Paper Machine Wires

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SUMMARY

After detailing the functions of wire in paper making, details of the salient points to be considered in the manufacture of the wire are given. The material of construction, weaves and meshes used are described. The factors controlling wire life and various preventive measures are also discussed.

INTRODUCTION

Wire is an integral part of any paper making equipment which may range from fourdrinier wire, wires on cylinder vats, rotatory formers or combination with fourdrinier wire for duplex and other special types of paper, or such new processes like inverform, twinverform or vertiforma. The main purpose of the wire is not only the proper formation of the sheet but also to help in the maximum drainage of water without affecting the formation. The length of the wire or the drainage of the water should be such that the wet web is strong enough to withstand the stresses involved in transfering the wet web from the wire to the press section. These are the main aspects governing the general operation of any wire section. The wet strength of the web at the couch and the overall quality of the paper is affected in some degree by the compaction to which the web is subject on the wire. This is not only affected by the suction boxes and pressure and the vacuum at the couch but the most importance influence comes from the operation of the dandy. This brief introduction highlights the inter action occuring between the various factors which influences the operation of the wire part of the machine. They also serve to show the complexity and difficulty of assessing the function and performance of each section of the wire.

MATERIAL OF CONSTRUCTION

The wire is an endless belt made of wire cloth woven from brass, bronze stainless steel and synthetic wire with mesh sizes chosen to fit the particular needs of the paper machine depending upon the stock furnish and the end product.

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The metal alloys used are usually phosphor bronze in the warp and brass in the weft. Some wires are all phosphorous bronze because phosphor bronze has a high mechanical strength and could resist resistance to abrasion and free from corrosion with normal paper making liquors. The phosphor bronze wire is more ductile than the brass. Brass and phosphor bronze wires could not be used on fast running machines and they have a relatively short life. These wires are heavy and are easily damaged.

Stainless steel wires have proved very promising and under certain conditions they appear to improve on the life of ordinary phosphor bronze wire. They have no operating problem connecting with them except rapid work hardning and fatigue. The drainage on stainless steel wire remains uniform due to lack of wear and corrosion and retain permeability better than the bronze. Stiffness in stainless steel wires explains their resistance to damage. Use of stainless steel wires reduces couched load by 40 percent. Because of corrosive resistance of stainless steel wires they are used when the furnish contains high amount of semi-chemical pulps.

Plated wires are also used. The plating is done with nickle, chromium or tin or coating with some varieties of plastics. Chromium coating is specially resistance to abrassive mechanical wear.

Other several types of wires have also been used with success. These include aluminium bronze, silicon bronze, nickle plated wires, tin plated wires, wires with plated warps and plastic coated wefts.

Synthetic polymer fabrics may be made from nylon, terrylene or polypropylene each alone or in combination. Each of these have its advantages and disadvantages. These plastic wires are used mostly on fast machines. They are light, easy to handle and resist most chemical attack. But plastic wire apart from the greater stretch (2–3% during the course of wire life) have higher risk of being punctured by hard objects, have lower strength and greater liability to wrinkle. Because the fabric can be flexed much more than a wire, it is simpler and quicker to put on the machine.

Recently wires have been introduced with stainless steel in the cross direction (for stiffness) and synthetic polyster in the machine direction for abrasive resistance and flexibility. These are called combined wires.

The basic characteristics of paper machine wires are as under:–

(i) Its construction should be such as to allow proper drainage of water from the wet web.

(ii) It should have sufficient tensile strength and flexibility so as to turn around rollers.

(iii) It should have transverse rigidity to resist crease formation and greater resistance to wear and tear.

WIRE WEAVES AND MESHES

Paper machine wires are woven from fine metal or synthetic plastic wire. There are different types of weaves used for paper making which are designed for a definite purpose. Some of the types of weavs are as under :—

Twisted Cable

The threads consist of more than one metal filament twisted together. If the threads of the warp only are cabled this is termad 'single twist' if both warp and weft are cabled, it is termed double twist.

Triple warp

Three fine warp wires are used in close, paralleled in each warp position instead of only one to produce fine meshed wires for tissue making.

Plain (square) weave

In this both warp and weft threads pass alternatively under and over each other.

Twill (long crimp) weave

The warp wires pass over one weft and under two : the weft wires pass over two warps and under one.

Chevron weave

A twill weave in which the weaving mechanism is changed to produce a change in diagonal direction of the twill knuckles every few inches to avoid grooving of the vacuum box tops.

Snake weave

The warps are made to take a sinuous path through the weave to avoid grooving of box tops.

Staggered weave

Each warp is so woven that when seamed it is joined to another warp several places away from its other own end.

Metal wire cloths woven in lengths are formed into continuous loop by sewing, soldering or welding the two ends together wire by wire. Welding is the most common method. Plain weave is stiffer than twill weave but with twill, the number of weft wires is greater than the equivalent plain weave, therefore there are more holes which are similar resulting in better retention of fines in the sheet. Twill weave is more common espacially with fine wires. Twill weave wires have greater tensile strength than plain wire for a given reduction in their thickness due to wear and this is of great importance to the wire life.

Size and mesh of wire to be used depends upon the factors such as stock furnished and the final product in relation with the speed of the machine. Direct influence of the wire on paper is mainly confined to the size of the mesh to give a certain drainage and formation of the web.

Printing papers are made on a fine wire cloth with a large carrying surface and reduced capacity for drainage which is also limited by the speed of the machine. Newsprint manufactured on high speed machine, on the other hand required such a wire cloth which has a large drainage capacity. Strong papers and boards manufactured with large dimension fibres require the use of wire cloth with an open mesh.

A fine mesh gives a greater fibre and loading retention and less wire mark but a slower drainage.

In speeding up the machine the type of wire mesh used becomes an important factor as increased speed cuts down the time of formation and time for water removal.

In practice for various grades of paper different mesh count and weaves are used which are detailed below:—

Types of the wire used for different grades of paper

Grade of paper	Mesh count	Type of weave
Pulp	24–30	Twisted cable
Straw Board	50–55	Twill
Kraft wrapper	55–60	,,
Bag	55–60	,,
News	60–65	,,
Bond	70–75	,,
Book	70–80	,,
Glassine	70	,,
Tissue	75–80	,,
Condenser	70–210	Triple warp
Cigarette	100	,,

MACHINE WIRE LENGTH

Many factors affect drainage rate through the wire. These are furnish freeness, temperature, mesh and weave of wire, spacing and size of table rolls.

An examination of several hundred wire frames (excluding those having a forward drive roll for suction pick up) shows that the ratio of making length to total wire length is fairly constant, the making length being on the average about 30 per cent of the total wire length. The wire length is expressed as

$$L = C\sqrt{P}$$

Where L = Wire length (ft.)

P = Output (lb/hr/in trim)

C = Constant depending on the type of paper.

Value of C can be obtained only from actual practice. P being the output of the machine reel plus broke or it is derived from data of substance and speed. A table of value of C derived from existing machines is appended. These factors vary from machine to machine and mill to mill, but in deriving values of C from a comparision of machines, making similar grades of paper, the variations have not appeared to be so great as to make the value of C unpracticable. The values obtained were found to be reasonably consistant. Indeed in some cases, notably newsprint the value of C was found to be fairly regular from machine to machine.

Values for constant C for various grades of papers

Printings :—	Rag and high quality furnish	14-15
	High quality esparto	14-15
	Esparto body papers for coating	13-14
	Wood-frees-medium quality	11-12
	Mechanical-mixed furnish	10-11
	Newsprint and wallpaper	9.5-10
Manilles —	Fourdrinier	12
	MG	10
Tissues: Fourdrinier	— free beaten	10
	— air mails, carbon, bible	13-17
	— cigarretes (flax and hemp)	20-23
Lick-up MG—	Facials and wedding	7.5
Krafts: Sacks	— Bleached and — unbleached	11-13
	— Lamination	14
	— Mg. bags and wrappings Bleached and unbleached	11
Sulphites:	MG wrapping and bags	11
Straw papers:		13-14
	Corrugating	12-13
	Imitation (container waste etc.)	10-11
Greaseproof and glassine:		20-23

WIRE LIFE

Improper installation, faulty operation and mechanical damage are some of the factors which shortened wire life and increased cost. The other common causes of wire failure are abrasion, corrosion and metal fatigue in addition to normal wire wear. In many cases the failure may be caused due to a combination of these.

Although steady wear is the most common cause of wire failure, there are of course vulnerable accidental damage especially when being put on the machine, a small hard particle passing between the wire and a roll creates a pinhole which wears faster than surrounding portions of wire especially when facing inwards, so that sooner or later a burst occurs.

A large number of wires are removed because of damage rather than wear. There are considerable incidence of pinholes due to lumps of stock or foreign material being pressed into the wire.

TENSION

One of the most important factor in wire life is the tension at which a wire is operated. Tension on a wire is not the same at all points. It is greatest between the last suction box and the couch roll because of the accumulated braking loads of suction box friction, breast roll and table roll friction and stock load friction. Wire tension is least between the last supporting roll and the breast roll. The running tension of a wire should be equal to that tension which will prevent wire slippage on the couch roll to obtain the best results. Wire should be operated at the proper tension to overcome slippage on the couch roll and this tension must be maintained constantly throughout the life of the wire. If the wire is too tight it may stretch beyond the elastic limit, if it is too loose it will slip and wear. Proper tension is essential for high wire life.

Wire could be used on a paper machine until the knuckles are worn down to half the original warp wire thickness. At this stage it becomes unsafe to run a wire because the maximum tension between the couch and flat boxes are liable to lead to wire failure.

ABRASION

During the life of wire the inside knuckles are worn and the thickness of the wire diminishes. Most wear occurs at the suction boxes. The rate of wear of wire can be expected to increase with the vacuum applied. The quality of abrasive material in the stock, especially loading and grit coming from the grinding stones used in ground wood pulp, also effects the rate of wear. At least for loading, the abrasive effect depends mainly on particle size. For example a common filler clay may posses some abrasive characteristics that will cause the wire failure. The use of talc for opacity or for any of the reason may sharply increase the abrasion potential in the mill system. If abrasion is from extraneous substances such as pitch, asphalt etc. the additive selected for wire life extensions should posses good cleaning power, to minimise deposit adherence. Adequate showers will help to keep the wire clean.

CORROSION

Corrosion of wire presents a more serious problem than either wear or damage due to other causes. The factors that effect the corrosion of wires in paper making are (i) acidity (ii) temperature (iii) air saturation.

The different forms of corrosion are, direct chemical action, pitting or galvanic (2—metal cell) action, dezincification and corrosion cracking.

Direct chemical action occurs when acids combine with the metal to form non-metalic salts. Air will greatly accelerate the action.

Galvanic action occurs when two dissimilar metals are immersed in an electrolyte salt water is a good electrolyte so that we can have corrosion by galvanic action where it is present. Galvanic action is increased by temperature rise or air agitation. In many cylinder mills, operation with alkali solutions have wire failure due to galvanic action.

Dezincification occurs in fourdrinier wires due to the use of copper zinc alloys in warp or weft wires.

The last form of corrosion is the corrosion cracking. Corrosion of any form attacks first the surface of the metal and the action procedes more rapidly due to the development of cracks which cause a further penetration of the corrosion and then failure of wires.

The relative role of wear and corrosion vary from machine to machine. It is found that corrosion is responsible for removing more copper from the wire then wear. If corrosion is a primary cause of the wire failure an additive with good corrosion inhibitory properties may be effectively applied. The inhibitors will lay down a tenacious protective film. It was found that fourdrinier wire could lose as much as 20% of their strength through corrosion during their normal life.

CLEANING OF WIRE

It is most important to keep the wire scrupulously clean bath to prevent the mesh gradually becoming clogged and to reduce the possibility of damage.

CLEANING SOLVENTS FOR METAL WIRES

Strong hydrochloric acid, sulphuric acid and caustic soda are used to remove obstinate material but they attack the metal itself so these should be avoided if possible. Dilute solutions, like 10% acids or 7% caustic soda should be used. Prepared cleaning solutions are also supplied by wire makers and such solutions should be prefered.

Organic solvents such as xylene, carbon tetrachloride, trichlorethylene, acetone, petrol and paraffin (kerosene) may be used to remove pitch and similar substances.

Keeping the above precaustions in mind the wire life can be increased to a great extend.

REFERENCE

1. Suttle, V. R., Paper Technology Vol. 2 No. 4. T 39—T 41, T 149, (1961).