Fundamentals on design parameters of paper machine wire cloth and its principal application on paper machine

VENKITESWARAN, K. R.*

SUMMARY

Machine Clothing is one of the most essential and important consumable in the Paper Industry The cost of Machine Clothing is negligible. but the effects of good clothing are tremendous and can never be overlooked. Its performance contributes a major role in increasing the efficiency and quality of the product.

Machine Clothing comprises of wires and felts and this paper deals with the wet-end clothing namely wires.

Factors affecting wires life are numerous and differ with individual Paper Machine conditions. Setting standard design parameters for wires. therefore, is rather a difficult task. One can work under certain basic guide lines only. For a successful run the wire cloth has to be designed suiting to individual Paper Machine conditions.

In this paper, therefore. I have tried to briefly explain the basic factors involved in our designing a paper machine wire be it metallic or synthetic. Because Synthetic Forming Fabrics is the latest technology available I have dealt with this area a bit more in detail.

RAW MATERIAL

Starting with raw material, the wire threads either metal or plastic-should have basically adequate tenacity, ductility and resistance to abrasion, fatigue and corrosion. Some of the properties that a wire maker would like to have for weaving his wire cloth are contradictory to each other, hence an optimum relation suiting to the various requirements has to be accepted. The aim is to manufacture a wire cloth having maximum abrasive resistance properties, while maintaining other qualities such as flexibility, stability, rigidity proper retention of fibres and sufficient drainage.

Giving due consideration to these basic requirements till the middle of 1950's, during which time initial trials and development of Synthetic Fabric started, combination of Phosphor Bronze as warp and Brass as weft were found to give the best results.

Before coming to Synthetic Forming Fabrics, which has been recently introduced by the Indian wire cloth manufacturers, to begin with I would like to explain the various designs available in metal wire cloth, as even today majority of the Indian Paper Mills are using metal wires.

WEAVE PATTERN

To suit various grades and kinds of paper and board manufactured a range of machine wires of different characteristics must be available. In addition to the difference in mesh and materials of construction of the threads, there are also different patterns of weaves employed.

*M/s. Wires and Fabriks (S. A.) P. Ltd., Industrial Area, Jhotwara, Jaipur-302012, India.

I. PLAIN WEAVE

The earliest and the simplest pattern of weaving wire cloth is the Plain Weave-one up and one down weave pattern - alternately the warp wires or threads passes under and over and weft wire. This is still used widely and successfully where the wire cloth itself does not move laterally-say for example Cylinder Mould Covers.

II. TWILL WEAVE (LONGCRIMP)

In this type of weave the warp that is the length-wise wires pass over one weft wire and then under two weft wires alternately. This is a one up two down weave. In a Fourdrinier Paper Machine the wire cloth itself moves acting as a conveyor and at the same time draining water. The warp strands have to withstand the tension in the finished machine wire and are also subjected to wear, whereas the weft strands act as a holding wire and knit the whole wire cloth into a belt. The longer underside crimp of the warp wire gives a greater contact surface for the wear of the cloth. (The wire must retain the maximum amount of fibres and also allow maximum drainage. It should not affect the quality of paper produced. A mesh number suiting to individual requirements are produced).

Improvements and modification in Twill Weave

A Snake weave wire is woven in a Zig-zag fashion so that a warp wire does not run straight but in a sinnous form. The friction between the wire and the surface of the flat boxes constitutes the maior load on the fourdrinier drive. This Zig-zag weave reduces the possibilities of grooving of suction boxes and hanging of the wire.

III. LEVEL WEAVE OR 4 SHED WEAVE

A two up and two down weave. That is a warp wire is woven over two shute wires and then under two shute wires alternately. In this case the warp (longitudinal wires) and weft cross direction wires are almost in the same level. The weft wire also resists the abrasion together with the warp-for this reason best results are obtained when Bronze weft wires is used in place of Brass weft. In addition to the increased wear surface available in this level weave this construction offers an excellent shoot modification and flexibility. However, the long warp knuckles on the paper side leads to certain wire marking problems and as such this is considered only in such production ranges where marking on the paper could be overlooked.

IV. POWER WEAVE

By development of high pressure weaving together with increased warp tension and possibilities of absolute tension control on both warp and weft enables to weave a wire cloth, the crimp of which is very tight. Experiments have shown that the above modifications in the weaving process offers considerable control over such properties as caliper, shute modifications shape of the bottom warp knuckles clearance under the top warp knuckle firmness and cloth contour. Additionally, the life increase of a POWER WEAVE wire cloth is also due to a special raw material composition developed in cooperation with our overseas raw material suppliers coupled with a special shute wire lubricant used for forming a stronger shute crimp in the wire cloth. These are the factors which determine the life and performance of the wire on the paper machine.

Specific objectives of the POWER WEAVE technology can be summarised as follows :

i. Without the inherent defect of wire marking of fourshed weave wires we are able to weave a wire cloth resulting in an increased life.

ii. An optimum selection of wire diameter and mesh count results in increasing the wear surface and at the same time maintaining the effective drainage.

iii. This weaving enabled to produce a flat contour more flat than any produced with the usual normal weaving.

iv. Increase in stability of the wire at higher paper machine speed.

v. Because of tight crimps, entangling of fibres between the knuckles is reduced considerably resulting in less clogging with the close cooperation of the paper mill technicians of Shree Gopal Paper Mills and Amlai Paper Mills extensive trials were made with this type of weave. In Shree Gopal Paper Mills the average life increased from 14 days to 22 days and in Amlai 9/10 days to 20/22 days.

V. RIBBON WEAVE

In this case, instead of a round wire, flat warp wires are used. The wear surface increased and at the same time the crimp contact area between warp and weft also increased tremendously. The flat top surface gave an increased fibre support resulting in quicker mat formation and even distribution of fibres and fines.

To manufacture flat warp threads with uniform dimensional properties is not so easy and the raw material cost is very high even though this type has proved very successful in foreign countries. In India we are now in the process of actual trials. Technically it should prove more advantageous than the increased cost and when the paper machine conditions do not permit to run plastic wires these flat warp wires are worth trying. We have supplied these types of wires recently to some Indian paper mills.

CHANGES IN METALLURGY

'Z' Metal Wires

Another improvement in Phosphor Bronze wires is the introduction of molecular particles of a special element in the warp thread construction—as the warp wire starts wearing these particles imbedded in warp wire structure act as lubricants, thereby reducing the wear. Trials are being presently conducted on this type of raw material and laboratory abrasion resistance tests have shown tremendous possibilities of increasing the wire life.

Because of developments in using Synthetic materials and diminishing market potential of conventional metallic wires, no further improvements in Phosphor Bronze wire cloth is expected. Therefore, it is felt that by the above weave designs we have reached an ultimate stage in the Bronze weaving technology.

Now I would like to deal with *Synthetic forming fabrics.*

SYNTHETIC FORMING FABRICS

The development of Polyester monofilament yarn with low tolerances and the possiblility of thermo heat setting of crimped threads are the main reasons which successfully lead to the real development of Synthetic fabrics. Of course, it is known that the Synthetic threads give a much higher wear resistance, increased flexibility, more resistance to corrosion etc.

Manufacturing Features

POWER FLEX or SPIN-FLEX wire cloth are produced on super heavy precision looms at an extreme high warp wire tension. The individual warp wire tension is controlled while warping. For a 3.6 Mtr. wide wire cloth uniform tension is maintained for about 25000 wires. A weaving pressure upto 40 Kg/cm is applied. These special features combined with double thermo treatment after weaving process resulted in a wire clothing a very good transversal and longitudinal stability desired for a good run of forming fabric. Our experience shows that Synthetic forming fabrics woven on light felt making looms with a weaving force of 15 Kg/cm have limited stability.

Initially the traditional weaving designs like Plain Weave or Longcrimp were produced by replacing the metal threads with Synthetic monofilament. However, the finishing process was done under a heat source in the range upto 200°C. This weave pattern is still used for formation of pulps, hard board etc. main application being Shrink Sleeves for Cylinder Moulds. These weave patterns could be used successfully only for coarse fabrics where thicker monofilament wires are used which have very high tensile strength.

For the fine fabrics, however, the above designs were found to be not suitable and developments of other weave patterns were necessary. On the traditional designs, the fine Synthetic forming fabrics, especially on high speed fourdriniers were not stable enough and with increasing wear the tensile strength of the fine threads became low and the fabric started to stretch. By changing the design from three shed longcrimp to fourshed Twill together with modification in the weaving and the mixture of different monofilaments for warp and shute it became possible to devise a Synthetic wire cloth combining the valuable characteristics of the Bronze wire like stability, low stretch, good sheet formation, less wire marking together with flexibility and resistance to abrasion inherent in Synthetics.

SHUTE RUNNERS

On traditional weave patterns the longitudinal machine direction warp wires has not only to take up the wear but also the tensile load and power transmission. The weft wire or the cross machine direction wires helped only to maintain the transversal stability. That means the warp has got two functions to be fulfilled at the same time. As the wear increase the cross sectional area of the warp wire decreases and the stress per unit cross sectional area increases tremendously.

With a Shute Runner, we can separate the two functions :

Tensional Load and the Wear. The finer warp wire takes the Tensional Load due to power transmission and the thicker shute takes the Wear due to abrasion.

For example in a medium high speed paper machine, the highest wire tension between suction couch and suction box can increase upto 20 DN/CM. By a warp wire dia of 0.22 mm and 28 wires/cm and weft dia of 0.27 mm theoritically after about 45% of the warp wear the wire cloth will tear off. Whereas in Shute Runner, the breaking occurs only after about 25% more revolution i.e. the Shute Runners thus gives an increased life together with less clogging and less and even wear to suction box tops etc. Except in very special applications where Batavia Twill or 5 shaft twill and fine double layer weaves become recommendable a 4 shaft twill design has been found to be dominating and has proved successful in majority of the paper mills.

SEAM

A thorough examination only allows to discover the seam in Spin-Flex wire cloth. The mechanical fine woven seam based on our collaborators patent is produced on special pneumatic seaming machines. By a special after treatment on the finishing table a durable and absolutely marking free seam is produced. After heat setting, the ultimate elongation, the crimp profile of warp and weft are measured. We can predetermine the elongation which can be expected in the paper mills.

OPERATIONAL FEATURES

Due to the difference of the raw material characteristics all plastic wires show different operational features on the wet end than Bronze wires.

WIRE LENGTH/TENSION

Normally the supplied length of the Synthetic forming fabrics is about 0.3 to 0.5% shorter than the Bronze wires. So while mounting the wire it will seem to be more tighter. Of course, it has to be seen whether this shorter length could be mounted on the paper machine. The details of the maximum and minimum length which could be mounted on the paper machine is most important. If the breast roll is equipped with a swinging devise a shorter wire length could be mounted very easily by lowering the breast roll - thus the wire can be well tensioned from the beginning when the breast roll is brought back to the operating position. During the first days of run the elongation - depending on the pretension applied - is between 0.1 to 0.3%. It is possible to easily adjust this elongation by the usual tensioning devices available in the paper machine. It should be kept in mind that for a good run of a plastic wire the static wire tensioning should always be kep 4 to 5 Kg/Lcm. It is, therefore, important to measure the tension on the plastic wire frequently during the initial run of the wires. Due to less tension on the wire, slippage may occur leading to high wear of the wire. This should be avoided.

Periodic measurement of wire tension and feed back information is absolutely necessary.

The Synthetic wire has a different friction co-efficient on linings of rolls, foils and suction box tops than the Bronze wire. Usually the friction co-efficient is higher, therefore, an increase in the load of driving rolls can be expected. This depends extensively on the quality of foils and suction box tops.

Low density polyethelene covering is not suitable for plastic wires. All internationally known manufacturers of such lining offer the right material for this particular application. However, special attention has to be paid that the water film on the suction box should never get interrupted, The moment the wire cloth runs in dry condition on these suction boxes high wear is unavoidable.

In order to obtain a good transmission of power from the driven rolls on to the wire cloth, the drive rolls should be covered with semi hard rubber cover with approx. 15° PJ. If this is not possible, we recommend to to increase thewarp at the driven rolls.

A steady wire tensioning of 4-5 Kg/Lcm also improves the ability of power transmission.

WIRE CLEANING

The affinity of Synthetic wires getting clogged is higher than Bronze wires, therefore, the wire cleaning is of more importance on plastic wires. We recommend to provide showers for each guide roll-the distance of shower should not be more than 10 cm and a pressure of 5-8 atm. A high pressure oscillating shower is also recommended. These showers should work 10-20 minutes once per shift. Even after this, if the wire gets clogged the wire could be chemically cleaned during machine shuts.

In short the following features are dangerous for plastic wires which affects its normal life:—

1. Sand grains jammed between the foils or suction tops and the wire destroy the synthetic wire cloth.
2. High wear is caused due to wire running dry especially in the last suction box zones i.e. no water lubrication.
3. Slippage. If the wire starts slipping, the wire gets abraded from inside within a short period.

4. Insufficient cleaning causes deterioration of dewatering.
5. Bad doctors and showers at the rolls: which causes concentration of fibres on certain points leads to formation of stripes on the wire.
6. Uncontrolled wire tensioned and not maintained slippage occurs.

These are the main factors to be considered when mounting Synthetic wires and has been experienced by our technical team.

It is evident that in future the manufacturer of paper machine wires will be expected to meet the specialised requirements of individual types of fourdrineir machines. This will be made possible only through very close cooperation of the user with the wire cloth manufacturer. Synthetic raw material for the manufacture of Paper Machine Wire Cloth gives tremendous opportunity for for increasing wire life, the development of this important phase has to be seen together with thc changing influences demanded by change in paper machine designs (such as twin wire formers) higher speeds, and even diminishing availability of conventional raw materials.