General Review of Paper Machine Wires

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SUMMARY

Machine wires have been developed with the co-ordination of paper makers and wire manufacturers. The bronze wires used now-a-days are the result of developments of many years. Now the bronze wires can be manufactured very evenly with good drainage, physical and chemical properties. The bronze wires are permanently deformed even at moderate elongation. For bronze wire it is necessity that thickness is kept to its minimum in order to resist the fatigue. The fabric wires can however be made several milimeters thick even double layered, the fatigue resistance hundred times superior and even at high elongations they deform very little. While using synthetic wires a few changes are required on the wet end of fourdrinier.

Generally there is no edge problem with the forming fabric neither small holes are to be patched; any holes caused by accidents can be patched easily and quickly and moreover patch does not mark the sheet.

INTRODUCTION

The Paper Machine Wire has always been a great concern to Paper Makers. Amongst all the Paper Machine Clothings wire being the most costliest item having shorter life in comparison to other Machine Clothings. The cost of production is likely related to the cost of wire per tonne of paper or we may say with the wire life for a particular machine. Machine wire is a screen of metallic or synthetic structure of finer mesh having warp and weft wires which run across the width, warp wires are interlocked with the weft wires and are at right angle to the weft. Machine wires have been developed with the co-ordination of the Paper Makers and Wire Manufacturers. Bronze wires used at present are the result of manufacturing techniques developed through a number of years. The present bronze wires can be manufactured very evenly and with good drainage, physical and chemical properties. Lately chemically treated wires were also developed. Many chemicals were also developed commonly known as "Wire Life Extenders". Then came the synthetic wires.

The aim of all these developments was to improve the wire life thereby reducing the cost of wire per tonne of paper and to improve the quality of paper by obliterating wire marks and improving the sheet formation.

METAL WIRES

Manufacturers select their particular combination of alloys that produce the best machine wires. In general the warp wire must have high strength and resistance to fatigue and wear, whereas the weft must be sufficiently ductile to yield to the interlocking action of the warp while the wire being woven, to give the machine wire the necessary rigidity and to provide suitable surface. The composition of alloy for warp and weft wires is as under :

Warp		Weft	
Phosphor Bronze		Brass	
Copper	91.7 - 93.05%	Copper	80-83%
Phosphorus	0.2 - 0.3%	Zinc	17-20%
Tin	6.75 - 8.5%		

In addition to the above physical properties both warp and weft wires must be resistant to corrosive chemical conditions to which they are subjected during manufacture of paper. Furnishes containing semi-chemical pulp for newsprint and similar grades of paper, contains chemicals which reduces the life of phosphor-bronze wires to almost two third.

The use of chemicals to improve the machine wire performance was introduced in late 1960. Many wire life extenders were developed to provide control of corrosion with reduction in the rate of wire wear and maintain a clean open wire, operating on a clean surface. Aqueous solution of Mercepto-benzothiozole (M.B.T.) mixed with sulphur when showered on return cycle of wire gave excellent results, works as good lubricating agent against metal fatigue and wear. The use of life extender chemicals is generally associated with increasing slime formation and pitch problem on some machines, which is mainly due to the increased

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time that machine wire run between two wire change, because of increased wire life.

A survey by newsprint committee of tech nica section of Canadian Pulp and Paper Association reported that eight machines producing a combined 1928 tonnes per day newsprint on the west coast of Canada had tried wire life extenders and all have reported postive results. It was also observed that the life extenders should be used from the inside surface and as far away from the breast roll as possible to avoid filling of wire mesh.

Out of the 49 mills manufacturing unbleached Kraft Paper in Southern and South Eastern United States having 79 machines about 90% machines are using extenders as a routine reported increase in wire life by 50-200%. Chemically treated metal wires have given positive success on machines running on semi-chemical pulp, increase in wire life was 25-100% in different cases.

Stainless Steel wires have usually proved to be the best for problems concerning wire life in general and nickel plating the close second. Chromium Plating is usually the most successful treatment against abrasion. Other variations are the tin plating, plated warps and plastic coated bronze. A recent development in plated wires is a copper plated stainless steel which has had some success. The only problem with stainless steel wire has been a seam but now that too has been eliminated to a great extent. Stainless steel Wire did not have any undue wearing effect on the boxes and the wire mesh kept very clean. It is very good specially when using neutral sulphite semi-chemical pulp. Recently some combination of metal/ plastic wires having stainless steel in cross direction of machine has been developed giving good results.

FACTORS EFFECTING WIRE LIFE

This includes the weaves, metals used and surface plating, corrosion that is specially caused by aeration of stock and dissolved solids, the pH value of white water, temperature of stock, the covering of rolls, suction box tops (Material and construction), type of seam, wire tension, tension on warp thread, abrasion by grits in stock, dent edges, stock on return roll, angle of wire around the return roll, radius of return roll, wire slip etc. The impact of these factors varies from mill to mill and machine to machine.

It is generally considered that there are three more factors in wire wear.

(*a*) Air saturation in stock (degree of aeration) is the most important.
(*b*) Temperature of the stock.
(*c*) Acidity of the stock.

The increase of pH of machine white water from 5 to 6 almost double the wire life. However, the higher the pH of shower water the greater will be the tendency towards filling and plugging of wires which is confirmed by our own experience at our mills.

The use of poly-tetra-flourethylene suction box cover extends the wire life because of its lowest coefficient of friction of any known organic material. Ceramic tops are also known to give excellent results because of very low coefficient of friction.

Ficher measured the wear of wire with the special tester and constructed a scale on which a wire thickness of 0.127 mm. equal to 100%, which is considered to be the end of useful life of machine wire. He gave the method of calculation of coefficient of friction and stresses the impact of water lubrication on boxes.

Boadway, Friese and Husband have checked carefully the drag forces caused by suction boxes. The drag is divided into three components, a friction force, a viscous force and hydraulic impact.

The effect of operating the suction boxes was examined for the resulting wear of the wire. More copper was lost from the body of the wire than from the knuckles. The rate of loss from knuckles was greater by the presence of grit in the stock.

The wire tension varies around the wire run, for each revolution the tension increases from its minimum after forward drive roll to its maximum before the couch roll. This tension was investigated mathematically by Loyall which is given as under at different points.

Couch	24467.00	Kgs/m^2
Wire Roll	42.21	Kgs/m^2
Breast Roll	224.90	Kgs/m^2
Table Roll	14.10	Kgs/m^2
Apron drag	513.10	Kgs/m^2
Rotabelt unit of three boxes	675.01	Kgs/m^2

Schuahma presents an equation from which wire tension and power can be calculated for the installation of additional drives which enable a smaller angle of contact to be maintained at the couch roll which will relieve the wire of some of the strain of driving the various parts of fourdrinier.

The various factors which effects the wire life generally are indicated below:

1. Pulp should be carefully cleaned with sand-tables, screens, strainers and centrifugal cleaners.
2. The lowest possible wire numbers (i.e. cross wires) should be used.
3. Nylon strengthened edges upto 35 mm wide prevent edge tears which must be repaired as quickly as possible if they do occur.
4. The wire run should be such that when it passes over the guide rolls, it is bent as little as possible.
5. The wire should be kept taut and care taken that the seam runs straight.
6. All rolls that are driven by the wire should have antifriction bearings.
7. All rolls must be perfectly cylindrical and have rigidity.

8. Any bulge that appear in the wire must be flattened out or it will wear through quickly.

9. Good wet-end drainage should be ensured by using the largest possible table rolls. (Water removal is directly proportional to the diameter of the roll).

10. Light weight, close-fitting plastic doctors should be used on wire rolls. If the water purification plant is available these doctors can be replaced by spray pipes at some positions.

11. The bars in the suction box should be 25-30 mm. wide and distance between them should not be more than 30-40 mm.

12. The suction box bars should be of smooth non-porous material, since grit may lodge in pores that are present.

13. The vacuum in the boxes should increase in a step-wise fashion from box to box, since this makes it possible to operate at a lower vacuum.

14. Suction boxes should be situated close to each other.

15. It is advantageous to have long suction part operating at a low vacuum and it is essential to have control over the vacuum in individual boxes.

16. Deckle straps should be replaced by spray pipes as far as possible.

17. The wire should be cleaned with orgânic solvent only. No acid should be used and if used it should be in a very dilute form.

18. Frequent checks should be made to ensure that the wire rolls are parallel to each other and wire table absolutely square and thoroughly aligned.

19. Suction box pump should be equipped with safety valves.

SYNTHETIC WIRES

With the advent of synthetic wires a lot has been written and said for the changes required on the wet-end of fourdriner. Among these are (a) complete foil table provides the best results (b) drive power will have to be boosted (c) hard surface required on suction boxes (d) a bowed roll needed to prevent the fabric from wrinkling (e) soft covered wire turning roll is required. Some of these may be required in certain cases but not always.

In a mill at Macmillon Bloedels near Pine Hills for installation of fabric wire the only addition to the wet end was a bowed roll, the various wire showers had to be relocated when the bowed roll was installed. There were hard covers on eight boxes, the first three table rolls were fully grooved, the next two were grooved towards the ends and the rest were plain. The bronze wire averaged six to eight days in comparison to that of fabric wire running nine to ten times longer on the same machine. As regards power boosting it was not so at Pine Hill, in fact the load decreased. This allowed them to put roughly twice as much vacuum on the flat boxes for the same power load as before. (In an attempt to operate with two polyethylene covered flat boxes against the earlier hard covered resulted in a significant load increase).

DRAINAGE CHARACTERISTICS

As regards drainage properties hardly any difference is found with synthetic fabric for the kraft stock while using monofabric. But in case of double layer fabric the drainage is quite fast as water can flow in more than one plane. With fine paper stock, the bronze wire drains some what faster, the monofabric has the tendency of higher sheet adhesion which can be critical on tissue and fluting media grade of paper but double layer fabric has less adhesion because there are no vertical openings in the surface.

STRETCH & TENSION

The average running tension for an average size machine is around 5-5.3 Kp/cm. The bronze wire will elongate 0.2 to 0.25% while double layer fabric will elongate around 0.5% and mono-fabric 0.8 to 1.0%. So generally not much change is required on the wet-end for stretching. However, for monofabric it can be possible by making them somewhat shorter than ordered length of bronze wire. The double layer fabric is as good as bronze wire in cross machine stability at higher tension. In case of monofabric the contraction is around 0.4% for one percent of elongation.

GUIDING

Guiding the plastic wire with a hand or auto guide has no problem. They respond faster than bronze wires, the fabric must be tight on guide roll and lap at least 25°. It is advisable to chromium plate the palm of guide to prevent cutting of fabric.

CLEANING

The direction of oscillating spray jet working at about 125 psi is impartant and should be 10–15° for good cleaning. Steam through a shower can also be used for cleaning the fabric wire. Hydrochloric Acid can be used for cleaning the wire. However, the use of Sulphuric Acid for cleaning should be avoided or in no case should be used at more than 20% concentration. Use of Caustic is dangerous and should be avoided as far as possible and in no case it should be used more than 10% conentration.

PATCHING AND SEWING

Generally there is no edge problem with fabric neither small holes are to be patched. Any holes caused by accident can be patched easily and quickly and generally patch does not mark the sheet; edges can be repaired by sewing.

OPERATING PROCEDURE

The sequence to start the bronze wire at low speed, put the furnish on the wire and then bring the machine into speed is reversed in case of fabric wires.

CONCLUSION

The bronze wires are permanently deformed even at moderate elongation. Ridges and dents are difficult to avoid at the time of installation or during the service time. These spots wear rapidly which reduces the service life of bronze wire.

For a bronze wire it is necessary that the thickness is kept minimum, in order to resist the fatigue. The fabric can however be made several milimeters thick even double layered. The fatigue resistance is as much as 100 times superior in case of fabric than the bronze wire, and even at higher elongation they deform a little. The fabric change is easier and requires less crew for its changing.

The higher life of fabric wire is because bronze wire wears out more quickly by the combined effect of corrosion and mechanical wear and in most cases removed prematurely because of local wear on spots or edge cracks. Synthetic wires are almost minimum to these problems and give much better life.

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