Synthetic Forming Fabric Design and its Interaction with the Process of Sheet Formation

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SUMMARY

The use of synthetic forming fabrics for paper making has resulted in many improvements in the forming process. Better sheet formation is achieved as compared to metal wire due to finer mesh and improved drainage characteristics of the synthetic forming fabrics. Better machine runnability has resulted and the machine clothing costs have reduced due to longer fabric life. While opting for synthetic forming fabrics one has to take into account the factor of fabric stability and higher power consumption as compared to metal wires. Various designs and weave patterns are available in forming fabrics which give better permeability, drainage characteristics and dimensional stability. The interaction between the initial fibres and the fabric topography play an important role in deciding the form of the sheet thus produced. Fractional closed area, internal void volume fabric weave and topography will decide how the fabric will behave as far as drainage retention, formation and wire mark are concenred.

INTRODUCTION

There has been a shif towatrds the use of synthetic forming fabrics for sheet formation in the last decade. The reason for this shift was the development of Twin wire forming Technology and the need for better machine economics on the Fordrinier and improved sheet formation. Increase in machine speeds for all varieties of paper has also contributed to this shift.

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Benefits imparted by synthetic forming fabrics are two fold—

1. Sheet Formation:–Improved drainage over that obtained with a Bronze wire allows for more dilution/refining of the stock which will result in better formation. Increased fines retention and reduced wire mark are also seen.

2. Machine economics:–Major economic improvements can be achieved due to following reasons: –longer fabric life (at least 4 times that of Bronze wire)

-fewer clothing changes.
-faster clothing changes.
-cleaner running of the fabric as pitch, tar, latex and other contaminants do not adhere to it. Increased retention of fines. Disadvantages of the Synthetic forming fabrics are-

1. Fabric Stability-Synthetic forming fabrics are extremely flexible and hence the need for very accurate alignment of the machine components. One or two spreader rolls are also required to avoid wrinkling and assure good guiding on Fordrinier.
2. Power consumption-Synthetic forming fabrics required higher drive power than Bronze wires due to higher drag encountered at the Table rolls, suction boxes etc. The reduction in drag is achieved by use of hydro-foils and grooved table rolls and reduced vacuum levels at the suction boxes. Suction box tops are also made of hard-cota instead of polyethyline to reduce the drag.
3. Corrosion of couch roll due to sulphur compounds which was hither to avoided by Bronze wire which acted as anode, should be avoided by better cleaning when using the synthetic fabrics.

On a twin wire former, the forming media has to withstand lot of bending stress and work under relatively unchanged tension at all points on the loop. Metallic wires are not able to cope with these demands made on them and hence most of the twin wire installations use only synthetic forming fabrics.

TYPES OF FORMING FABRICS

Forming fabrics are available in three types

-Endless woven multifilament fabrics
-Endless woven monofilament fabrics
-Joined monofilament single or double layer fabrics.

Fabrics that are woven endless are typical in that the machine direction yarn is virtually uncrimped and the cross machine direction yarn received most of the wear. Joined fabrics must have crimp in the machine direction yarn for the joint to hold. This crimped yarn will stretch under tension unless the CMD yarns are closely packed. Close packing of C M D yarns will mean less open area. Endless fabrics are more stable and give very long life. Among multi, monofilaments, monofilament fabrics are the most stable ones.

The Multifilament fabrics, MD yarns are normally Dacron and CMD yarns are Nylon. These fabrics are resin treated after being woven to develope dimensional stability and abrasion resistance.

Monofilament fabrics are mostly made of polyester material. Polyester is chosen as raw material because it is wear resistant, resilient, fatigue proof and dimensionally stable. It is unaffected by water and is highly inert to chemicals ordinarily used on paper machine wet-ends.

Most widely used synthetic forming fabrics are made of polyester monofilaments. Several weave patterns are available. These include—

-2 shed (plain weave)	
-3 shed (semitwill)	1x2
-4 shed Twill	1x3 (diagonal mark)
full twill	2x2
broken satin	1x3 (diagonal mark is broken up)
alternating shute	1x3
-5 shed	
- double layered (two layers of CMD strands)	

These modifications in fabric design have been tried by the fabric manufacturers in order to improve permeability, drainage characteristics and achieve better dimensional stability. Most common design today is the 4-shed type. The advent of double layeared fabrics has imparted excellent dynamic stability in the cross machine direction.

FABRIC TOPOGRAPHY

According to Dr. Kufferath (1), three datas are sufficient for the general description of all forming fabric styles. These are :

1. The liquid touched wet surface.
2. Volume of the wire body.
3. Void volume.

The single layer fabrics could be described by percent open area in order to determine their effect on drainage rate, retention etc. But with the double layer fabrics which have open area tending to nearly zero percent the concept of void volume has to be considered. More open the fabric, faster the drainage rates it will allow.

In order to get a maximum drainage capacity fabric should be designed with a minimum of hydraulic drag which demands fabric thickness as small as possible, void volume as large as possible and internal wet surface as large as possible. An increase in the internal volume will mean for the fabric construction, a reduction of mass concentration in the fabric body. This decrease in mass concentration can be seen in the development of the new fabric styles, namely 3-shed, 4-shed and 5-shed.

WEB FORMATION

The process of web formation involves the interaction between two oriented systems i.e. the oriented fibres from the Head Box due to either 'rush" or 'drag' and the oriented knuckles in the paper making side of the forming fabric. The initial fibres settle down only on those parts of the mesh strands which arise to the actual fabric top level. The fibre-strand network thus formed will be the base for further web build up.

It is desirable to run the fabric with CMD knuckles on the paper side which allows for more bridges for the fibre hold up. Sheet release properties of such fabrics are also much better as compared to the fabrics run with MD knuckles on the paper side. In the latter case the fibres settle in between the MD knuckles. This results in reduced drainage and poor sheet release.

But from the fabric wear point of view, it is necessary to run the fabric with MD knuckles on the paper side. The CMD knuckles are thus subjected to wear and the load bearing warp yarns face minimum to nil abrasion.

The fabric topography plays an important part in web formation. According to Fleischer etal (2) permeability is determined by the forming media during the early stages of formation. It is not solely determined by the number and relative sizes of the fabric interstices. But is also dependent upon the manner in which the first few fibres are deposited.

This is illustrated by Table-I which shows permeability on two sides of the same fabric. The same mat-fabric permeability results in different drainage rates on either side of the same forming fabric. The fabric geometry influences the drainage rate during entire shreet formation.

TABLE–I

Effect of fabric topography on mat permeability. Fabric: Desgin 24 FORMEX*

Mat wt. g/m^2	Permeability Cm/sec/Cm H_2O Top side	Under side
10	0.84	0.98
20	0.25	0.30
30	0.09	0.12
40	0.04	0.06

*According to Fleischer etal.

type of pulp and form of the fibres. Table-II gives the fabric data and Table-III drainage time for these fabrics on either sides.

Formation and wire mark on the sheet are also dependent upon the fabric design. The topographic surface marks are controlled by the mesh count. According to Ionides and Douglas (4) both formation and wire marks improve as the fractional closed area increases. Rapid drainage gives poor wire mark. Closing the fabric surface results in slower drainage as also better fines retention and hence better formation. Sheets formed with long knuckles in

TABLE–II

FABRIC DATA

Fabric No.	2	19A	37	40
Type	Duotex-204	4-shed-B	Duotex-207B	4-shed-B
Warp count/cm.	60	31	64.4	28
Weft count/cm.	43	23	50	20
Warp diameter	0.17	0.17	0.17	0.24
Weft diameter	0.17/0.20	0.24	0.20	0.31
Fabric thickness	0.67	0.45	0.58	0.52
Fractional closed area	0.81	0.29	1.0	0.42
Void volume $\frac{mm^3}{cm^2}$	41.8	27.2	27.8	23.8

TABLE–III

DRAINAGE TIME

PULP	Substance	Fabric 2		Fabric 19A		Fabric 37		Fabric 40	
		Top	Under	Top	Under	Top	Under	Top	Under
	g.s.m.	sec.	sec.	sec.	sec.	sec.	sec.	sec.	sec.
Bamboo	0.54	2.4	1.9	1.7	1.8	1.8	2.0	1.8	1.8
(27^0 SR)	0.90	3.3	3.0	2.5	2.5	3.0	3.0	2.4	2.4
	1.08	4.4	–	4.0	–	4.8	–	3.9	–
	0.54	3.3	2.9	2.6	2.8	3.2	2.8	3.0	2.2
Eucalyptus	0.90	4.6	3.9	4.0	4.2	4.3	4.2	4.0	3.3
(32^{0}SR)	1.08	7.0	–	5.8	–	6.4	–	5.8	–
	0.54	2.7	2.2	2.0	2.4	2.5	2.6	2.0	1.9
Spruce	0.90	3.8	3.4	3.3	3.4	3.5	3.2	3.2	3.1
(28^0 SR)	1.08	5.8	–	5.2	–	5.4	–	4.6	–

Experiments (3) carried out on laboratory sheet former show that double layer fabrics show higher drainage time as compared to 4-shed fabrics. The reason for this is that double layer fabrics have low fabric resistance due to high void volume but they retain maximum fines which will cause the flow resistance.

Drainage rate decreases as the sheet weight increases. This decrease is also dependent on the

MD on paper side give worse wire mark as compared to sheet formed with long knuckles in CMD on paper side.

Filler and fines retention is improved by having a high mesh count which reducing the size of drainage opening and moderate drainage rate whereby initial retention losses aswell as latter washout losses can be minimised.

CONCLUSION

SYNTHETIC FORMING FABRICS AT WEST COAST PAPER MILLS, DANDELI

West Coast Paper Mills has been the first company in India to use forming fabrics on twin wire papriformer.

The forming media on a twin wire machine has to withstand a lot of bending stresses in the loop. Iintially company tried the indigenous phosphur bronze wres but they gave a life of hardly 1–2 days due to creasing. Synthetic fabrics also had the creasing problem due to mis-alignment of the papriformer rolls but these could be reused after ironing out the creases. The fabrics now give an average life of more than sixty days.

The company has been trying various weave patterns such as 78x50, 70x50, 76x54, 82x56, 81x58 and designs such as 4-shed twill, broken satin and 5-shed. These trials were made in order to arrive at the most suitable combination of fabric design and weave for our furnish which comprise of 60% Bamboo and 40% Mixed Hard woods. Finer mesh fabric on the bottom position gives high fines retention in the sheet.

The mill has experienced also the problem of rippling on the fabric in CMD specially in the bottom position. It was suggested by one fabric supplier that inversion of their fabric will reduce the drainage resistance by about 5% due to sheet being formed on the CMD knuckles and thus avoid the rippling of the fabric. This was tried out but without success. Then we tried a 5-shed fabric in this position which has better dimensional stability and thus solved the rippling problem. Our contention is that instead of reducing the drainage resistance by fabric inversion as was suggested above, improving the dimensional stability of the fabric by replacing some of the CMD yarns by thicker yarns in a 4-shed design will reduce the rippling of the fabric. This is preferred over the 5-shed design which has shown no rippling for the reason that sheet release and wire mark are better in the 4-shed design.

West Coast Paper mills recently tried on experimental basis an indigenous forming fabric in 4-shed satin weave, 81 x 56 mesh in the Papriformer top position. This fabric had the MD stability problem for which the same was removed after only 6 days of life.

REFERENCES

1. Kufferath, W., To compare wires by drainage, CPPA Meeting, 1976.
2. Fleischer, Thomas B., Wilson Robert G. and Eames John D. The permeability of the forming fabric/fibre system in contact with dewatering elements on the paper machine, CPPA Meetng, 1976.
3. Gune, N.V., Effect of forming fabric design on web formation – A laboratory study, Thesis, NTH, Norway, 1978.
4. Ionides, G.N. and Donglas, E.C., Effect of Plastic wires, on newsprint quality and printability, TAPPI Vol. 60 No. 1, 1977.