Right Selection of Clothing Design Key Factor for Machine Performance

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ABSTRACT

In the present recession affected scenario, Control on manufacturing costs has become the key factor for survival of the paper industry. Being a high energy consuming sector, energy efficiency is key to control manufacturing cost. Energy cost is in turn a function of refining, vacuum and drying; with the cost of drying costing the highest among these sections. An important function of the paper making process is to improve the web dryness at the entry to the dryer section; where the performance of machine clothing is becoming critical to cost & quality. This paper present showcases the technological comparison of different designs of wires and felts which will lead to energy efficiency and improved machine runnability at competitive quality, cost.

Introduction:

Clothing plays a significant role in the forming, pressing and drying stages of paper production. Since clothing products are consistently in contact with the paper surface, they also have a significant role on the quality of paper/Board produced.

Modern forming fabric designs helps in

1. Reducing energy consumption by increasing sheet consistency entering the press section,
2. Reducing drive loads
3. More life leading to improved uptime of machine by reduction of number of wire changes.
4. Fiber, filler and fines retention to improve overall chemicals retention, improve system cleanliness and reduce load on effluent.

Modern Press felt designs helps in

1. Reducing rewetting and increasing sheet dryness entering the dryers.
2. Better moisture profile to reduce No. of breaks at Wet End
3. Reduction of two sidedness of high speed paper machines of trinip configuration.

Modern dryer fabric designs helps in

1. Energy saving by improving sheet-to-dryer contact,
2. Improving air movement in dryer pockets, and providing resistance to fabric filling.

Some progressive papermakers have achieved significant improvements in machine speeds and operating efficiencies and reductions in energy consumption by installing modern clothing designs. Papermakers that are not taking advantage of these developments are missing some excellent opportunities of cost benefits. This is case Study on use of modern clothing designs to improve product quality and reduce energy consumption at ITC PSPD.

Experience

Even though the Fabric suppliers are giving the best suitable design as per the specification of the particular machine, it is the paper makers responsibility to analyze the performance of fabrics in co-ordination with fabric suppliers to customize the fabric design, which view to improve product quality at optimum energy consumption.

Case Study 1: Forming Fabric design optimization

Logical Steps:

Step 1: Fish Bone analysis to find out all the possible Parameters that are influenced by Wire design.

Step 2: List out the most influencing parameters as per PUG matrix.

Step 3: Identify variables that are having impact on the selected parameters.

Step 4: Optimized and fixed all the parameters within limits to compare the relation with fabric Design & these Parameters.

Step 5: Identify the fabrics which has given the best results for the above parameters.

Step 6: Analysis of the best performing fabric for the further optimization.

Step 7: Discuss with the fabric supplier to provide the fabrics closer to be arrived design.

(Courtesy for Step 1 7, TPM techniques)

Sr no	Inputs	Parameter
1	Pulp	Pulp refining, head box consistency, Broke percentage, GSM , etc,
2	Chemicals	Filler loading, Delta Ash,Retension chemicals,% of different loading
3	Process parameters	Total head, jet angle,wire tension, Drainage profile,
4	Fabric / wire design	FSI,Void Volume,Caliper,Draiange Index,Water Permiablity,GSM

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First Fish bone Analysis was done to find out all the parameters that are influenced by wires (refer Annexure 1)

With the help of PUG matrix (refer Annexure 1), high influence parameter (listed below) were short listed for understanding the design features of wires .

- Formation Index
- Ash Retention
- Drive Power
- Dryness after fabric
- Productivity

CTQ for a typical Writing & Printing papers is Formation index which is a function of the process parameters. (Table on last page)

By fixing the first 3 of the 4 input within specific limit range (Shown in Annexure 2) optimum, the following comparison was made with respect fabric design

Comparison of above said parameters are as shown in the Graph

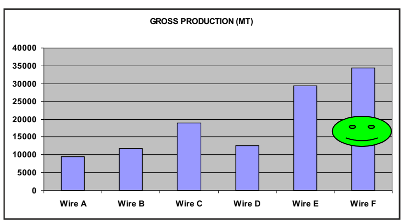


Fig 1 Production for different wire types

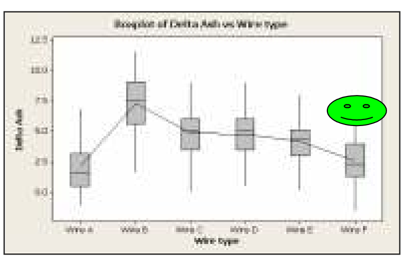


Fig 2 Ash retention for different wire types

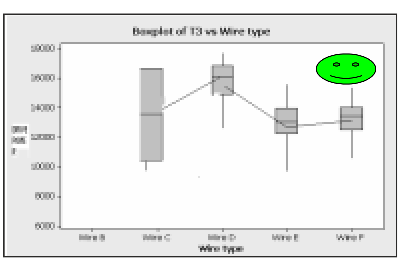


Fig 3 Power consumption Vs wire type

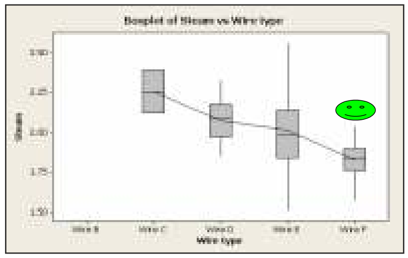


Fig 4 Steam consumption t/t of production Vs wire type

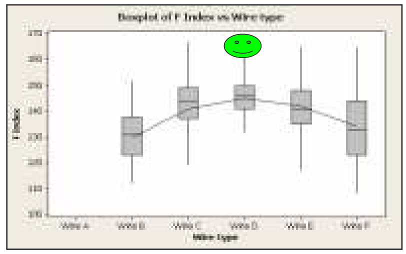


Fig 5 Formation index Vs Wire type

Observations

Better life was given by type Wire F
Target formation with consistency achieved with Wire D
Better steam efficiency achieved with Wire F
Lower power consumption achieved with Wire F
Better ash retention with Wire F
Design features of wire affecting were short listed

Correlation chart of different Wire properties Vs Machine & paper parameters

Parameter	Permeability	FSI	Caliper	Open area	S'Count
Formation	Yes	Yes	Yes	Yes	Yes
Life	Yes	-	Yes	-	Yes
Steam	-		Yes	-	Yes
Power	-	Yes	Yes	-	Yes
Ash	Yes	Yes	-	Yes	Yes

Properties of the BEST found Wires are given below

Wire Type	Layer	CFM	Caliper	FSI	DI	S'COUNT	GSM	Open area
Wire D	3	380	76	158	31	61	435	36
Wire F	3	400	80	181	36.6	71	440	29.00

Optimization OF Fabric features

Optimization for formation

1. Permeability Less than 400
2. FSI Less than 181
3. Drainage Index Less than 36.6
4. Open area More than 29

Optimization for wire life

1. Caliper - more than 76

Optimization for better steam efficiency

1. S Count Higher than 61
2. Drainage index more than 31

Optimization for lower power consumption

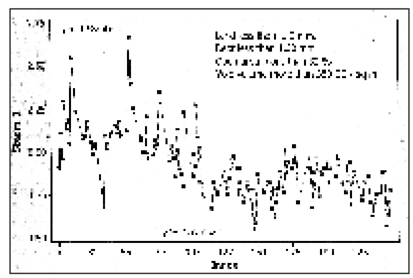
1. Variation of power between different types of wire are not significant

Optimization for Ash retention

1. FSI More than 158
2. Open area less than 29.0

Case study 2:

We have done comparison between two designs of sym belt with respect to steam consumption.



Case study 3: Press Felt design Optimization

After pulp & chemical cost the next critical cost element is steam consumption. Optimum parameters at press part were identified, analyzed & concluded using the following Logic sequence (methodology).

Logical Steps:

BASIS: Writing and printing, 60 GSM and below, keeping all parameters influencing parameters in the optimum range.

1. Box Plot for each Felt vacuums Vs steam consumption
2. Identifying the Optimum range of felt vacuum at which steam consumption is on target (Less than 1.8 T/T)
3. Correlate Optimum felt vacuum range with different felts mounted
4. Identifying Felts which have given desire vacuum for most of its Life.

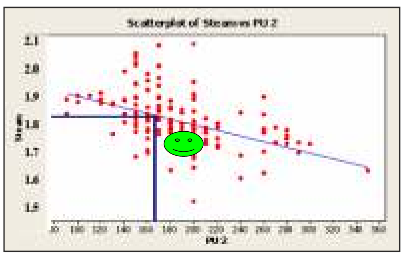


Fig 6 Steam consumption t/t of production Vs Pickup felt vacuum

Optimum vacuum 165 mmHg

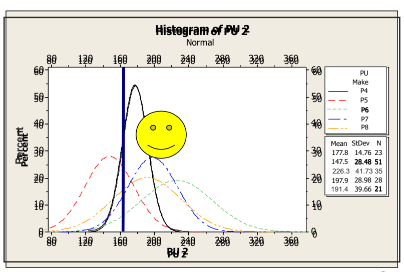


Fig 7 Frequency Plot - Type of Pick Up felt which has run at Optimum vacuum for longer life period.

Best felt P4

Pick Up felt Design parameters are as follows

Pick up Felt	GSM	Permeability	Caliper(mm)	BATT	Paper side dTex	BATT GSM
P3	1500	50	3	700	17/30/30	250/300/150
P4	1440	27	3	960	17/27/27	240/480/240
P5	1500	50	3	700	17/30/30	250/300/150
P6	1690	42	3.5	750	17/30/30	250/300/200
P7	1690	48	3.5	750	17/30/30	250/300/200
P8	1670	42	3.6	730	17/30/30	210/330/210

Optimum parameters FOR Pick up felt:

Permeability lower side </= 42

Higher BATT GSM >/= 750

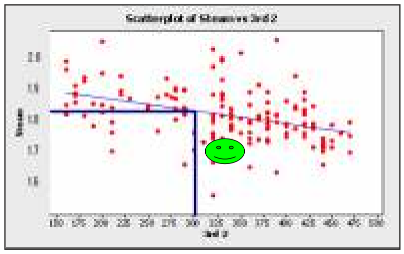


Fig 8 Steam consumption t/t of production Vs 3rd Felt vacuum

Optimum Vacuum 300 mmHg

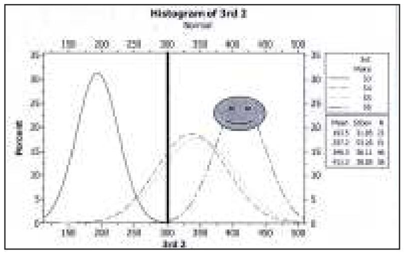


Fig 9 Frequency Plot - Type of felt which has run at Optimum vacuum for longer life period.

3rd press	GSM	Permeability	Caliper(mm)	BATT	Paper side dTex	BATT GSM
S3	1620	31.4	3.5	760	11/22/22.	
S4	1620	28	3.1	750	11/22/22.	250/375/125
S5	1600	25.6	3.3	742	6.7/11/22	212/318/212
S6	1710	18.3	3.1	870+100	11/22/22	

Best felt S4 and S5

Bottom felt	GSM	Permeability	Caliper(mm)	BATT	Paper side dTex	BATT GSM
B3	1200	52	2.6	625	22/22	500/125
B4	1200	52	2.6	625	22/22	500/125
B5	1300	34.3	2.8	640	22/22/22	210/220/210
B6	1300	34.3	2.8	640	22/22/22	210/220/210

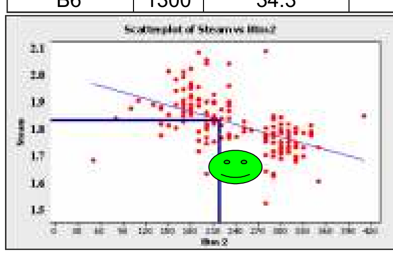


Fig 10 Steam consumption t/t of production Vs Bottom Felt vacuum

Optimum parameters for 3 rd Press felt:

Permeability < /= 31.4 Optimum

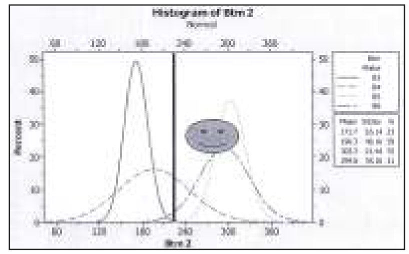


Fig 11 Frequency Plot - Type of felt which has run at Optimum vacuum for longer life period.

Permeability >/= 18.3

Optimum Vacuum 215 mmHg

Best felt B 5 & B 6

Optimum parameters for 3 rd Press felt:

Permeability ~ 35

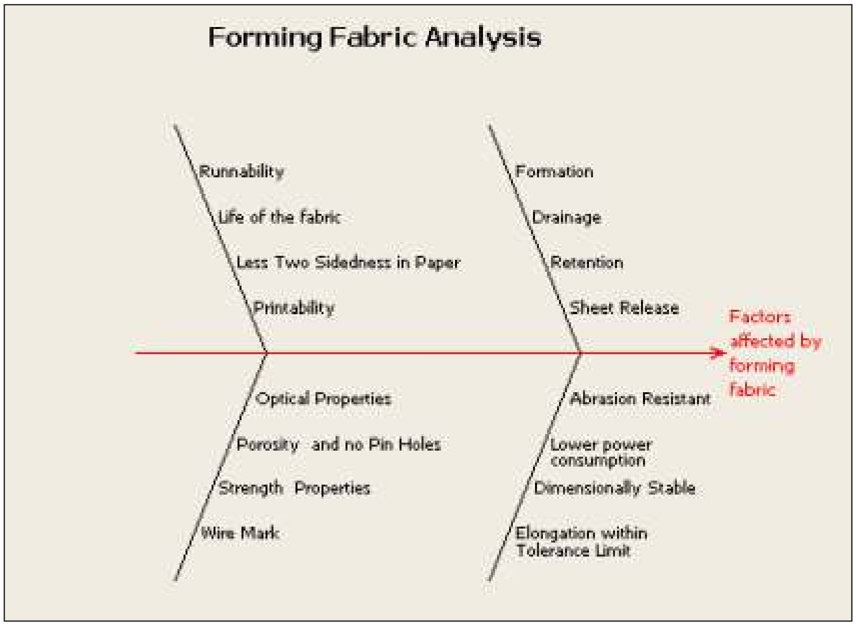
Path Forward

There is an increasing demand from market for permanence and high opacity papers, paper makers are forced to go for higher PCC/GCC loading with ASA sizing which demands higher filler retentions. The requirement therefore is for fabric design that supports higher filler retention, improving machine drainage, formation &life of fabric. Wire manufacturers are coming up with new designs like SSB to have better filler retention while keeping the, improved drainage formation and higher life.

Present paper machine configurations are moving towards Trinip press for better runability and higher steam efficiency which throws up quality challenges like two sidedness and felt impression. Felt manufacturers are coming up with new designs like PU laminated and optimization of base.

Based on above Fabric/Felt analysis in co-ordination with suppliers we have proposed improved design of clothing

Annexure 1



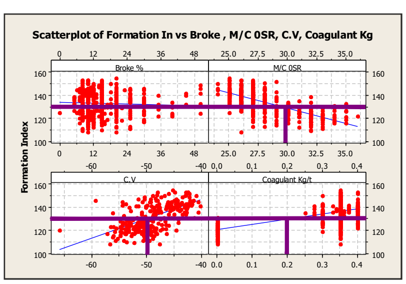
List Of the Factors that having signification impact with Fabrics (Wire & felts)

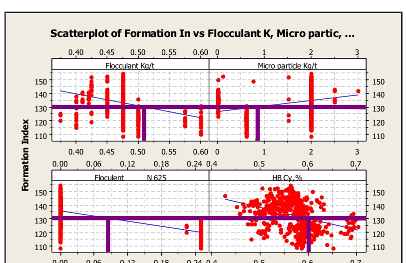
Assessor	Mr. TKC	Mr. PG	Mr.	Mr. KN	Mr. AK P	Mr. PS	Mr. Esw	Mr. CH V	Average
Formation Index	9	9	3	9	3	1	9	9	6.5
Drainage	3	1	9	1	3	9	1	1	3.5
Retention	3	9	1	1	1	1	9	1	3.3
Ash Retention	3	1	9	9	9	9	3	9	6.5
Sheet Release	3	9	1	9	1	9	1	1	4.3
Machine Runnability	1	1	1	1	9	1	3	3	2.5
Productivity	9	9	9	9	3	1	3	9	6.5
Two Sidedness in Paper	1	9	1	9	1	3	1	9	4.3
Printing Properties	3	9	1	1	1	1	9	1	3.3
Wire Mark	9	1	9	1	9	1	1	1	4.0
Strength Properties	9	1	9	1	3	3	1	1	3.5
Porosity and no Pin Holes	1	9	1	9	1	3	1	3	3.5
Optical Properties	3	9	1	9	1	9	1	1	4.3
Elongation within Tolerance Limit	1	3	9	1	1	9	1	9	4.3
Dimensionally Stable	1	3	9	1	3	9	1		3.9
Drive Power	9	9	9	3	3	9	9	3	6.8
Transmit Power without Slippage	3	3	3	9	9	1	1	1	4.1
Sheet dryness	9	9	3	9	3	3	9	3	6.0
Abrasion Resistant	1	3	3	3	1	1	1	1	1.8
Stay Clean	3	3	1	1	1	3	1	1	1.8
Flat Fabric	1	3	9	3	3	1	3	1	3.0

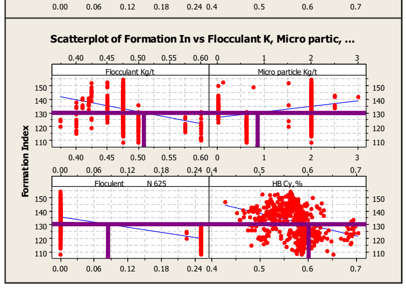
Annexure 2

for further better product quality at better energy efficiency and higher life of clothing.

Below Box plot shows the trends between Formation index verses Various machine parameters







Deg SR </= 30
Couch Vacuum </= 50
Coagulant </= 200 gm / ton
Flocculent </= 520 gm / ton
Micro particle >/= 1.0 kg / ton
Anionic Flocculent under trials
HB Cy - </= 0.6 %
BW Cy </= 0.14 %
FPR >/= 74 %
HB Ash </= 29 %

Glossary

Forming Fabric

A forming fabric comprising an upper layer which is intended to serve as the paper-forming side and consists of thinner yarns, and a bottom layer which consists of coarser yarns. The two layers are interconnected in that threads form the upper layer alternately pass downwardly to interweave with the bottom layer and in the upper layer replace one another in such a manner that together these threads form the same weave pattern with the upper layer as the rest of the yarns in that layer, which yarns do not interweave with the bottom layer.

Press Felt

Felt is a dense, non-woven fabric and without any warp or weft. Instead, felted fabric is made from matted and compressed fibers or fur with no apparent system of threads. Felt is produced as these fibers and/or furs are pressed together using heat, moisture, and pressure. Felt is generally composed of wool that is mixed with a synthetic in order to create sturdy, resilient felt for craft or industrial use. However, some felt is made wholly from synthetic fibers.

Permeability

The permeability of a forming fabric on a paper machine is a measure of the amount of water that passes through the fabric for a given pressure drop across the mat.

FSI

Fiber support index is the average number of support points on the fabric surface per unit of fiber length.

square centimeter

Dtex Weight of yarn of 10 km length in grams (linear density)

S Count
Count md yarns on paper side per cm plus cd yarns on paper side.

T Count
Number of yarn crosses in one square centimeter

Delta ash
The Difference between the percentage of filler loading to final paper ash percentage.

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References

ITC-PSPD Bhadranet and Vidyalaya (intranet of PSPD)
ITC PSPD Paper machines Data.
Clothing Fabric Supplier's Data.