REVIEW OF ANALYSIS OF TEXTILE SQUEEZING ROLLER

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ABSTRACT

The purpose of this paper is a literature review on deflection of long rollers used in textile machines. This literature review accomplish the different techniques to reduce this deflection in ordered to get proper squeezing of wet fabric and is also gives different techniques of reducing wet pick up from the fabric. The initial surplus amount of liquor from the wet fabric is squeezed by two mechanical counter rotating rollers and uneven squeezing of wet fabric throughout the length of roller is affecting the further process and resulting in production loss. So this review is carried out to obtain different techniques to reduce the deflection, it gives different wet pick up processes to remove surplus amount of liquor from the fabric and also gives an idea about analysis of rollers.

1. INTRODUCTION

The textile industry is one of many industries that utilize large volumes of water in the manufacturing process. In the last three decades, the development of research related to drying has grown exponentially. In the textile industry, the drying process is one of the major cost elements among the textile finishing operations, directly affecting the specific energy consumption and the quality of the product; therefore, a proper understanding of drying is of great importance. Drying is necessary to eliminate or reduce the water content of the fibres, yarns and fabrics following wet processes. The drying process for fabric usually involves two steps: the first one is aimed at removing water which is mechanically bound to fibres, while the second one is necessary to dry completely the fabric.

Hydro-extraction by squeezing:

The fabric is squeezed by means of a padding machine through two or three rollers covered with rubber. This process cannot be applied to delicate fabric.

Hydro-extraction by suction:

The fabric is transported flat over a "suction drum" which is linked to a pump. The external air is sucked through the fabric and thereby removes the excess water.

Stenter:

This machine is used for full drying of the fabric. The fabric is conveyed through the machine in open width. A hot current of air is blown across the fabric thereby producing evaporation of the water. The fabric is sustained and moved by two parallel endless chains. The fabric is hooked undulating and not taut to allow its shrinking during drying.

Air dryer-use in fabric processing:

This machine can be used for washing, softening and drying operations on woven and knitted fabrics in rope form. During the drying phase the fabric in rope form is re-circulated in the machine by means of a highly turbulent air flow. Water is thus partly mechanically extracted and partly evaporated. In this case the bottom of the machine is

filled up with water and the required chemicals and the fabric is continuously soaked and squeezed. The capacity of this machine is determined by the number of channels.

Padding is also done while holding the fabric at full width. The fabric is passed through a trough having dye in it. Then it is passed between two heavy rollers which force the dye into the cloth and squeeze out the excess dye. Then it is passed through a heat chamber for letting the dye to set. After that it is passed through washer, rinser and dryer for completing the process.

Drying can be applied to the following textile materials: loose fiber, hanks, yarn packages, fabric.

2. REVIEW OF ROLLER ANALYSIS

W.SOSZYUNSKI, A. STUDNICKA[1], Has review on cold rolling of products with highly accurate dimensional tolerances, there are three main direction of actions are identified that are by removing the formation of defects, achieving closer dimensional tolerances and obtaining uniform distribution of internal stress. Conventional solutions for reducing the deflection of roller are based on a combination of measurement of material thickness, roll force with compensating systems of roll gap, roll bending, as well as technical solutions interfering the shape of the roll bite.

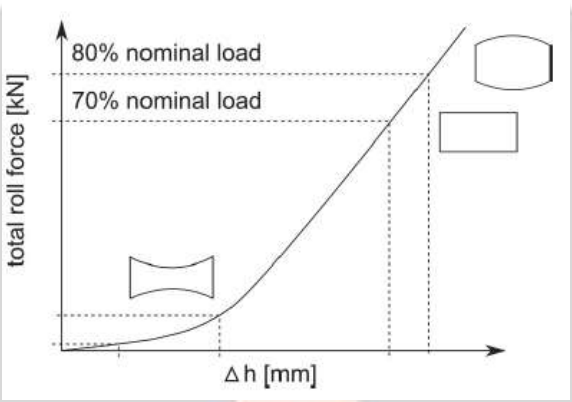

Fig-1 Impact of running the pressure outside 70-80% of nominal load boundary on cross- section shape of roll bite

Methods to control the deflection of the roll are the use of profiled shape of rolls instead of simple solid rollers, roll crowning according to deflection and roll shifting system.

There are types of crowning given in the paper are conventional crowning, CVC (variable) technology and dynamic shape roll (DSR), here variable crowning consist of an oil chamber under a metal sleeve that contacts with the rolled material and change in pressure in oil chamber directly affect the shape of the roll, Dynamic shape roll is similar to variable crowning roll but the sleeve rotates on the bearing mounted on a stationary core of the roll and core is equipped with an actuator segment, by applying an appropriate pressure between the core and sleeve it is possible to obtain any shape of roll profile.

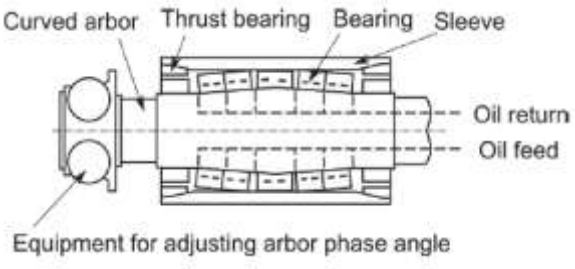

Fig-2 Variable crowning roll

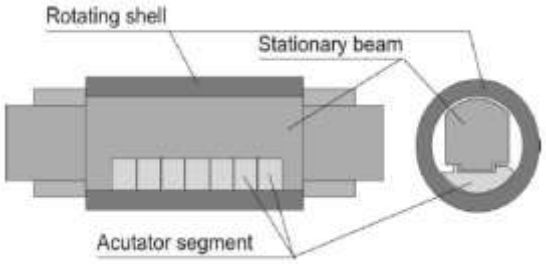

Fig-3 DSR roll

Overall conclusion of this paper is said that the deflection of roll is minimized by applying an external force at the point of deflection by using different methods of crowning.

VAISHALI K. KUMBHALE, V.H.BANKAR[2] are gives an idea about development of anti bending roll design without midsupport applied to shell to withstand over press boundary condition.

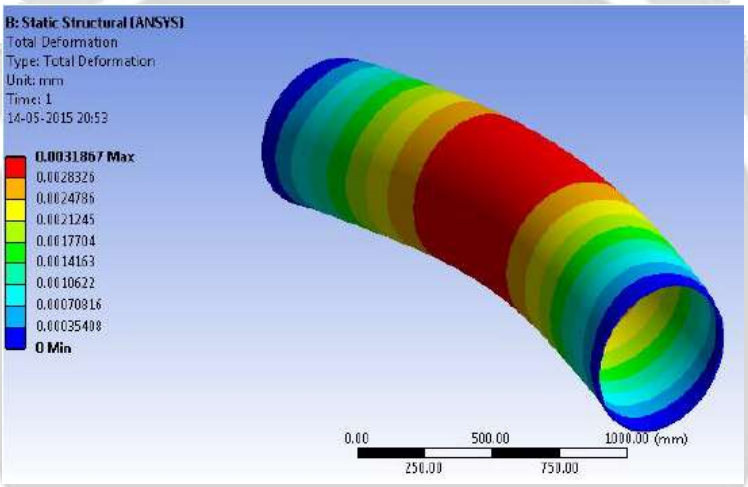

Fig-4 Total Deformation of Cover

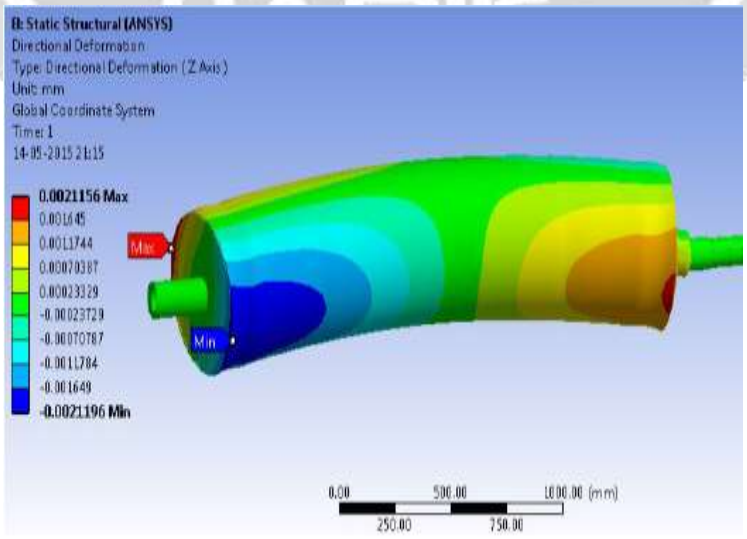

Fig-5 Total Deformtion of shaft

The analytic and software calculations of shaft and roller are given. Here shaft is a steady component and shell is rotating element. For a typical value of boundary loads this paper gives a feasible idea to make long rotary cylindrical roll.

W.C.LEE, S.W.KIM, C.M.LEE, W.J.CHUNG, C.S.KIM, J.I.SONG[3] had represented a modeling and analysis techniques to obtain more accurate simulation results for very long composite material shaft for the manufacture of a LCD thin film.

Static and dynamic analysis two types of analyses were performed. Static deflection is obtain from a FE analysis using ANSYS and to create a FE model of the shaft, equivalent material properties of the composite material and modeling method using solid elements were applied in the modeling techniques. The dynamic analysis is used to observe the dynamic deflection in rotating shaft.

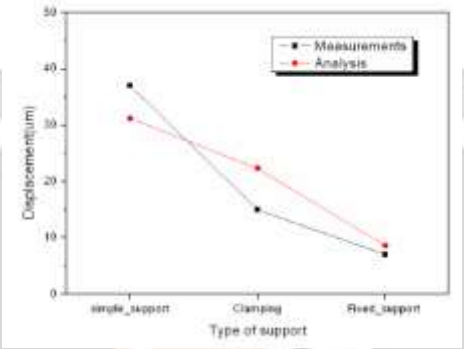

Fig-6 The comparison of data between analysis and measurement

These results can be used as reference data for developments such as a change of the material or design of a rubbing roller.

G.H.J VAN DER WALT, N.J.J.VAN RENSBURG had review on low add-n and foam application techniques [4].

2.1 Wet pick-up and the distribution of liquor on a fabric

In the practical mill situation the wet pick-up associated with the conventional padding process is normally about 60% to 100%, depending on fibre type. After the fabric has been padded through the liquor and prior to being squeezed through the rollers of the padder, the liquor is distributed as follows:

- Within the fabric
- In the capillary regions between the fibres
- In the spaces between the yarns
- On the fabric surface

The operation of squeezing the fabric in the nip of the pad mangle largely removes the surface liquor and to some extent the liquor held in the interstitial spaces between the yarns. The liquor held in the fine capillary regions between the individual fibres, and also that held within the fibres is extremely difficult (if not possible) to remove by mechanical means, even when very high nip pressures are applied. Cotton fabrics, for example, have a lower limit of wet pick-up of about 40% to 45%, which cannot be reduced further by mechanical extraction devices such as mangle.

The amount of liquor which can be removed from a fabric by a padder depends on factors such as nip pressure, rubber hardness and modulus, roller diameter and the speed at which the fabric is passed through the padder, and it is generally accepted that it would not be possible to further reduce the wet pick-up levels attained with conventional padders.

The lowest wet pick-up values attained by padding are partially related to the water of imbibitions values of the different fibres. For example the water imbibition of cotton is approximately 30%, while that of most synthetic fibres varies from 3% to 20%. In order to obtain wet pick-ups values lower than the water is imbibitions values for the various fibres, methods other than padding should be sought.

2.2 Techniques for reducing wet pick-up

In the field of techniques for reducing wet pick-up there have been several approaches to the goal of minimizing the amount of water used to convey the required amount of chemicals to a textile substrate. Some of these approaches are based on expression techniques where the surplus liquor which has been applied to the fabric is removed by squeezing or other means and others on topical techniques which simply apply a limited amount of liquor to the fabric. Recently another technique, namely foam application was introduced to the market. It differs in principle from the general low add-on techniques because air is used to dilute the liquor and thus reduce the wet pick-up.

2.3 Expression Techniques

In these techniques an excess of liquor is applied to the fabric, and as much as possible is removed subsequently by squeezing between special rollers or fabrics. Alternatively, the liquor is removed by vacuum extraction or forced out by compressed air or steam.

- Roberto Fibre-Filled Rollers
- The Dehydration System
- Vacuum Extractors
- Air Jet Ejectors

Roberto Fibre-Filled Rollers

An interesting alternative approach to rubber-covered pad rollers is the use of pad rollers made from special porous materials. Such rollers can directly replace rubber-covered rollers, and no major modification of equipment is necessary. Figure 1 shows the operation of the Roberto fibre-filled rollers.

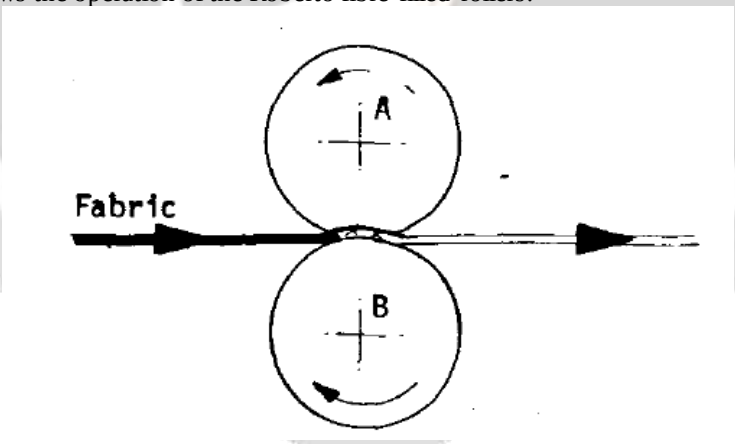

Fig-7 Roberto fibre-filled rollers

The top fibre-faced roller (A) consists of a mass of fibres (each fibre being coated with rubber of microscopic thickness), which tends to absorb the water during the squeezing process. The bottom roller (B), which is normally a steel roller, can also be replaced by a second Roberto fibre-faed roller. The Roberto roller-steel roller combination results in a wet pick-up of just fewer than 50% for cotton fabrics, with corresponding lower levels for synthetics and blends. It has been reported, for example, that with the Roberto roller-steel roller arrangement a wet pick-up of 10% can be obtained on lightweight knitted nylon fabric, but when two Roberto rollers are used, the wet pick-up could be reduced to 5%. As a result of the lower wet pick-up the processing speed could be increased by up to 66%, while an average saving of 20% on power Consumption was obtained. Roberto rollers can fit any pad mangle and the conversion can be made easily and at low cost. The rollers are resistant to most chemicals except oxidizing agents and strong mineral acids. One disadvantage of this system is the fact that certain polymers tend to clog the pores of

the Roberto rollers. The Prestech operate on the same principle as the Roberto rollers, but to date tittle information have been available about their commercial use.

The Dehydration System

Apart from squeeze rollers, reduction in the wet pick-up of a fabric can be achieved by various other extraction methods. Although some of these systems have been in use in other industries for many years, it is only recently that such equipment has been considered by the textile industry for reducing the wet pick.

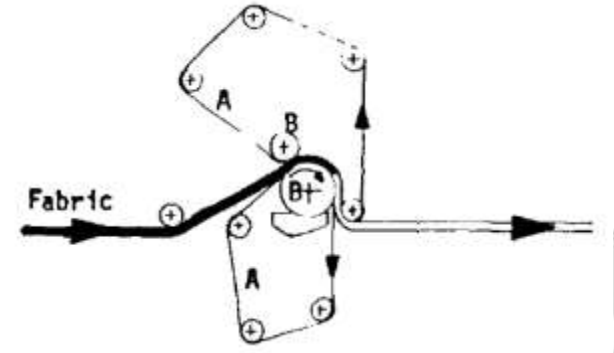

Fig- 8 The Hydrofugal system

Kleinewefers has developed a high capacity dehydration system under the name Hydrofuga, which is illustrated in Figure. In the Hydrofugal system two endless non-woven fabrics (A) are passing around two independent roller units and between two rollers (B). The fabric which has been padded is sandwiched under low pressure between the two nonwoven fabrics and in the process it transmits moisture to the non-woven fabrics, which in turn are dehydrated mechanically.

It is claimed that this system is suitable for fabrics which can be easily distorted or deformed such as knitted and pile fabrics, due to the low pressure exerted on the fabric. As with all other mechanical expression systems the removal of Liquor is less effective on fabrics containing natural fibres. The lowest wet pick-up obtained on a knitted polyester fabric is about 22%, and in the case of a 67%/33% polyester/cotton fabric, the lowest wet pick-up is about 44%.

Vacuum Extractors

One of the most common devices for reducing wet pick-up is the vacuum slot extractor. After the finishing liquor has been applied to the fabric, it passes over a vacuum slot where most of the liquor is removed. The extracted liquor is then recalculated and returned to the padder. It is important to note that the fabric must be continuously in contact with the slot for optimum liquor removal and consequently the vacuum slot is mounted in such a position that the fabric passes over it at an angle. Furthermore, the slot can have different types of configurations through which a vacuum can be applied.

The most widely used types are the straight slot and a herringbone pattern of single or double rows. Vacuum slots have to be designed for a specific application since factors such as slot width, slot configuration, fabric speed, fabric air permeability, fiber type, and vacuum can have an effect on the removal of water. The lowest wet pick-up obtained by the vacuum slot extractor for a 100% knitted polyester fabric varied from 10% to 20% and for a 100% cotton fabric the wet pick-up ranged from 40% to 50%.

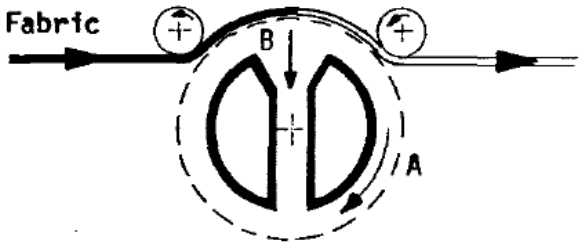

Fig-9 Vaccum roller extractor

A number of systems incorporating the above principle have been introduced to the market in recent years. One such system is the Jawetex vacuum system which incorporates a concave suction bar with offset suction slots to permit the bar to move close against the support roller over which the fabric is passed. The lowest wet pick-up values obtained on the Jawetex system are 18% for nylon, 24% for polyester, 64% for cotton and 75% for wool fabrics. It has been claimed that the drying capacity can be improved by as much as 60% when the Jawetex system is used. In the case of the vacuum slot system developed by Textile Vacuum Extractor Co. the lowest wet pick-up values obtained are 10% to 15% for polyester, 35% to 40% for 65%/35% polyester/cotton and 50% to 55% for cotton fabrics. A reduction of 45% in chemical consumption was also reported a vacuum extractor of more recent design is the suction roller extractor shown in figure.

The vacuum roller extractor operates on the same principle as the vacuum slot extractor except for the fact that the wet fabric is guided over a perforated roller (A) with a vacuum slot (B) inside this roller. The perforated roller rotates with the fabric and consequently the fabric is not pulled or dragged and thus it is not distorted, as can be the case with the normal vacuum slot extractor 'J'. Extraction of liquor by the vacuum roller extractor is more efficient than that of the vacuum slot extractor. The lowest wet pick-up values obtained by the vacuum roller extractor vary from 10% to 20% for knitted polyester fabrics and from 35% to 45% for cotton print fabrics. Maier and Gaston County are manufacturers of commercial machines based on the vacuum roller extraction principle.

Air Jet Ejectors

As an alternative to a vacuum, for extracting the excess liquor from a fabric. Compressed air can he used to remove or eject the surplus liquor. In principle such a system will be effective over a broad range of fabric properties and it is applicable even in the case of fabrics with very low air permeability, because of the higher pressure differential which can be maintained. Pneumatic ejectors are manufactured by Pletec, Brugman and Hikosaka.

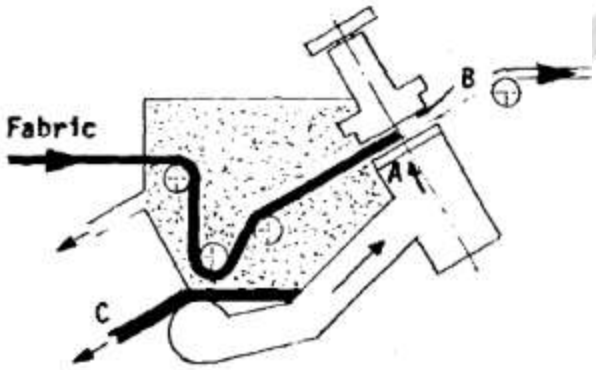

Fig-10 Pletec ejector

A pneumatic ejector for the removal of surplus finishing liquor, based on the Pletec "float on air" principle, is illustrated in Figure. During operation, compressed air (under a very high pressure) is forced through a slit (A) into the fabric moving between two plates, thus removing the excess liquor from the fabric. The gap (B) between the two plates can be adjusted according to fabric thickness. Furthermore, the finishing liquor (C) can be recirculated9. As

with vacuum extractors, all such ejector devices are more effective in removing liquor from hydrophobic synthetic fabrics than from natural fabrics. It has been claimed that on certain selected fabrics, wet pickups as low as 10% to 15% are possible, while on cotton and cotton blend fabrics wet pick-ups as low as 40% to 50% can be obtained.

2.4 Topical Techniques

The topical techniques differ from the expression techniques in that a low amount of liquor is applied to the fabric. The liquor can be transferred directly to the fabric, or by means of indirect transfer systems.

- Engraved Roller
- Nip Padding with Doctoring Device
- Lick Rollers
- Wicking System
- Loop Transfer System
- Pad Transfer System
- Spraying system

Engraved Roller

In the engraved roller application system, shown in Figure 8, the liquor is applied to the fabric by engraved rollers.

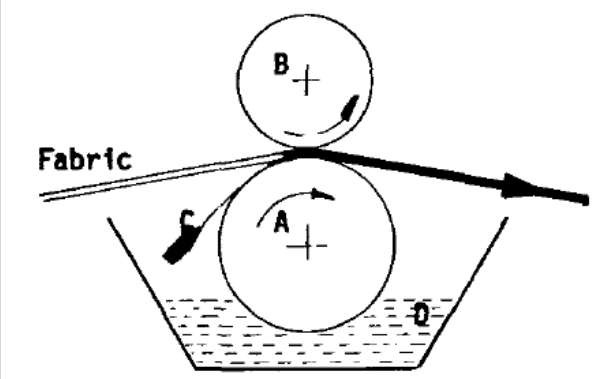

Fig-11 Engraved roller

This application system consists of four major components: the engraved roller (A), a rubber roller (B), a doctor blade (C), and the liquor bath. The engraved roller rotates in the liquor bath (D) where its cavities are fled with Liquor. The excess liquor is removed from the cavities by an oscillating doctor blade. The remaining liquor is then transferred from the engraved roller and forced into the fabric at the nip by the pressure of the top roller.

The construction and design of the engraved roller are critical and the volume of liquor delivered per unit area by the engraved roller depends on the surface of the engraved roller, and the number of cavities. This in fact can be a disadvantage of the system, since the same volume of liquor wig always be delivered per unit area by a specific roller. The wet pick-up, therefore, will vary with fabric mass and in order to achieve the same wet pick-up on different fabrics, different engraved rollers with different cavity structures have to be used.

Nip Padding with Doctoring Device

Another development in the field of low add-on techniques is the nip padding system which operates like a normal padder but which utilizes a doctoring device to control the wet pick-up. This is illustrated in Figure.

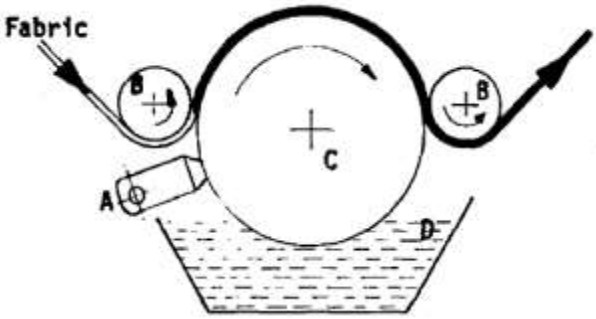

Fig-12 Nip padding with doctoring device

In the nip padding systemthe wet pick-up can be reduced by adjusting the doctoring device (A) and the pressure and position of the nip rollers (B).The lick roller (C) rotates in liquor (D) in the direction of the fabric movement. Advantages of this system are claimed to be a saving in chemicals (the trough contains only of liquor), wet-on-wet applications are possible and that no major capital investment is required (this system can be used with existing processing equipment). It has been claimed that a wet pick-up of 30% to 40% can be obtained on a fabric of 140g/m2, using the Mini-Fluid nip padding unit.

Lick Rollers

Lick or kiss rollers have been used in textile finishing for many years. Usually for the application of chemicals to the one side of a fabric. Lick rollers are normally used for a specific purpose for example, for the treatment of corduroy fabrics, where it may be necessary to apply a stiffening agent to the back of the fabric while still retaining a soft pile6. Apart from special one sided applications, lick rollers have been used for the application of durable press resins to fabrics at low wet pick-up the different kiss roller systems are shown in Figure.

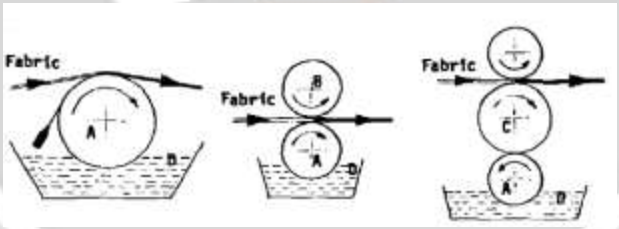

Fig-13 Kiss roller system

In the kiss or lick roller system (Figure), a pad roller (A) is partly immersed in the liquor bath (D) and the liquor is carried upward by adhesion to the roller surface onto the fabric that is being treated. In the single roller system (Figure), the fabric is not nipped, whereas in the 2-roller system (Figure: a top roller B nips the fabric onto the kiss roller. Alternatively, the kiss roller system could have a 3-roller arrangement (Figure) where liquor is transferred from the kiss roller (A) by the intermediate roller (C) to the fabric which is nipped by the top roller (B). The lowest wet pickup obtainable on cotton sheeting fabric by the single kiss roller system is about 25%. It has been claimed that the kiss roller system produces fabrics with slightly higher wash and wear ratings than those obtained by a conventional padder. The kiss roller is used for coating fabrics and can also be used for dyeing one side of a fabric.

Wicking System

Another technique for the application of chemicals to fabrics at low wet pick-up levels is the wicking system based upon the rotary-screen printing technique. The wicking system is shown in Figure the wicking system operates on the principle of creating a film of finishing Liquor on the inside surface of the screen (A) by means of a wicking device (B). This film of liquor is then forced through the mesh of the screen onto the fabric by means of a squeegee (C) under a relatively high pressure.

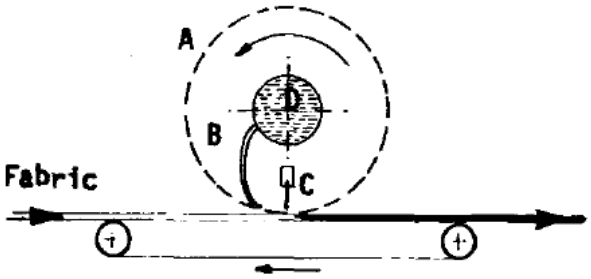

Fig-14 Wicking system

The wick is fed with liquor from the pressurized reservoir (D). Little information is available about this method of application. It is claimed, however, that the relatively high squeegee pressure could result in excessive noise levels6. Furthermore, it has been reported that low viscosity liquors cause lubrication problems and there is some evidence that it is difficult to control the add-on level.

Loop Transfer System

Another well known indirect padding technique is the loop transfer system. There are two basic loop transfer systems using a loop fabric and either two or three rollers, as illustrated in Figure, can be used.

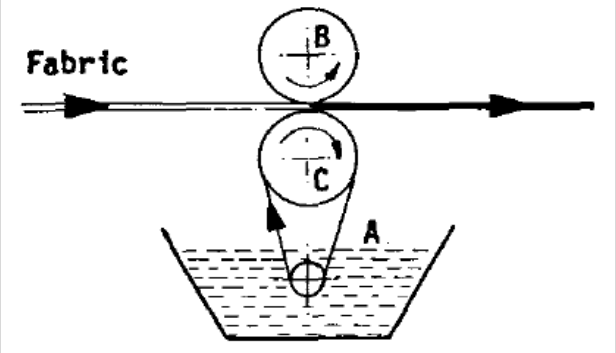

Fig-15 Loop transfer system

In the two roller system, the fabric loop (A) passes continuously through the finishing liquor up to the nip formed between the upper (B) and lower (C) rollers, and is then squeezed onto the fabric to be treated between the pair of rollers. The wet pick-up obtained with this system varies from 15% to 40%. But this could be further reduced by the use of a roller bar running against the loop to remove excess liquor from the loop.

Pad Transfer System

In the pad transfer system, as developed by Rossler and Pusch. The fabric which is treated can be used as its own transferring loop. The pad transfer system is shown is Figure.

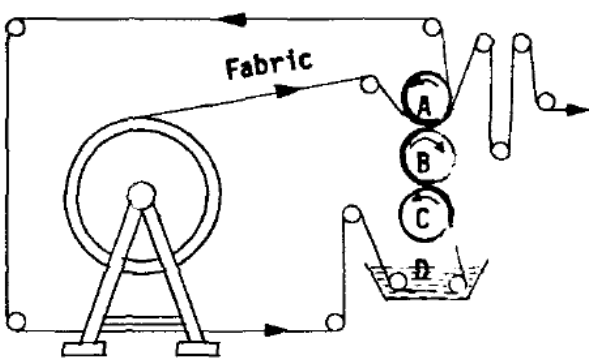

Fig-16 Pad transfer system

On a conventional padder with three rollers the incoming dry fabric is partially prewetted during the final squeezing between rollers (A) and (B) of the already impregnated fabric. The partially wetted fabric then moves over some guide rollers and is completely impregnated in a liquor bath where after it is squeezed at the nip of the top two rollers (A and B) of the padder together with the incoming dry fabric. This process is also known as the Q and S (squeeze/suction) technique.

Spraying System

Another system for the application of finishing liquors in controlled quantities at low levels to a fabric is that of spraying. In this system the liquor containing the chemicals or finishing agents is sprayed on the fabric through a manifold with spray nozzles (A) as illustrated in Figure.

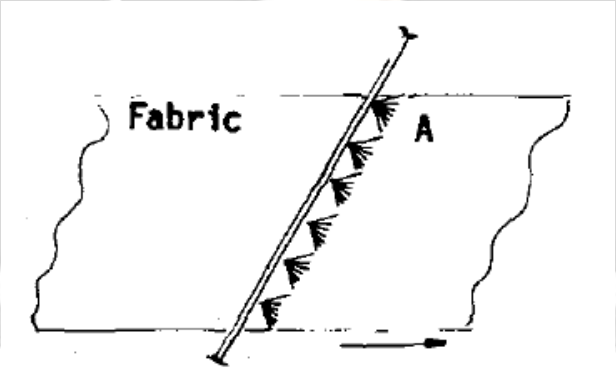

Fig-17 Spraying system

The amount of chemical to be deposited is controlled by the concentration of the liquor, the diameter of the nozzles and the pressure inside the manifold.

3. CONCLUSIONS

This review is done to show that initial surplus amount of liquor is removed by mechanical padders and a small deflection of roller directly leads to overweighting for further process of squeezing. So, it is very important to reduce the deflection to increase the squeezing efficiency and that will directly tends to industrial profit.

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