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Factor affecting absorbency behaviour of woven velour printed terry fabrics

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The present research work is aimed at designing the woven velour printed terry fabrics with improved overall performance. The influence of pile height, pick density and pile count (one ply and two ply both) on the water absorbency of fabric has been studied. Thirty samples have been prepared by changing variables as per Box – Behnken design of experiments. These variables are optimised for achieving high quality woven velour printed terry fabrics. The findings show that the absorbency of these fabrics increases with the increase in pile height and pick density. The results are found true for both the fabrics having one ply and two ply pile yarns. The absorbency of the fabrics having two ply pile yarn is always higher as compared to fabric having one ply pile yarn. The absorbency behaviour of these fabrics is different from the looped woven terry fabric which clearly indicates the importance of loop geometry.

Keywords: Absorbency, Pile height, Pick density, Printing, Velour fabric, Woven fabric

1 Introduction

Terry fabrics are the most popular in textile, especially in home furnishing. Cotton terry fabrics are made from pile warp, ground warp and weft yarns by 3-pick terry weave. Terry is produced by pile warp ends on both side of fabric, generally covering the entire surface which is the cause of uneven surface of woven terry fabric. So, the pile loops of one side of the fabric are sheared to make the surface even for printing the finest design. These terry fabrics are known as woven velour printed terry fabrics, which are one of the most exclusive and demanding class of terry fabrics. Printing increases the aesthetics of these fabrics and hence its demand is increasing day by day. It is accepted by consumer just like hot cake due to aesthetic exposure and properties, like absorbency, wash ability and performance.

Terry fabrics are printed by using continuous flat screen printing, which is a new technology introduced by Zimmer Austria Inc. company. It is the most versatile technology for printing woven velour terry fabric to achieve finest printing quality especially in case of centre printing and geometric designs. Serviceability, quality and manufacturing cost play important role in customer acceptability, but aesthetic properties are more important. Studies related to water absorbency of other types of terry fabric (non-sheared and non-printed) have been carried out by many researcher[1-6]. Absorbency capacity of terry fabrics mostly depends on yarn type, yarn twists and structural parameters such as pile height and pick density[7]. Rate of water absorption is increased with increasing threads density accordingly[8]. Water retention and absorbency are very much affected by pile height, loop density and related constructional parameters[9, 10]. Some more research has been directed towards this area for better understanding of absorbency behaviour of terry fabrics[11-13]. However, to the best of our knowledge, it is found that the systematic research studies on design, development, performance enhancement and structure-property relationship of these fabrics have not been reported yet.

Therefore, the aim of this research is to investigate the factors affecting general tendency of absorbency behaviour of woven velour printed terry fabrics by changing variables, like pile height, pick density and pile count in single and double pile yarns.

2 Materials and Methods

The samples of woven velour printed terry fabric have been produced on Toyata Loom (Model: JA4T-2800DE-EHT7100) using 100% cotton one ply and two ply yarns in pile. Terry is produced using 3-pick weave. Thirty samples of woven velour printed terry fabric have been prepared as per Box – Behnken design of experiments. The details of the variable and their levels are given in Table 1.

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Table 1 — Sample variables and their levels

Variable	Level		
	+1	0	-1
	One ply pile yarn		
Pick density, picks/cm	14.5	16.5	18.5
Pile height, mm	3.5	4.25	5.0
Pile count, Ne	12	14	16
	Two ply pile yarn		
Pick density, picks/cm	14.5	16.5	18.5
Pile height, mm	3.5	4.25	5.0
Pile count, Ne	2/16	2/20	2/24

The samples were tested for water absorbency and tensile strength by following ASTM-D4772 and ASTM D5035 respectively.

3 Results and Discussion

Prepared samples of velour printed terry fabric (both one ply and two ply pile yarns) have been tested for water absorbency. Statistical analysis of the results shows that the standard error of the data is in the range of 0.12 - 0.24. The results (Table 2) have been analysed and discussed in following sections.

3.1 Effect of Fabric Variables on Absorbency Behaviour of Fabric

3.1.1 Single Ply Pile Yarn

The F-value of 53.79 (Table 3) implies that the model is significant. There is only 0.02% chance that a large F-value could occur due to noise. P-values of less than 0.05 indicate that the model terms are significant. In this case A, B, C, AB, AC, A^2, C^2 are significant model terms. Values greater than 0.1 indicate that the model terms are not significant.

Figure 1 shows that the absorbency has increased from 37% to 57%, when pick density increases from 14.5 picks/cm to 18.5 picks/cm at pile height 5 mm. The increase in absorbency is found 27 - 39% at pile height of 3.5 mm. The rate of increase in absorbency is higher at high pile height as compared to that at low pile height. So for absorbency, this shows a positive interaction effect between pick density and pile height. Higher pile height gives more absorbency due to longer and less tortuous capillaries.

Figure 2 shows that the absorbency has increased from 35% to 56%, when pick density is increased from 14.5 picks/cm to 18.5 picks/cm at pile count 12 Ne. The increase in absorbency was found 27% to 37% atpile count 16 Ne. The rate of increase in absorbency is higher at coarse pile count as compared to fine pile count. So for absorbency, this shows a positive interaction effect between pick density and pile count. High pick density increases the number of pile in unit area of fabric. Hence more number of capillaries will be available which ultimately enhance the absorbency behaviour of the fabric. Figure 3 shows that absorbency has increased from 37% to 58% when pile height is increased from 3.5 mm to 5.0 mm at pile count 12 Ne. The absorbency has increased from 17% to 43% when pile height is increased from 3.5 mm to 5.0 mm at pile count 16 Ne. The rate of increase in absorbency is higher at coarse pile count as compared to the fine pile count. So for absorbency, this shows a negative interaction effect between pile count and pile height. Fine yarn has less diameter and less fibrous. Finer yarn has more twist

Table 2 — Yarn variable with measured response

Run	Factor 1 Pick density Picks/cm	Factor 2 Pile height mm	Factor 3 Pile count Ne	Response 1 Absorbency %
		One ply pile yarn		
1	14.5	4.25	12	36
2	16.5	3.50	16	31
3	14.5	3.50	14	27
4	14.5	5.00	14	38
5	16.5	4.25	14	48
6	16.5	5.00	12	54
7	18.5	5.00	14	57
8	16.5	4.25	14	46
9	16.5	4.25	14	46
10	16.5	5.00	16	45
11	14.5	4.25	16	28
12	18.5	4.25	16	38
13	18.5	4.25	12	55
14	18.5	3.50	14	37
15	16.5	3.50	12	38
		Two ply pile yarn		
1	14.5	5.00	10	51
2	18.5	4.25	12	48
3	14.5	3.50	10	38
4	18.5	4.25	8	76
5	18.5	5.00	10	75
6	16.5	4.25	10	59
7	16.5	5.00	8	77
8	16.5	3.50	12	37
9	16.5	5.00	12	50
10	18.5	3.50	10	43
11	14.5	4.25	12	39
12	16.5	4.25	10	59
13	16.5	4.25	10	58
14	14.5	4.25	8	44
15	16.5	3.50	8	42

Table 3 — Analysis of variance table for absorbency

Source	Sum of squares	df	Mean square	F-value	p-value
One ply pile yarn					
Model	1250.68	9	138.96	53.79	0.0002
A-Pick density	420.50	1	420.50	162.77	< 0.0001
B-Pile height	465.12	1	465.12	180.05	< 0.0001
C-Pile count	210.13	1	210.13	81.34	0.0003
AB	20.25	1	20.25	7.84	0.0380
AC	20.25	1	20.25	7.84	0.0380
BC	1.0000	1	1.0000	0.3871	0.5611
A^2	86.26	1	86.26	33.39	0.0022
B^2	16.03	1	16.03	6.20	0.0551
C^2	24.64	1	24.64	9.54	0.0272
Residual	12.92	5	2.58		
Pure Error	2.67	2	1.33		
Cor Total	1263.60	14			
Two ply pile yarn					
Model	2683.02	9	298.11	74.84	< 0.0001
A-Pick density	612.50	1	612.50	153.77	< 0.0001
B-Pile height	1081.12	1	1081.12	271.41	< 0.0001
C-Pile count	528.13	1	528.13	132.58	< 0.0001
AB	90.25	1	90.25	22.66	0.0051
AC	132.25	1	132.25	33.20	0.0022
BC	121.00	1	121.00	30.38	0.0027
A^2	41.03	1	41.03	10.30	0.0237
B^2	47.41	1	47.41	11.90	0.0182
C^2	47.41	1	47.41	11.90	0.0182
Residual	19.92	5	3.98		
Lack of Fit	19.25	3	6.42	19.25	0.0498
Pure Error	0.67	2	0.33		
Cor Total	2702.9314				

due to its linear density as compared to coarser yarn. So, finer yarn has less fibrous, less capillary and low absorbency.

Pick density, pile height and pile yarn count have been optimised for maximum water absorbency (Fig. 4). We can see that maximum water absorbency can be achieved at 18.3 picks/cm, 4.9 mm pile height, and 12 Ne pile yarn count. Absorbency of woven velour printed terry fabrics is maximised by maximising the fibres and fibrous surface, whereby high capillary and high hydrophilic of fabrics.

3.1.2 Two Ply Pile Yarn

The F-value of 74.84 (Table 3) implies that the model is significant. There is only a 0.01% chance that a large F-value could occur due to noise. Values of "Prob> F" less than 0.05 indicate that the model terms are significant. In this case A, B, C, AB, AC, BC, A^2, B^2, C^2 are significant model terms. Values greater than 0.1 indicate that the model terms are not significant.

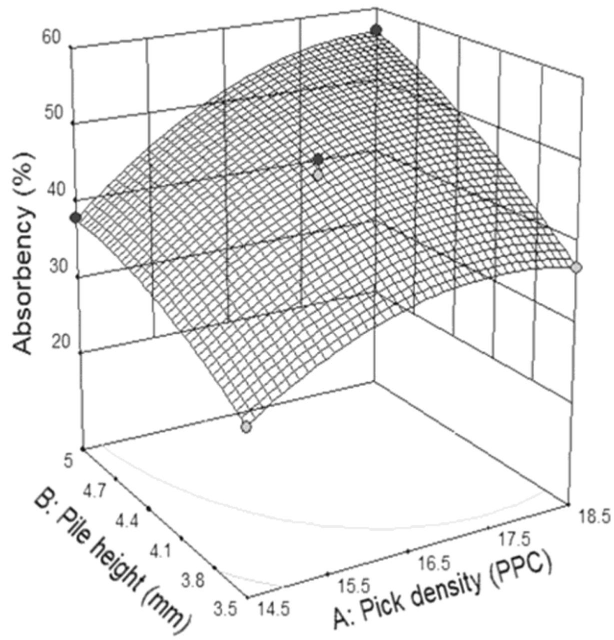

Fig. 1 — Effect of pile height and pickdensity on absorbency

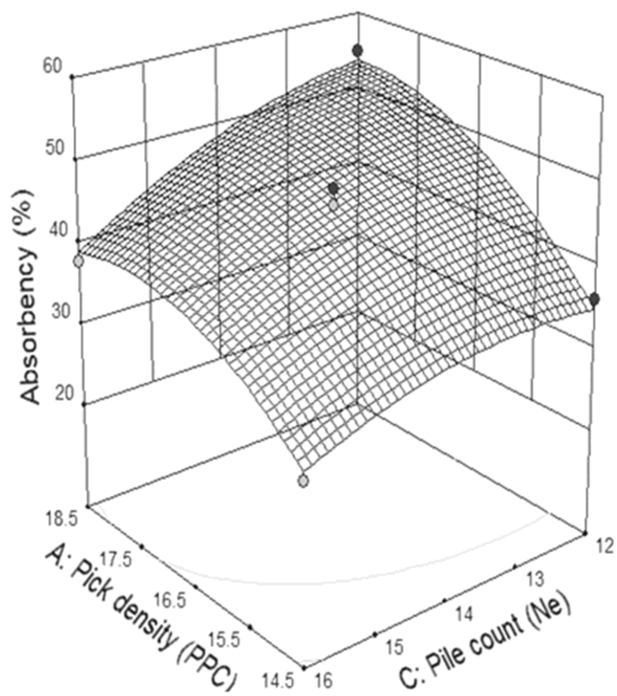

Fig. 2 — Effect of pile count and pick density on absorbency

Figure 5 shows that the absorbency has increased from 32% to 43%, when pick density increases from 14.5 picks/cm to 18.5 picks/cm at pile height 3.5 mm.

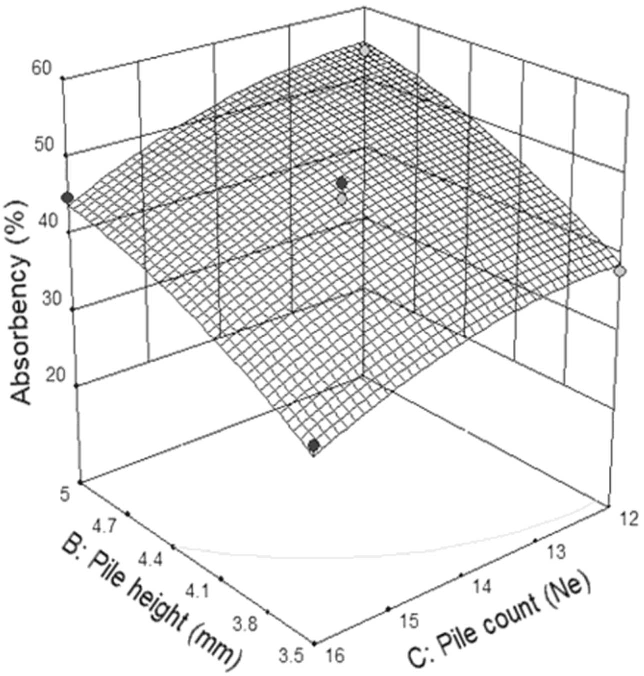

Fig. 3 — Effect of pile height and pile count on absorbency

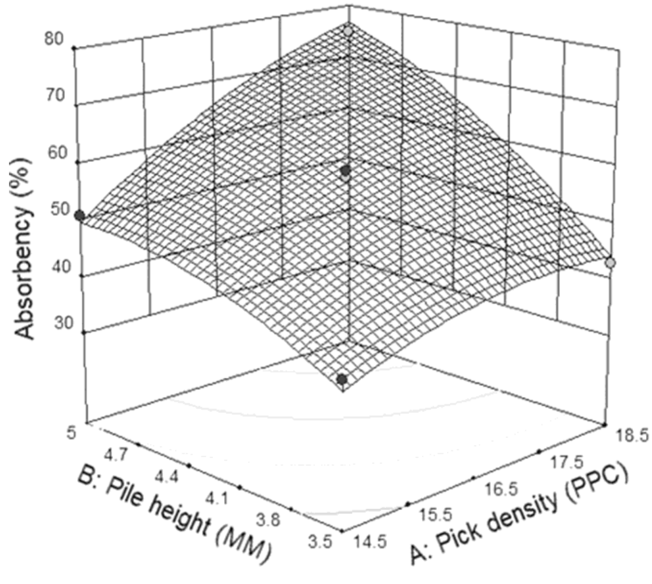

Fig. 5 — Effect of pile height and pick density on absorbency

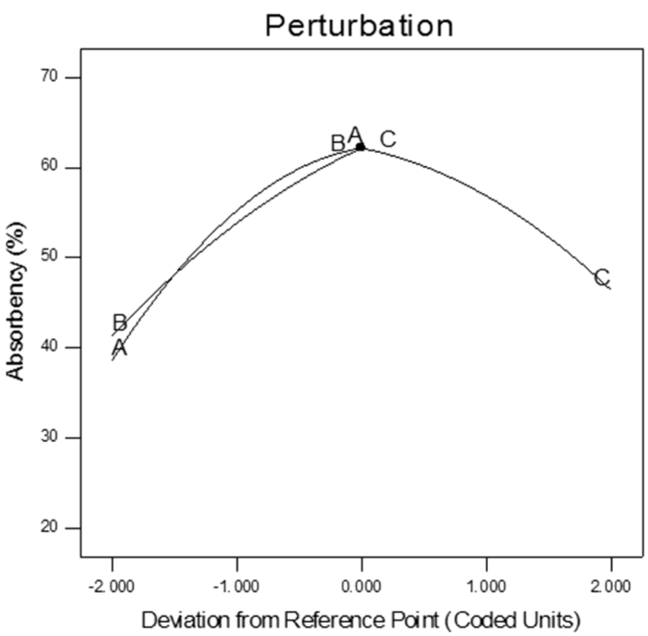

Fig. 4 — Pertubation plot for absorbency

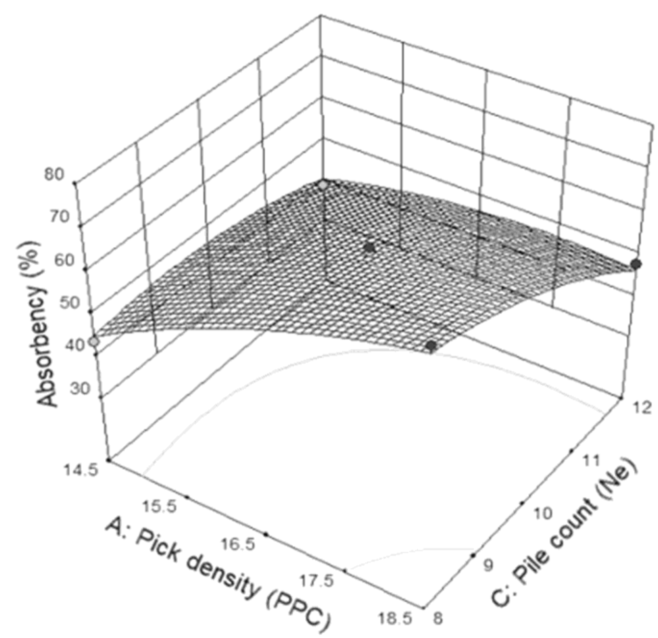

Fig. 6 — Effect of pile count and pick density on absorbency

The increase in absorbency is found from 50% to 78%, when pick density increases from 14.5 pick/ 18.5 picks/cm at pile height of 5 mm.The rate of increase in absorbency is higher at high pile height as compared to that at low pile height. So for absorbency, this shows a positive interaction effect between pick density and pile height. Figure 6 shows that the absorbency has increased from 42% to 57%, when pick density is increased from 14.5 picks/cm to 18.5 picks/cm at pile count 2/16 Ne. The increase in absorbency is found 31-47% at pile count 2/24 Ne. The rate of increase in absorbency is higher at coarse pile count as compared to that at fine pile count. So for absorbency, this shows a positive interaction effect between pick density and pile count.To increase wicking rate at the fibre level there are three basic physical alterations that can be made, namely low fibre diameter, high fibre per cross-sectional area and high fibre orientation in direction of

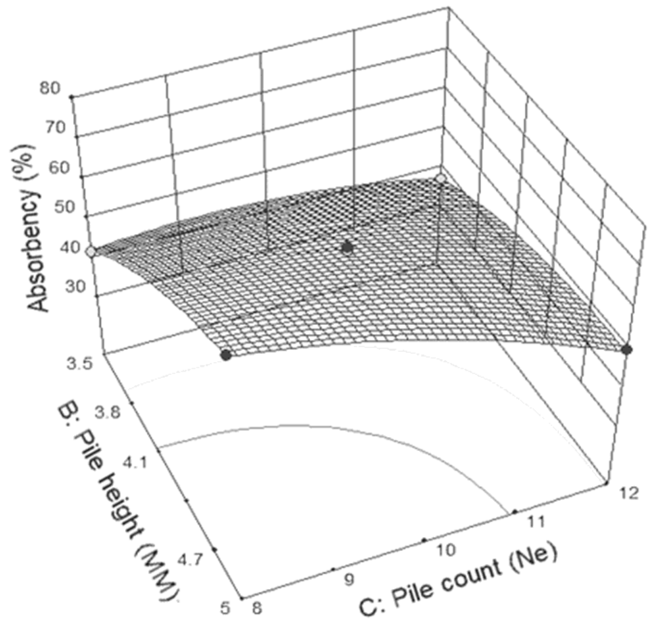

Fig. 7 — Effect of pile height and pile count on absorbency

transport. Due to more number of fibre per unit area and high fibre orientation in the water transport direction, absorbency of two ply woven velour printed terry fabrics is more than that of one ply woven velour printed terry fabrics.

Figure 7 shows that absorbency has increased from 40% to 67% when pile height increased from 3.5 mm to 5.0 mm at pile count 2/16 Ne. The absorbency has increased from 37% to 49% when pile height is increased from 3.5 mm to 5.0 mm at pile count 2/24 Ne. The rate of increase in absorbency is higher at coarse pile count as compared to the fine pile count. So for absorbency, this shows a negative interaction effect between pile count and pile height. Pick density, pile height and pile yarn count have been optimised for maximum water absorbency (Fig. 8). We can see that the maximum water absorbency can be achieved at 18.3 picks/cm, 4.9 mm pile height, and 2/16 Ne pile yarn count. The reason for such behaviour may be due to more open structures of velour nature of pile, enabling to absorb higher amount of water when compared to other samples. Shearing process reduces the pile height so it can also be said that increasing the amount of shearing will adversely affect the water absorbency performance of the fabric.

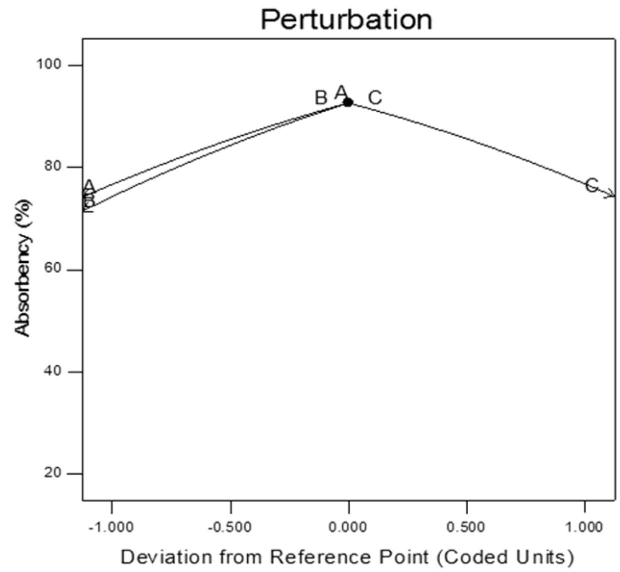

Fig. 8 — Pertubation plot for absorbency

4 Conclusion

It is inferred that the absorbency of woven velour printed terry fabrics increases with the increase in pile height and pick density. The results are found true for both the fabrics having single ply and double ply pile yarn. The absorbency of woven velour printed terry fabrics decreases with increase in the fineness of pile yarn count. Results also suggests that the absorbency of woven velour printed terry fabrics having double ply pile yarn is always higher as compared to fabric having single ply pile yarn. Absorbency behaviour of these fabrics is different from looped terry fabrics.

References

1 Behera B K & Singh J P, *Res J Text Appl*., 18(2014) 133.
2 Singh J P & Behera B K, *Indian J Fibre Text Res*, 40(2015) 112.
3 Buras E M, Goldthwait C F & Kraemer R M, *Text Res J*, 20(1950) 239.
4 Crow R M, *Text Res J*, 68(1998) 280.
5 Hsieh Y L & Yu B, *Text Res J*, 62(1992) 677.
6 Izabela F W & Snycerski M, *Fibers Text East Eur*, 12(2004) 40.
7 Sekerden F, *Wood Fibre Sci*, 44(2012) 189.
8 Diana G K & Galya D K, *Int J Cloth Sci Technol*, 25(2013) 243.
9 Petrulyte S & Nasleniene J, *Fibers Text East Eur*, 18(2010) 93.
10 Yamamoto T, Miyazaki K, Ishizawa H & Matsumoto Y, *J Text Mach Soc Japan*, 58(2005) 147.
11 Karahan M, *Fibers Text East Eur*, 15(2007) 74.
12 Karahan M & Eren R, *Fibers Text East Eur*, 14(2006) 59.
13 Kissa E, *Text Res J*, 66(1996) 660.