A scientific approach towards optimisation of wet end configuration

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SUMMARY

Today's Paper Maker faces increased demands for higher production levels, superior product quality and lower costs. In the present article, we report some of our findings on the systematic study conducted on forming zone preformance in many paper mills in India to achieve the above mentioned stringent demands.

The study highlight's two latest techniques, (a) Wet End Profiling via ULTRASIONIC DRAINAGE METER and (b) Study of Turbulence in forming zone by STROBOSCOPE. The interpretation of results obtained by these techniques and the results of suitable corrective actions taken therefrom, are discussed in some detail with appropriate case studies.

INTRODUCTION

Today, the ever increasing cost of inputs has necessitated a constant look for avenues which can increase productivity and quality and reduce costs.

One such avenue where many of these demands can be met by a Paper Maker is by "*Optimisation of Forming Zone*". Experience has shown, that to a great extent, in many cases, Forming Zone optimisation can be done without incurring heavy expenditure.

An attempt has been made by us through the use of two process control equipments namely (a) Drainage Meter and (b) Stroboscope, to study the dynamic characteristics of process variables of forming section in order to give the paper maker a qualitative and quantative understanding of the forming zone.

The optimisation of Forming Zone refers to :

(a) Increased first pass retention
(b) Increased water removal
(c) Improved sheet formation and
(d) Improved wire life.

Until recently, the above said objectives were achieved mainly through:

(i) Past experience of the Paper Maker.
(ii) Hit and Trial methods.
(iii) Blow-off sampling.

Limitations of the above techniques were:

(a) There is no quantitative measurement, hence, optimisation was not always feasible.
(b) Loss of productivity.
(c) Low success rate.
(d) Delayed decision making due to non availability of immediate results.

In the present circumstances, it is always necessary that a Paper Maker not only gets an instant indication of what is happening on the wire table but can also measure and record the findings. This demand motivated us to systematicaly study the dynamic characteristics of various critical process parameters of forming

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zone with the help of two latest instruments namely Drainage Meter and Stroboscope.

The use of Ultrasonic Drainage Meter & Stroboscope helps the Paper Maker to –

(i) Measure and record existing/changed wire table activity levels.

(ii) Identify key problem areas for corrective action.

(iii) Virtually avoid any loss of productive time.

ULTRASONIC DRAINAGE METER

Description of equipment:

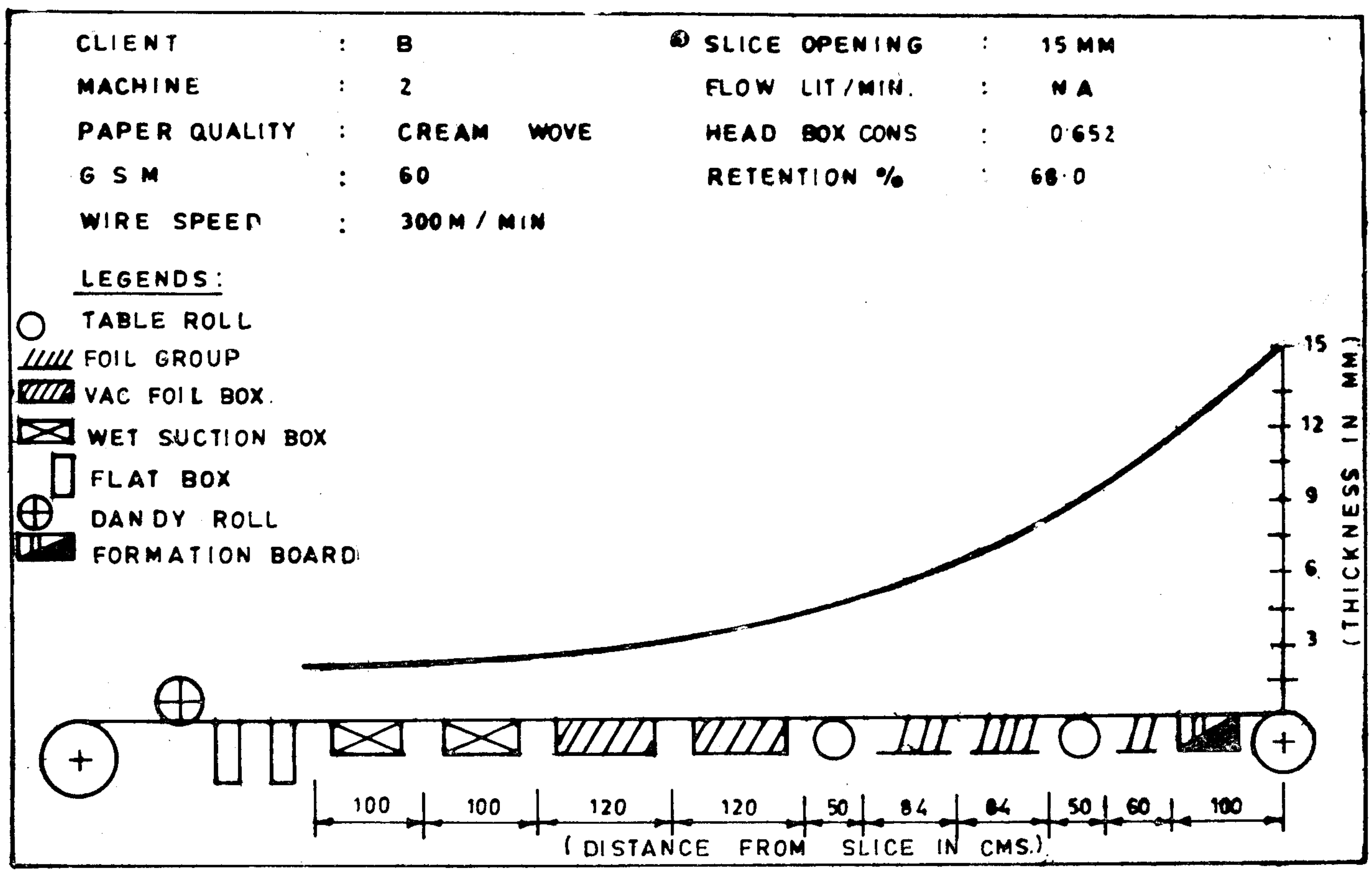
The instruments of a specially designed transducer activated by an electrical source. This transducer converts electrical ultrasound pulses of known frequency. These pulse are directed through pulp water suspension on the forming fabric. When pulses meet the air/stock interface a proportion is reflected back to transducer and the design of circuits allows the time of flight to be measured, i.e. the time between the signal being transmitted and received back. This time period is converted in to thickness measurement and is shown on a L.E.D. display to an accuaracy of plus or minus 0.1 mm. This system when used on a moving stock suspension, indicates a maximum and minimum reading depending on the degree of turbulance on the surface of the stock, measuring peaks and valleys.

DRAINAGE ANALYSIS

PROCEDURE—

First a schematic diagram of the forming zone showing drainage elements up to flat box is drawn. An example of one such schematic diagram is shown in Fig 1. It is then necessary to mark a point one meter from the slice and the actual distances of other drainage elements from the slice. The foil angles and/or table roll diameter are noted. Also noted are basic wet end conditions like, GSM, slice opening. m/c speed etc. This is needed for comparing the results after changes or at a later date. Reading from the drainage meter are taken after every drainage element, up the dry line.

Figure—1



The analysis is started by putting the "probe" under the fabric approximately 2 feet inside the edge. The maximum and minimum values shown in the 'console' are noted. Similarly readings are noted at all the marked places. The mean of maximum and minimum readings are taken to plot the drainage curve. A standard drainage curve for a fourdrinier machine manufacturing writing and printing paper is shown in fig. 1. This curve is based on a hypothetic situation where all related variables are supposed to be set at an optimum level. It can be noted from the curve that there is no sharp reduction in thickness of pulp slurry, which means that drainage is gentle and gradual on the table. When such a curve is obtained then the retention % is expected to be higher alongwith a good sheet formation.

The advantages of carrying out this drainage analysis and the improvements that could be derived upon, based on such analysis, is explained through some case studies.

Case Study—A

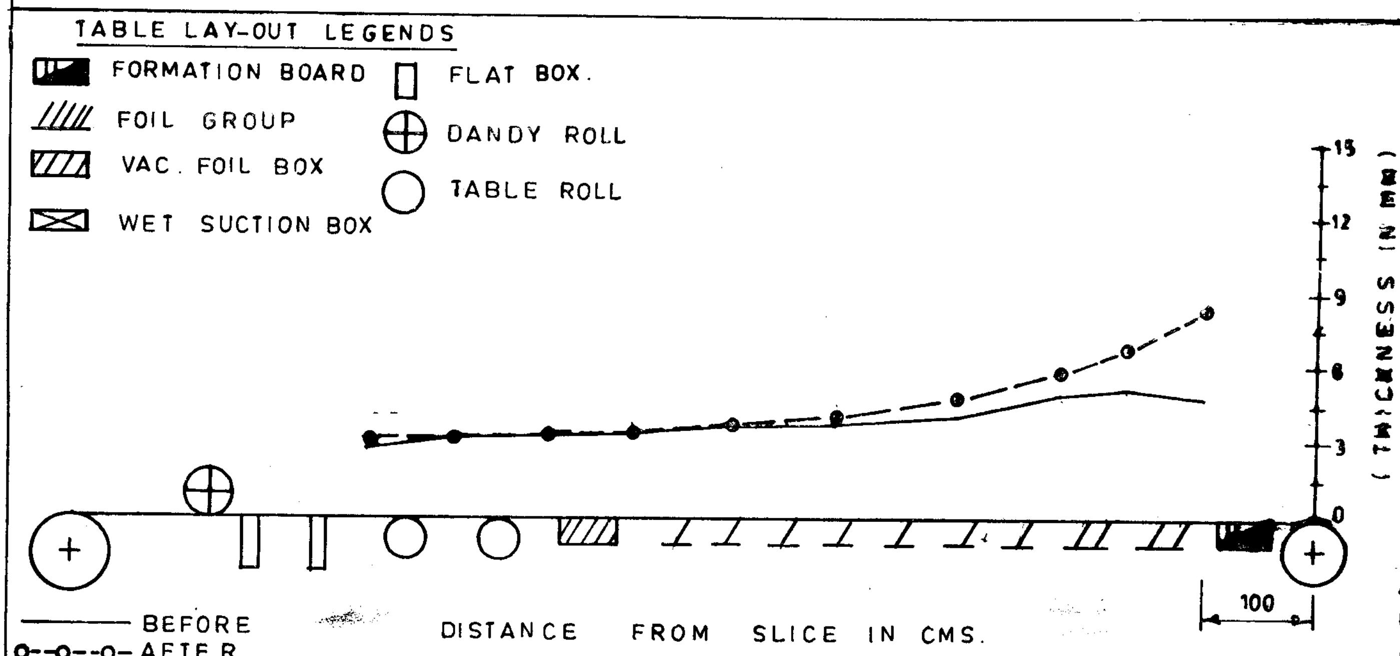
SUBJECT : Improvement in retention through Drainage Analysis.

PARTICULARS :

(1)	MACHINE TYPE	:	FOURDRINIER
(2)	GSM	:	37
(3)	QUALITY OF PAPER	:	WHITE POSTER
(4)	SPEED	:	180 M/MIN

Figure—2

CLIENT : C		SLICE OPENING : 10 MM.	
MACHINE : M G		HEAD BOX CONS. : 0·432	
WIRE SPEED M MIN : 180M /MIN		RETENTION % : 57/ 62	
QUALITY OF PAPER : M G POSTER		FLOW LIT /MIN : NA	
G S M : 27		DATE : 29.08. 91	
FABRIC : SINGLE LAYER		CONDUCTED BY. : SBH	



Preliminary Observation and Inference :—

In fig. (2), The curve (A) obtained during the initial study clearly showed that slurry thickness is less in the initial stages of the forming zone. There is no preciable gradient in the drainage curve indicating that a very rapid drainage is taking place within one meter distance from slice. This indicates that retention % is low, which incidently was also the problem faced by the client.

Corrective Action and Results :

To overcome this problem slice opening was increased from 10 mm to 13mm in steps of 0.5 mm. The drainage analysis was done for each change in various slice opening. The resulting drainage curve refering to a slice opening of 12mm is shown as (B) in fig. 2 which was found to be giving optimum results. From the curve it can be clearly seen that the change has resulted in an increase in the initial thickness of pulp slurry and the gradient of the drainage curve was close to the ideal curve. The retention percentage measured after the change showed an improvement from 57% to 62 %. This could be attributed to the fact that the drainage after the change was gradual across the length of the forming zone.

Case Study—B

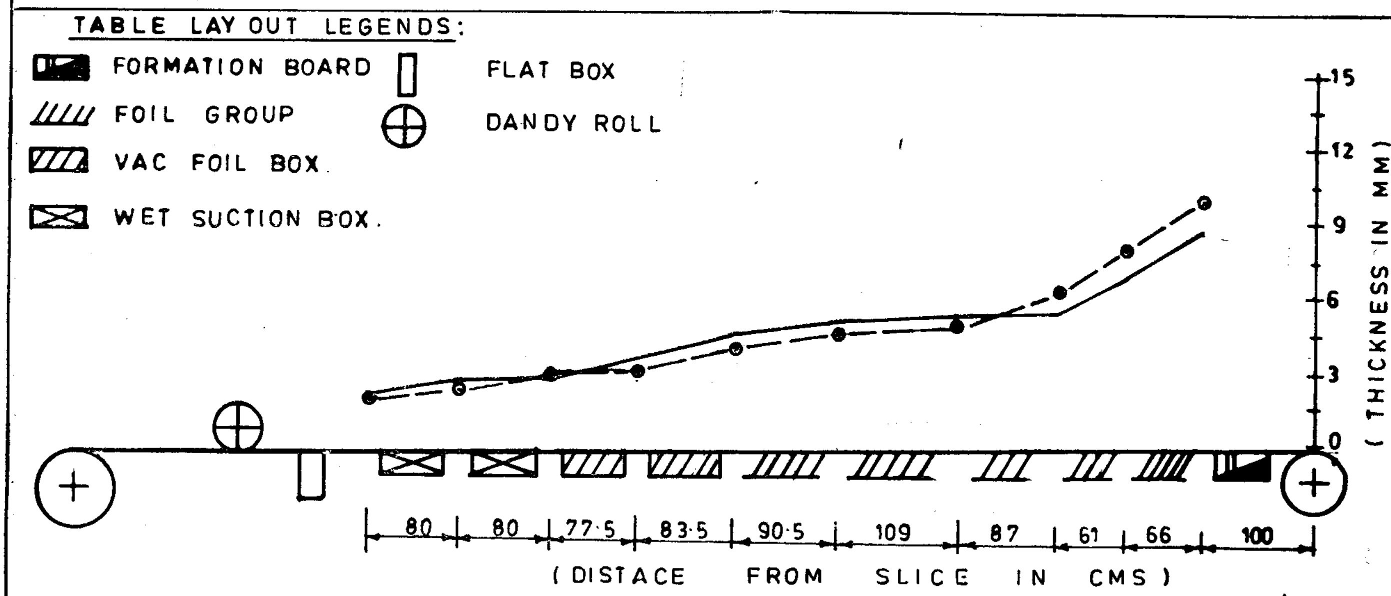
SUBJECT : Improvement In Formation Through Drainage Analysis :

PARTICULARS :

(1)	MACHINE TYPE	: FOURDRINIER
(2)	GSM	: 58
(3)	QUALITY OF PAPER	: S.S. MAPLITHO
(4)	SPEED	: 373 M/MIN

Figure—3

CLIENT	: D	SLICE OPENING	: 13·5 MM
MACHINE	: 3	HEAD BOX CONS	: 0·745
WIRE-SPEED M/MIN	: 350 M / MIN	RETENTION %	: N A
QUALITY OF PAPER	: MAPLITHO	FLOW LIT/MIN	: N A
G S M	: 58	DATE	: 17 09 91.
FABRIC	: DOUBLE LAYER	CONDUCTED BY	: SBH & MADH.



Preliminary Observation and Inference :

Here the paper maker was not satisfied with the retention on wire and also on the formation of paper obtained from the machine. In fig. (3) drainage curve A indicates that the thickness reduction as compared to slice opening at 1 m from the slice, is around 47%. This reduction is very high as compared to the normal reduction of 30–50%. This led to sheet sealing and low first pass retention and consequently resulting in poor sheet formation as well.

CORRECTIVE ACTION AND RESULTS :

To avoid sheet sealing corrective action was taken by reducing the slice opening from 17 to 15 mm in steps and also repositioning of forming board and lowering first foil box. The curve obtained after these changes is marked as 'B'. The results gave clearly the anticipated improvement in the end product. There was a reduction in drainage at the initial stages resulting in higher first pass retention and improved formation without disturbing the dry line. The first pass retention increased from 59.3% to 62.4%.

The improvement in the formation was done by subjective evaluation.

GENERAL OBSERVATIONS:

Based on our numerous studies coducted on various paper machines we could derive the following conclusions

(A) The drainage curve obtained depends upon many factors such as—

(i) Furnish used.
(ii) Refining of stock.
(iii) Temperature of stock.
(iv) Positioning of dewatering elements.
(v) Process conditions.
(vi) Forming Fabric design.

The interpretation/recommendations for changes are to be made on the basis of a proper knowledge of the abave mentioned variables In absence of the any of above information, interpretation of drainage curve and recommendations there of may not lead to the best possible solution.

STROSBOSCOPIC ANALYSIS:

Increasing demand for printers on superior sheet uniformity has put pressure on paper makers to produce quality paper having uniform formation. Good formation of paper depends upon many factors which are not visible when the machine is shut, but cause disturbances while the machine is running. Till recently, paper makers achieved required results after a lot of bit a trials or changing one thing or the other at a time. This resulted in loss of time, or production of substandard paper quality, which in present circumstances is unaffordable. A well known and proven technique is the study of sheet dynamics, which greatly influences the formation, through a STROBOSCOPE.

DESCRIPTION OF THE EQUIPMENT :

The principle of operation of a Strobostope is that the objects in rapid motion appear to be apparently static when illuminated by periodic flashes of intense light. The object will appear frózen only when the frequency of the flashing light is in the same multiple of the speed of the object.

A STROSBOSCOPE has to parts : a high power single & mnltiple flash generator and a flash tube. The flash tube is used to illuminate the object and frequency is matched with the help of a generator, with the result that the object appears to be forzen. With the STROBOSCOPE it is practically possible to view critical para meters and also take photographs for future reference.

The STROSBOSCOPE (specially designed for observing the paper making process) is an important tool. Which when used in conjunction with the drainage meter, can help analyse and understand important problem areas. With the help of this instrument turbulence in the forming zone can be seen as the forming process is optically frozen during operation. By conducting a series of surveys, ideal turbulence curves are drawn and recommendations made to achieve them. Still photographs and video recording is also possible to help in better problem understanding. No guess work is involved and there is no production loss as there is no contact with the object under study.

Our Stroboscopic studies conducted on various machines showed that stock turbulence of any appreciable level exists only on paper machine running at speed of above 400 M/Min. On paper machines running at slower speeds, no visual stock turbulence was observed.

Through Stroboscopic analysis it is also possible to evaluate the following wet-end phenomenons.

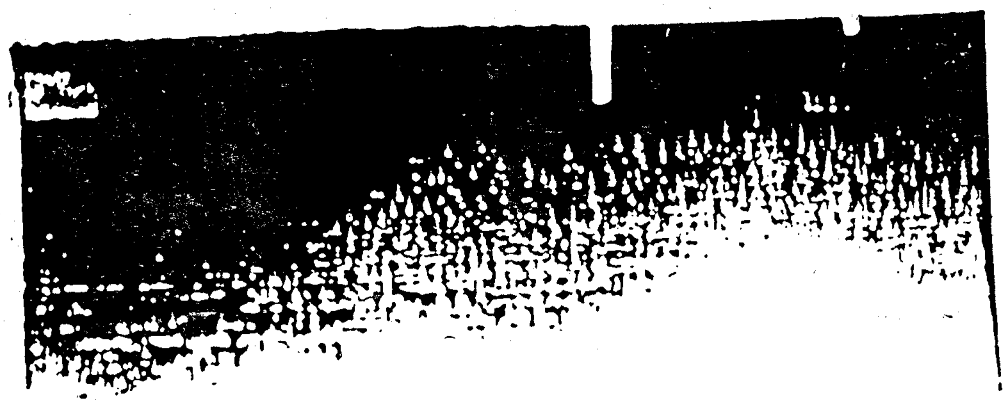
i) flow of stock from the slice and its impingement on wire.
ii) operation of high pressure shower.
iii) slippage between fabric & drive roll.
iv) observation of effectiveness of different drainage elements. Interesting results obtained by studying the above phenomena under dynamic conditions using STROBOSCOPE are given below.

Case Study - C (Turbulence)

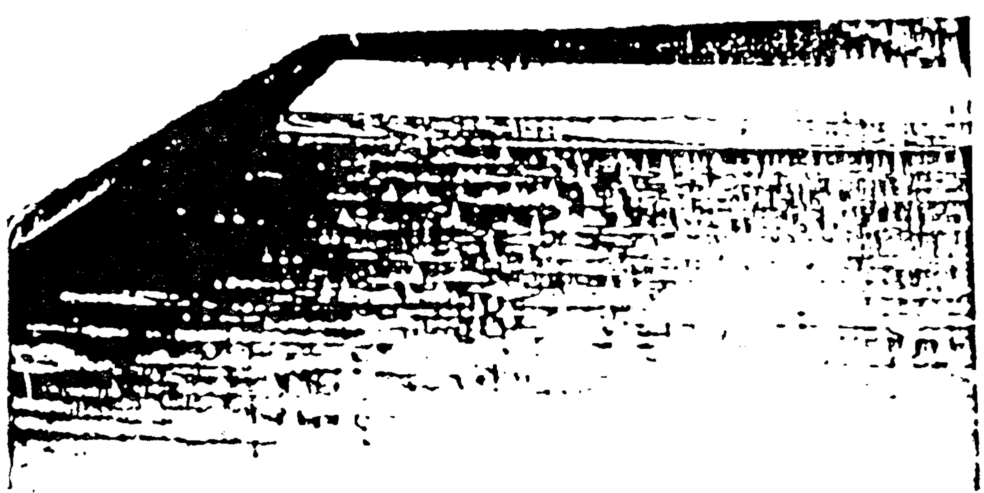
Photographs of the forming zone were taken on a machine running at 500 m/min making 48 gsm Cream Wove paper. Photograph No. 1 shows how the turbulence looked when viewed as such. Photograph No. 2 is as the turbulence looked when the forming zone was illuminated with the STROBOSCOPE. With the help of such photographs the problem area was identified and after initiating necessary actions, formation showed significant improvement.

Case Study— D (Disturbance Due to Table Roll)

During Stroboscopic survey on a machine making Maplitho paper at 350 m/min, disturbances created by the table roll placed down stream were watched. Replacement of this roll to an upstream position was done and this improved the formation considerably.



Photograph No. 1



Photograph No. 2

Case Study — E (Dandy)

In another survey conducted on a fourdrinier machine running at 300 m/min making Cream Wove paper, the sheet was breaking frequently. On our suspision, the dandy seam was inspected under strob light. The dandy seam was found to have opened by I/2 cm. causing an inpression on the paper, thereby causing continous breaks after the couch.

Case Study — G (Slippage)

During analysis of used fabrics pertaining to one particular case it was found that practically all the fabrics was failing prematurely. Due to severe abrasion on the machine side of the fabric a systematic study was conducted on the paper machine. During study, the machine was running at 300 m/min. The drive roll and the couch roll were lighted with the Stroboscope and the concened Paper Maker was shown the slippage of the fabric at couch. Correction of this minor slippage at cocuh resulted in increased fabric life.

Case Study - H (H.P. Shower)

On a machine running at 450 m/min making Cream wove, it was found that the fabric was getting dirty very frequently, even after continuous use of H.P. Oscillating shower, resulting in frequent chemical cleaning. When the shower portion was optically freezed with the help of Stroboscope it was found that the shower distance and impingment angle were not properly set. On correcting this, the chemical cleaning frequency of the fabric reduced considerably and fabric life also increased.

Conclusions

We end survey by Ultrasonic Drainage Meter coupled with stroboscopic study helps identify and measure the problem areas in the wet end. Respective preventive and corrective steps result in increased productivity, better and consistent quality of paper.

The advent of forming fabrics has created new opportunities for paper makers in terms of drainage and formation possibilies. Therefore selection of a proper fabric design can immensely help in efforts to optimise the wet end.

ACKNOWLEDGEMENT

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