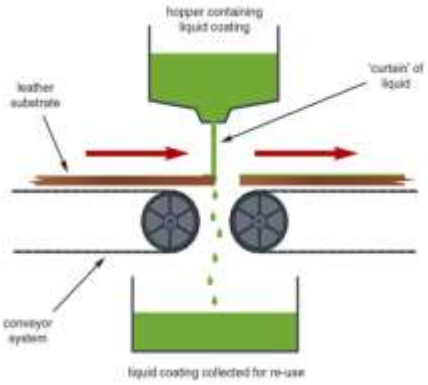
III. CURTAIN COATING MACHINE

The family of finish application machine originally was developed for the lacquer and colour coating for wood panels using comparatively simple technology. In the early 1960's it was realized that this technique could be adopted in leather finishing. In the 80's and 90's use of sophisticated spraying machine and then of roller coating ,practically reduced investment in curtain coaters which now remain in service chiefly in patent leather finishing.

Curtain coating machine is a high speed production process for applying smooth film of lacquers, patent finish and impregnation on leather surface. It uses the flow coating principle of passing the piece through a failing; continuous screen of material, but with one big difference is the stream of coating material is accurately controlled in thickness and rate of flow so there is no excess runoff. The surface of a piece passing through is coated uniformly and continuously, piece after piece at high production rates. The Leather is placed onto the coating conveyors which transport it under the pouring head. The speed of the coating conveyor is infinitely variable in abnormally range from 3m/min to 150 m/min.The amount of product applied per unit leather area is governed by the speed of the coating conveyor and the viscosity of product allowed to flow out of the pouring head. A modern curtain coater can be set to apply as little as 5 grams/ft2 and as much as 50 grams/ft2.

Design of the machine

The curtain coating machine consists of either one or two circulation systems for the coating material and of the transport system. The work-pieces pass through the liquid curtain formed by the pouring head and are thus coated uniformly and without stripes.



Pouring Head

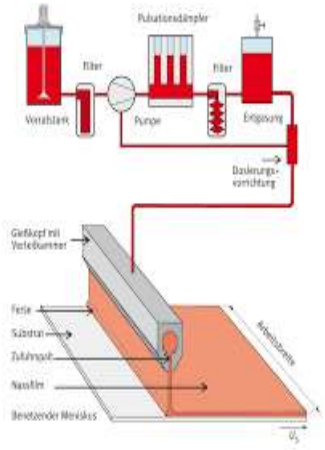
The Heavy and distortion proof steel construction combined with the stainless and re-adjustable pouring lips ensures highest level of application. Exact adjustment of the pouring gap is done by an eccentric shaft and a micro screw. Fast opening is done by means of a dial gauge.

Circulation system

Submerged pumps, feed and return pipes of a large diameter, filters, return gutter and container are provided for the circulation of the coating material. The submerged pumps are pivot ably arranged in order to allow the easy cleaning. A content of the container is normally 40-litres.

Transport system and drives

Safe transport is done through wide in-feed and out-feed belts. Smooth and vibration less run of the conveyor belt is with the help of conveyor belt rollers are balance and placed on the ball bearing. Drive of rollers by means of the 'V'belts.Speed controlled by a speed indicator. Pump drives either for one speed or variable speed.



Specifications

S.no	Specification	Value
1.	Speed	100-450 RPM
2.	Motor power	3 HP
3.	Voltage	220-240 Volts,
4.	Viscosity	20-100 Seconds=4 ford standard
5.	Length of the conveyor	7 inch in-feed and 7 inch out-feed

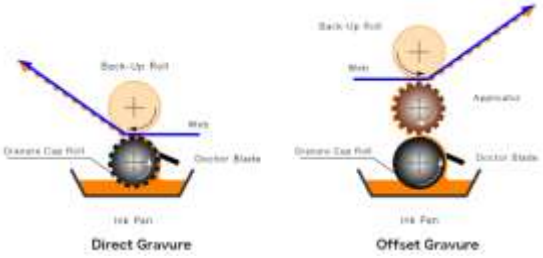
IV. ROLLER COATING MACHINE

The method of roller coating has been employed in the textile and wood industries for many years to apply finish coats and to print patterns. The German engineering company Dornbusch was manufactured Roller-coaters for printing in 1928, which are tried on leather. More attempts to adopt the technique in leather finishing date back to the 1950's but failed to be accepted because machine then used were designed to coat rigid or uniform materials and therefore could not handle leather satisfactorily. The German tanners Freedenberg built their own forward coater in 1974 and used in successfully. German tannery machine specialist KELA produces forward coater successfully. A significant development appearing in the early 1980's was the so called reverse roller-Coater also known as a padding machine because of its ability to pad the preparation coats into the leather, thereby phasing out labour intensive hand and automatic padding methods.

Roller application process consists of three coating methods they are

1. Roller coating by direct method
2. Roller coating by the indirect method
3. Roller coating by reverse-coating

All the above methods are rotogravure coating technique, i.e.the mixture to be applied is contained in cavities in the coating rollers and the surplus is scraped off with a doctor blade. In the direct method finish is transferred from the screen roller directly onto the leather. In the indirect method the finish is transferred from the coating roller onto the leather via robber roller

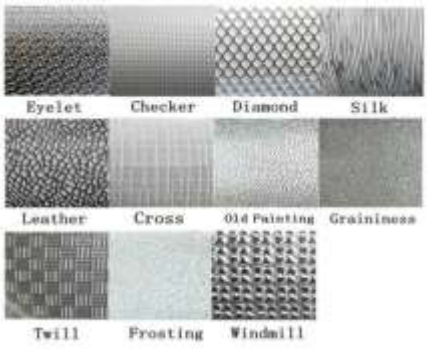


In the roll-coating process, the coating roller and conveyor belt (guided belt)runs in the same direction and the same speed (1:1).It can be good idea to have the coating roller running approximately 0.2m/min faster, as this stretches the leather to a certain extent and reduces the amount of creasing. The amount of product applied by the coating roller should be taken up as completely by the leather. Any product left on the roller is a sign of poor flow-out on the leather. The result is streaks, which often remain visible even after drying. The material to be coated should not be less than 0.8mm thickness; otherwise there is not enough pressure. It must also lie flat, otherwise creasing is inevitable.

As the roller runs in the opposite direction to the leather, there is a certain amount of friction at the point where the leather is fed in and as result some product inevitably lands on the conveyor belt. A washing unit is therefore essential when using this coating machine. The ratio of the speed of the coating roller to that of the conveyor belt depends on various factors and is generally somewhere between 2:1 and

5:1.Normal screen roller are not very suitable for this method of application because only small amount of product can be applied and so cross-line screen roller,i.e.rollers with diagonally intersecting groove are used.

Screen rollers have a uniform surface with cavities of equal width and depth. The size of screen rollers is expressed in terms of the number of cavities per centimetre. The screen rollers used in practice generally have between 20 and 40 cavities per centimetre. Pattern rollers are generally 60 screen roller in which the cavities vary in size and depth depending on the design. The cross-line screen rollers have diagonally intersecting grooves instead of cavities to hold the product.



Design and construction

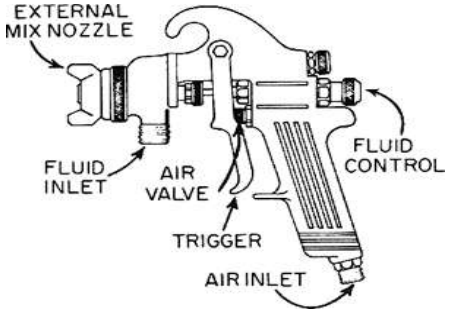
The core elements of the roller-coater are its application cylinder, the doctor blade, the support roller and the leather transport conveyor. The application cylinder is a complex component and is the determining factor in obtaining coating and finish effects as well as the quantity of the product to be deposited. The doctor blade/application cylinder is used to wipe the surface of the cylinder clear of any product/season leaving only that contained in the engraved patterns that to be transferred to the leather. The well behind the blade is designed to hold the application product which is continuously replenished as it flows into the patterns of the application cylinder. The support roller which is made up chrome plated or solvent resistance rubber covered is place below the application cylinder. Its diameter is slightly less than that of the application cylinder. Sometimes vertical axis is slightly ahead of the cylinder on machine which can be operate in reverse mode as this may help in grip the leather. More often the two axes are in line and are certainly so on forward mode. It is possible with certain design of machine to adjust the position of a normally in line axis support roller.

Specification

S.No	Specification	Value
1.	Working width	1800-2200mm
2.	Working speed	100 m/min
3.	Power	4 HP

V. SPRAY GUN

A spray is a tool which uses compressed air to atomize season or other spray able material and apply it to a surface. Air and the material enter the gun through separate passages and are mixed at the air cap in a controlled manner.



Spray guns can be classified in various ways. One is by the location of the container. First one is gun with an attached cap; second one is a gun using material from a container some distance away. The type of material feed system can also be a way of classifying guns with the material either kept under pressure-a pressure feed gun or using the suction feed principles to deliver material to the gun. Gun can also be classified as either external or internal mix, bleeder or non bleeder types.

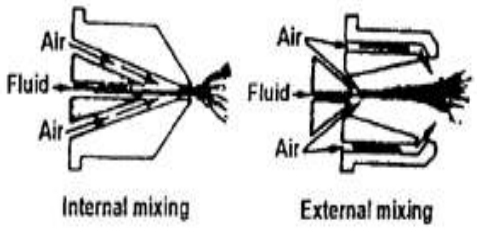
A spray gun design in which a stream of compressed air creates a vacuum at the air cap, providing a siphoning action, atmospheric pressure on the material in the suction cup force the material to the air cap of the gun. The vent hole in the cup lid must be open. Suction feed guns are suited to many colour changes and small amount of material is used. In pressure feed gun the fluid tip is flush with the face of the air cap and no vacuum is created. The fluid is forced to the air cap by pressure kept on the material in the system; a separate cup, tank or pump. This system is normally used when large amount of material are being used. Pressure feed gun is used where material is too heavy to be siphoned from a container, or when fast application is required.

Bleeder type spray gun is designed without an air value. Air passes through the gun at all times. It is usually used with small compressor of limited capacity and pressure which have no pressure controlling device such as un-loaded or pressure switch. In this type the trigger only control the flow of fluid.

Non-bleeder gun is equipped with an air value to shut off the flow of air when the trigger is released. The trigger controls both air and fluid flow. It is used with compressor having some type of pressure control device.

External mix gun mixes and atomizes air and fluid outside the air cap. It can be used for applying virtually all types' materials; it is also used when a high quality finish is desired.

Internal mix gun mixes air and material inside the air cap before expelling them. It is usually used where low air pressure and air volumes are employed or where slow drying materials are being sprayed.



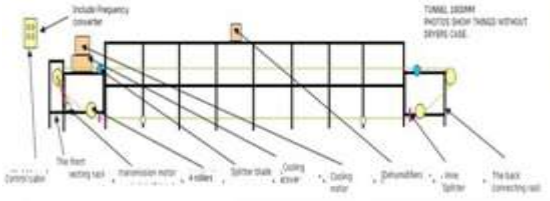
The principal components in the gun are removable spray-head unit containing the air cap, fluid and fluid needle. As the trigger is pulled back it first makes contact with the air value stem; which turn on the air. It then moves to the fluid needle, pulling it out of the fluid tip so season can flow. When the trigger is realesed, this process is reverses. There is always atomized air at the air cap whenever season is turned on or off. Air cap directs compressed air into the material steam to atomize it and form the spray pattern. There are various styles of caps producing different sizes and shapes of patterns for all types of application. A suction feed system consists of

1. Suction feed spray gun
2. Air compressor
3. Air control device
4. Length of air hose

Connect air line from the compressor outlet to the air control device inlet. Connect air hose leading from the outlet, on the air control device to the air inlet on the spray gun.

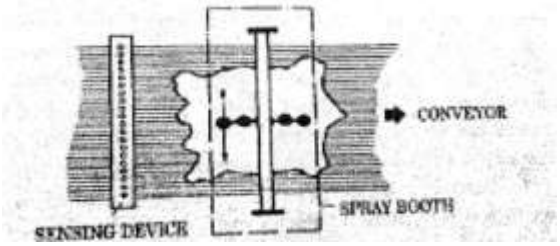
VI. AUTOMATIC SPRAYING MACHINE

Spraying techniques is plays a vital role in finishing. Earlier with hand guns the leathers were finished by hand spraying. This operation requires more labour, expensive wastage of finish etc.The auto spray booths increases efficiency, reduce the labour, but gives better covering of the leathers. In most tanneries surface coating is done by automatic spraying machines, but the fashion finishes and the variable nature of the materials means high degree of expertise required to obtain the results. There are three types of automatic spraying characterized by the type of motion and arrangement of the spray guns.



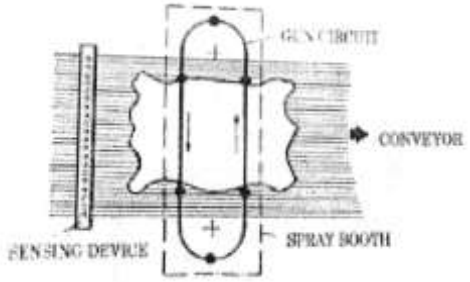
Reciprocating (or transverse) machine:

Two, three or four spray guns mounted on a support frame which moves to and fro across the conveyor at right angle to the direction in which conveyor travels. The spacing of the guns for uniform spraying is very important, these should not be altered.



Oval path machine:

This machine uses neither the conventional rotary nor the reciprocating action. The spraying path has a parallel track joined by semi-circular end sections to give one way continuous running of the spray guns. Any number of guns can be fitted spaced equidistantly.Gun rotation can be linear induction motor, hydraulic or standard chain tract support by rotating sprockets.



Rotary machine:

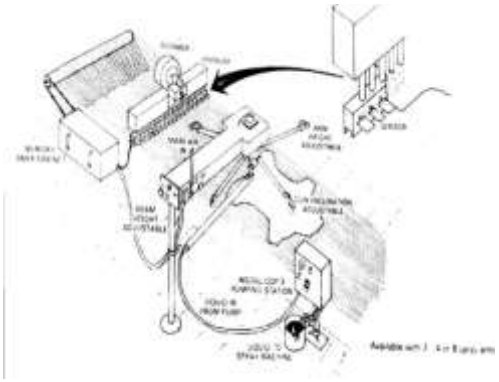
Rotary spraying machines are normally fitted with four, six or eight guns mounted at equal intervals around the periphery of a ring or alternatively mounted on the ends of equidistantly spaced arms. The motor is mounted on the centre line of the conveyor.

Spraying machine design:

Automatic spraying machine generally consist of the following main units:

1. Conveyor for transporting the leather under the spray gun and through the drying system
2. Spray booth, housing spray guns
3. Exhaust unit to remove solvent vapour from spraying booth
4. Tunnel for drying
5. Cooler fitted after drying
6. Control system and sensing device to scan and profile the leather

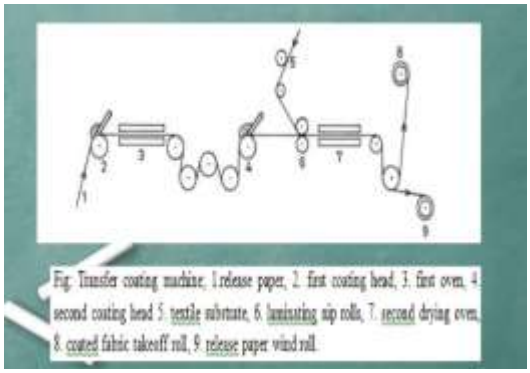
The most important part of the spraying machine is the guns. Unless these are set up precisely serious problems will arise neglect, improper cleaning and bad setting cause uneven spraying, excessive wastage of finish etc...In the industry air atomizing spray guns predominate, the other types of guns are used for special work e.g. air less and air mix spray guns.



VII. TRANSFER COATING SYSTEM

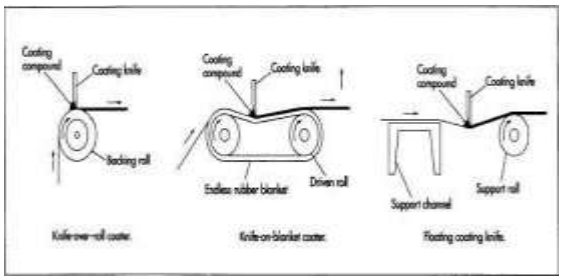
Ecoderm system for the upgrading of split leather:

The technology of transfer finishing initially developed to reproduce the imitation leather. The transfer coating systems are a reality in upgrading splits in particular when there is a request of high quality. The use of release paper allows a perfect reproduction, in every part of the split.



The transfer coating system consists in producing a polyurethane film on a paper roll support, coupling the split to the film. The film producing using two application heads that deposit on the release paper the polyurethane resins in different layers. Then coupled with a double cylinder rotary press.

The cost of this technique is lower than the any other up gradation techniques. The release paper can be reused many times and with proper use of the system. Today there are two types of transfer coating system on release paper offered in the market utilizing water based chemical products.



1. Transfer coating line by knife
2. Transfer coating line by Roller

With the knife system all impurities mix with the chemical product in the first machine causing lines in the applied film, and if the impurity is consistent or rigid it can cause tears on the release paper compromising the reliability of the paper. With the roller system this problem is eliminated because the impurities stay in the doctor blade that scraps the engraved roller. In this case, the release paper will never be damaged because of impurities in the chemical mix.

Due to the simplicity of the roller system, the cost of the coating line is reduced, as well as the maintenance cost compared to the knife system.

Principles of Roller coating system

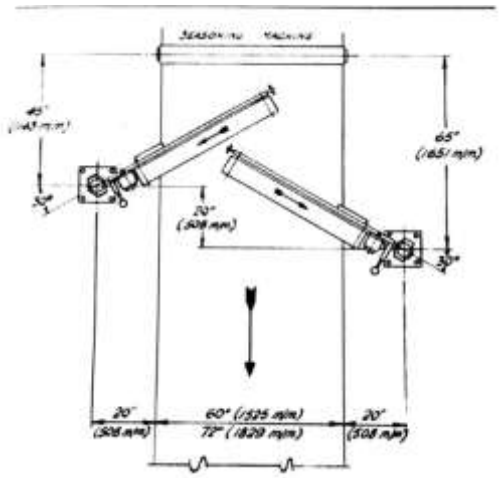
1. It is necessary to apply the adhesive on the total surface of the release paper with a notable waste of chemical product.
2. The adhesion of the film is not superior to 30N/cm; the industry average is about 25N/cm, which is still quite far from 50N/cm that solvent based product are able to achieve.
3. The production speed is between 4-5 m/min run by two operators that manually lay the split on the paper to couple with the film.

The film is produce using two cylinder heads(it is possible to interchange a third head with the second without stopping the machine during a colour change).The application of the adhesion on the split is done with a STARPLUS-S,and coupling of the same is done with a special double cylinder rotary press machine. The cylinders are protected by a rubber conveyor belt washed through an efficient washing system.

VIII. AUTOMATIC PADDING MACHINE

Padding, a process cheaply employed for the application of base and intermediate coats, for many years was carried out with hand held plush pads spreading the product on the leather surface. This hand held operation is replaced by the machine. The installation embodied two units identical in construction expert that one is right and other left hand. Each unit comprises a mild steel post fitted into a cast iron base, these posts being mounted on each side of the padding conveyor and which in turn carry endless plush belt in centres. These belts are set an angle to one another and to the centre line of the padding conveyor. Each plush belt is driven by a special motor.

The angle at which the belts are set across the conveyor can be varied, as can the tilt or angle of contact which they make it; while the speed at which the plush belts travel is controlled by a single electronic controller, which operates both motor units simultaneously. In addition the pressure which the plush belts exert on the leather is controlled along the whole length of contact by means of adjustable weights, which operate on the belt through hinged pressure plates.



The finish is much more uniform than with hand padding, and colour is more thoroughly rubbed in. The plush belts are easily removable and can be replaced in a few seconds for changing colour. After use belts are rinsed and dried before being used again.

IX. FOAM FINISHING

Foam finishing is the finish which is done with the foam (instead of season mix). This is generated by using special device called foam mixer, which mixes the season with air in the ratio of 1:3.

The physical appearance of foam is like a melted/ molten ice cream. The foam is then pumped into the gemata/ roller coated and applied the same way like normal season application.

For

Full grain - 5g/sq ft

Corrected grain - 190g/sq ft

Splits - 20g/sq ft

After application of foam, it is dried well and then embossing (hair cell/ print in any design) is compulsory to level out the finish film.

After embossing it is further finished the same way like any other finish and fixed with either lacquer or PU.Note that foam has to be applied only one and not twice or more.

Foam finish is sustainable for making resin finish and only no polish or glaze finish.

Viscosity of season mix is vital as it contributes for quality of foam.

Required viscosity: 22sec in FC'4

Foam finish requires special stabilizers, which keeps the foam in stability and prevents foam settling.

Advantages

-Very high up gradation.
-High physical properties Scuff resistance, Abrasion, Wet rub& Dry rub fastness.
-Higher with yield.
-Suitable for high performance leather.
-Production friendly.
-Less wastage.

Disadvantages

-Heavily pigmented, no natural look.
-Not suitable for elegant finishes such as polish, glaze, burnish articles.
-Cost of foam mixer is additional investment

X. CONCLUSION

Art of leather making includes balanced control in machinery operations. Control deals with selection of right machinery for right place, cost, productivity and availability of skilled labour. Film formation is the conversion of a coating film from a liquid or fluid form into a solid. A key difference between waterborne acrylic coatings and solvent borne coatings such as oil-based alkyds is their mechanism of film formation.

So to produce quality leathers, technologist must have good exposure in machinery side. Above the study is the tip of iceberg. From the literature survey we came to know that Italy is strong in leather machinery of coarse German machines are costly but more reliable. On the other hand Chinese's machinery is cheaper. It is very to see the development of machinery. For example, mechanical shaving machine was invented by Turner Company. They attempt to modify the same by introducing the hydraulic system.Thus, they introduced partly mechanical and partly hydraulic system after overcoming certain drawbacks the developed hydraulic shaving machine. The aim of the present study is to bring in operational detail of the machine which is widely used in finishing department. Study is limited due to the fact that availability of the information is very limited.

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