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Study on the effect of drafted fibre strand width on mass irregularity and tensile properties of ring spun yarn

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Abstract: *In ring frame, the edge fibres of the drafted strand either attached on the yarn surface or collected as waste at drafting set-up which affects the entire quality of the yarn. In this study, the parameters that will affect the drafted fibre strand width and the quantity of edge fibres going to be attached on the yarn surface such as total draft, break draft, traveller weight and twist level were varied and analysed. The increase in break draft and traveler weight increases the unevenness% of the yarn. This trend has been seen in all the samples. The increase in total draft slightly decreases the unevenness% in 50 Ne cotton combed material. In 50 Ne polyester/cotton blended material there is no significant difference initially and then increases when the total draft increases. The increase in yarn twist increases the yarn unevenness to the maximum level and then slightly decreases. The change in unevenness value directly reflect on the tensile properties of the yarn. Increase in unevenness value of the yarn decreases the strength and elongation value of the yarn.*

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I. Introduction

The roving is supplied to the back rollers of the drafting system in ring spinning where the pressure present between them flattens the roving material. The break draft given at back zone removes the twist present in the roving and the fibres get spread on the middle roller. The main draft given at front zone causes further fibre spreading and some of the fibres move far from the normal strand and finally when the fibres exit from the front roller, they get twisted by the rotation of traveller to form yarn. The uncontrolled fibres coming at edges of the fibre strand will be poorly held on the yarn surface or even may be collected by the pneumafil suction or caught in the cloth roller present on the top of the drafting rollers. The number of poorly controlled edge fibres and the width of the exiting fibre strand have a great influence on the yarn structure and its qualities. The amount of loosely attached fibre on the yarn surface varies with respect to the size of the spinning triangle and the yarn tension. Therefore, in this work, the fibre strand width exiting from the front roller and the edge fibres-those collected on the cloth roller (i.e Bonda waste) have been analysed for different conditions of break drafts, total drafts, twists and traveller weights. The yarns produced with different total draft, break draft, traveller weight and twist level were tested to analyse various yarn properties.

II. Material And Methods

The parameters that affect the spinning triangle as mentioned in the works of the Klein (1993) and Stalder (2000) such as draft, roving hank, twist and traveller weight have been selected as process variables in this study. A Lakshmi G5/1 Ring frame was used to spin 50 Ne and 80 Ne cotton combed yarn from MCU 5 cotton for three different break drafts (1.14, 1.39 and 1.66), and four different traveller numbers (12/O, 10/O, 8/O and 6/O). Two different roving 1.22 Ne and 3.2 Ne were used to produce 50 Ne and 80 Ne yarn respectively. 50 Ne polyester/cotton blended yarns (65:35) were produced from the roving hank of 2.1Ne with three different break drafts (1.14, 1.39 and 1.66), four different twist levels (21.67, 24.13, 26.59, 29.30 TPI) and four different traveller numbers (2/O, 4/O, 6/O and 8/O). The effect of total draft on the yarn samples were analysed from the samples produced with different roving hank such as 1.22 Ne, 1.5 Ne and 1.8 Ne.

Testing of Yarn Properties: The exiting fibre strand width and the fibre distribution across the web affect most of the yarn properties. In this work, the yarn properties such as unevenness%, breaking strength and breaking elongation have been analysed.

Testing of yarn tensile properties, unevenness% and hairiness: The yarn unevenness% was determined using a Premier IQ evenness tester manufactured by Premier Polytronics Ltd. The yarn was tested at a speed of 400 m/min for a period of one minute. Ten tests were carried out for each sample. The yarn tensile strength and elongation% were determined using PREMIER TENSOMAX and fifty tests per sample were done.

III. Results & Discussion

Effect of break draft on yarn unevenness%

The break draft and the back zone length normally will be selected based on the twist present in the roving, roving count and the fibre parameters. The study conducted at three different break drafts in 50 Ne combed (Figure1), 80 Ne combed (Figure 2) and 50 Ne polyester/cotton blend yarn (Figure 3) shows that an increase in break draft significantly increases the unevenness%. In the case of 50 Ne polyester/cotton blend yarn there is a slight increase in unevenness% while increasing the break draft from 1.14 to 1.39 and then shows a tremendous increase from 1.39 to 1.66. The polyester/cotton blended roving has higher cohesive forces between the fibres compared to the cotton roving due to the higher coefficient of friction of polyester fibres. So the polyester fibres need higher break draft to remove the twist and cohesiveness present in the roving and further increase in break draft causes to stick-slip action on the movement of fibre resulting in higher unevenness% Foster G.A.R. (1958).

Effect of total draft on yarn unevenness%

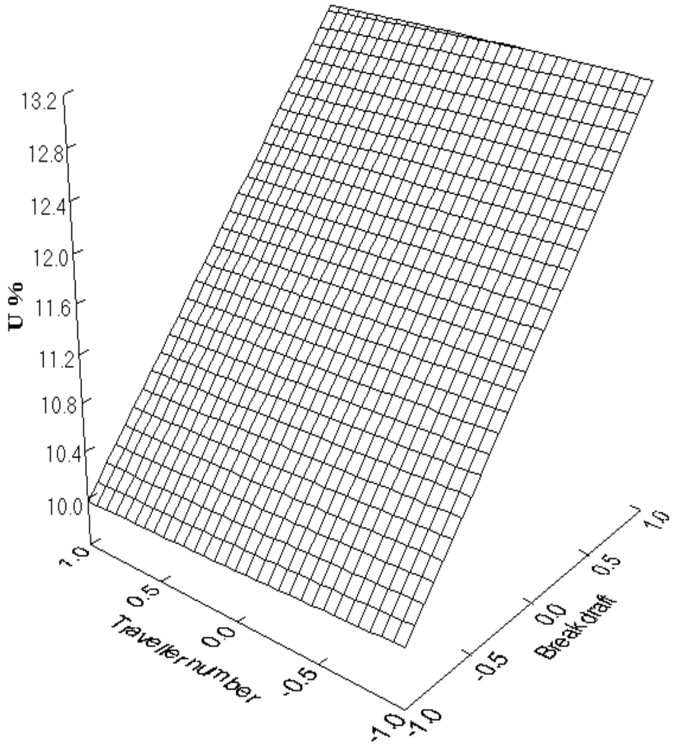
The unevenness% measured in 50 Ne combed and 50 Ne polyester/cotton for three different total draft (The roving hank has been changed accordingly to produce same yarn count) is given in Table 1. From the Table, it is inferred that as the total draft increases the unevenness% decreases in the case of cotton combed material. When the total draft increases, the fibre strand width increases and that causes a greater gap between the fibres (Sengupta A.K. and Kapoor I.M. (1973), (Anderson S.L. and Foster G.A.R. (1955)). During drafting, the front roller pulls the fibres with less drafting force therefore unevenness% decreases. However, the trend found in the polyester cotton blended material differs from the cotton combed material. From the Table 1, it can also be observed that the increase in total draft from 25 to 29 slightly increases the unevenness but it is not significant at 95 % confidence level. However, while increasing draft from 29 to 35, the unevenness increases which is significant at 95% confidence level. This may be due to the slippage of polyester fibres with drafting rollers while increasing the total draft (Bakhar M.I. (1969) Plate D.E.A. and Taylor D.S. (1967)).

Effect of twist on yarn unevenness%

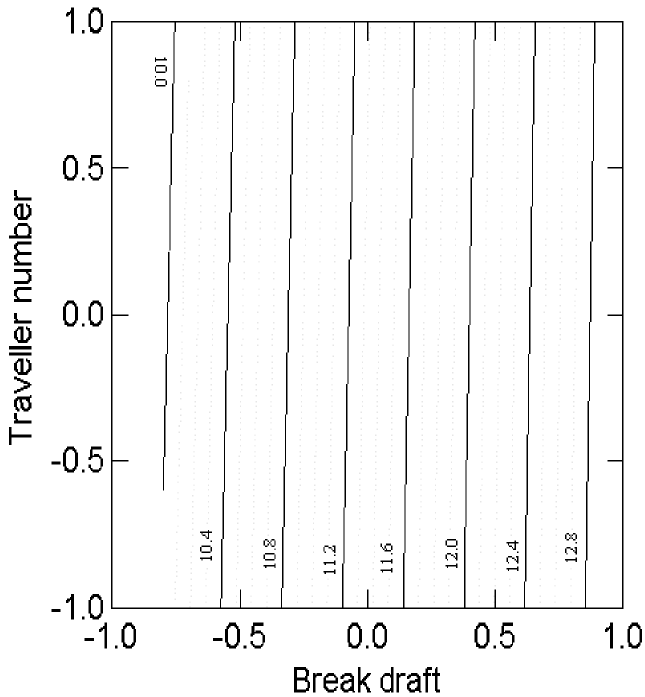
From the Figure 3, it can be seen that increase in yarn twist initially increases the unevenness% gradually to a maximum and then further increase in twist causes a slight decrease in unevenness. Usually, the yarn twist at first flows through the thin places and after saturation it flows through the thick places. At low twist level, the thick places present in the yarn are drafted slightly by the tension present in the balloon whereas, in the thin place there will not be any draft since they have more twist density compared to the thick place which makes the yarn more even. When the yarn twist increases, the fibres in the thick places are compacted and the balloon tension could not give any drafting on the fibres, therefore, unevenness increases. However, when the yarn twist exceeds the maximum level the contraction of yarn takes place only at thin place, which reduces slightly the unevenness% of the yarn. Also at higher twist levels, the length of the spinning triangle decreases that reduces the chance of uncontrolled edge fibres attachment on the yarn surface. If there is mass variation in fed roving material that will also cause in variation in exiting fibre strand width. When the roving feeds a thick place, the amount of uncontrolled edge fibres will increase and these fibres will not be taken by the yarn at spinning triangle and causes reduction of thick place in the yarn. This may also reduce slightly the unevenness of the yarn.

Effect of traveller weight on yarn unevenness%

The unevenness of the yarn produced increases significantly with the increase of the traveller weights (Figures 1 to 3) at all levels of break draft, twist and in both combed cotton and the polyester/cotton blended materials. The increase in traveller weight increases the yarn tension as well as the variation in yarn tension, which causes a variation in pulling force on fibres at spinning triangle zone. Also at higher yarn tension, shearing of the surface fibres while moving in-between traveller and ring causes unevenness.

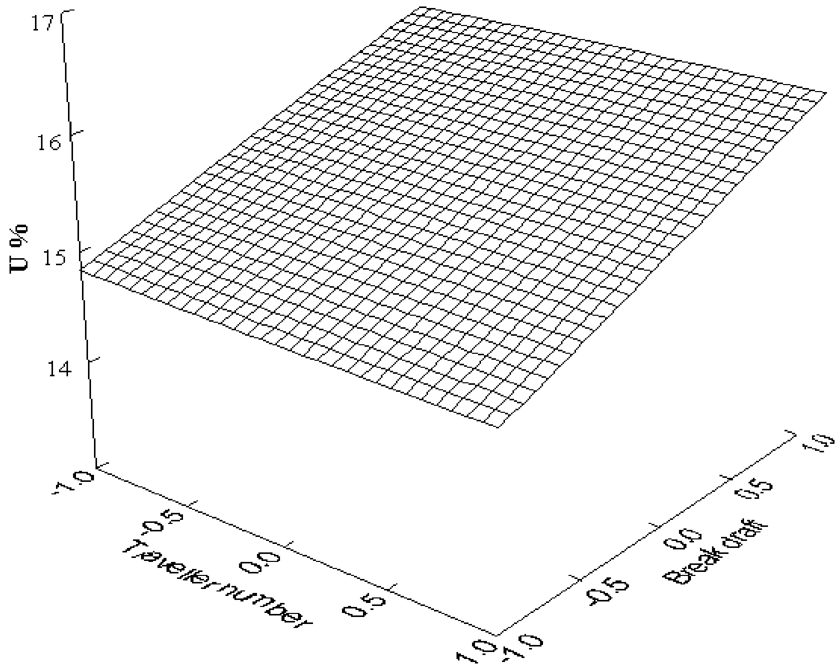


(1a)

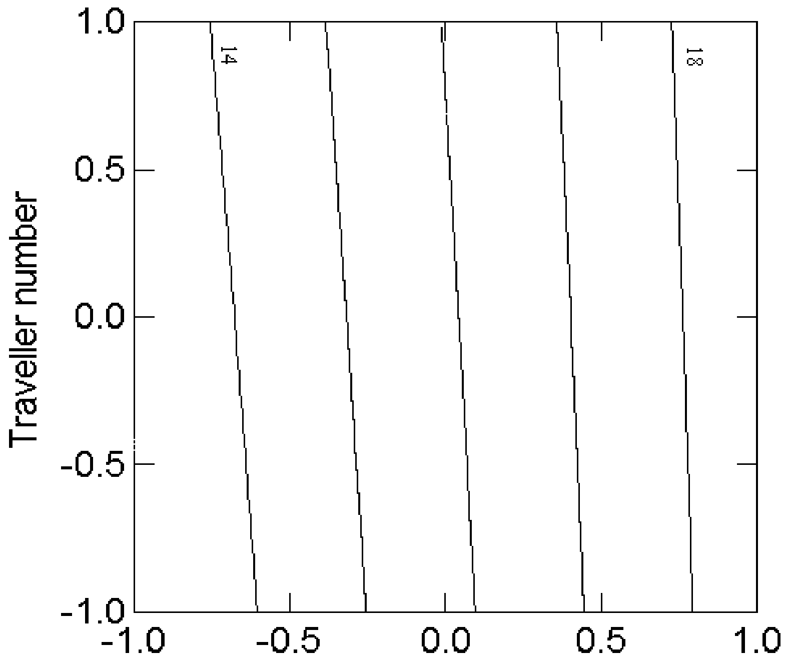


(1b)

Figure 1 Effect of break draft and traveller number on unevenness (U%) for 50 Ne combed yarn (a) 3D-graph (b) Contour graph

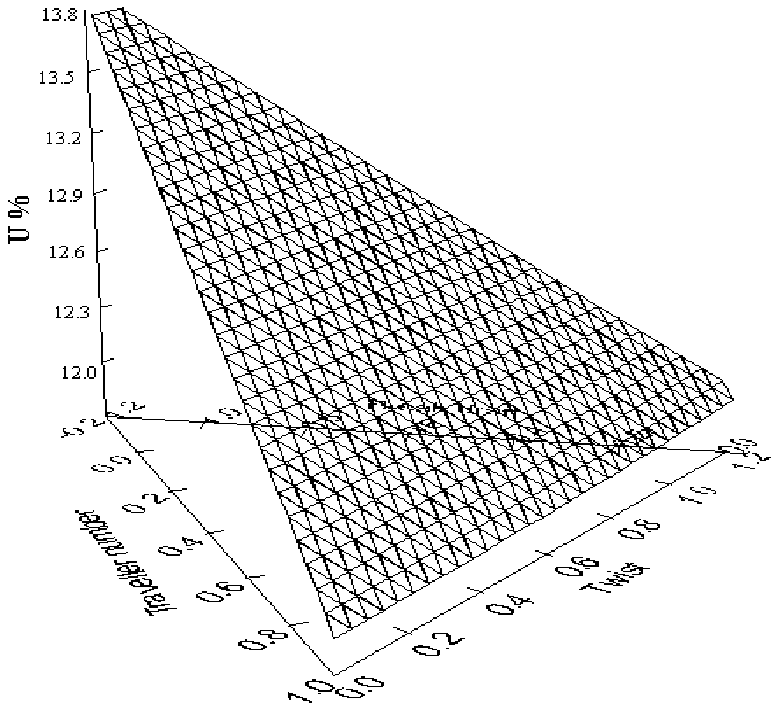


(2a)

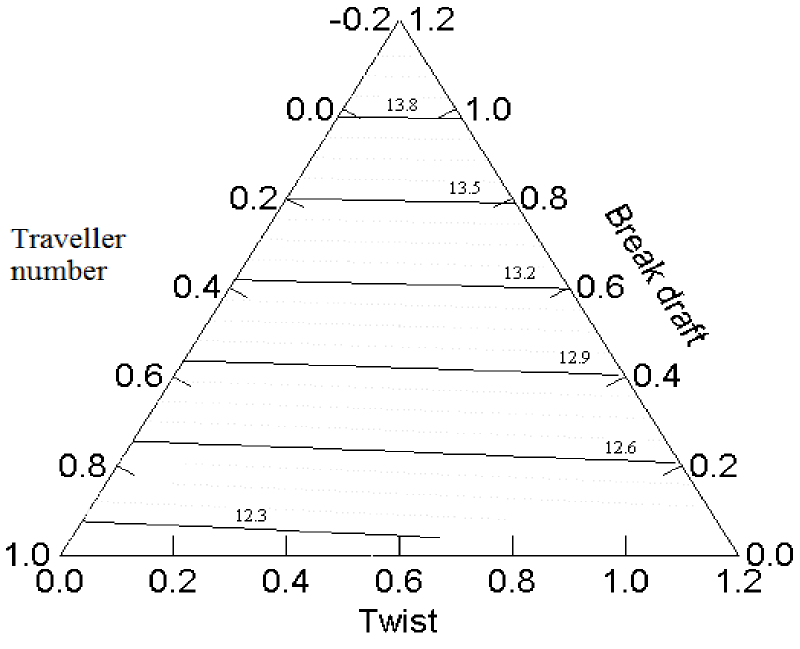


(2b)

Figure 2Effect of break draft and traveller number on unevenness (U%) for 80 Ne combed yarn (a) 3D-graph (b) Contour graph



(3a)



(3b)

Figure 3 **Effect of twist, break draft and traveller number on unevenness (U%) for 50 Ne polyester/cotton blended yarn (a) 3D-graph(b) Contour graph**

Yarn Strength and Elongation

Effect of break draft and total draft on yarn strength and elongation

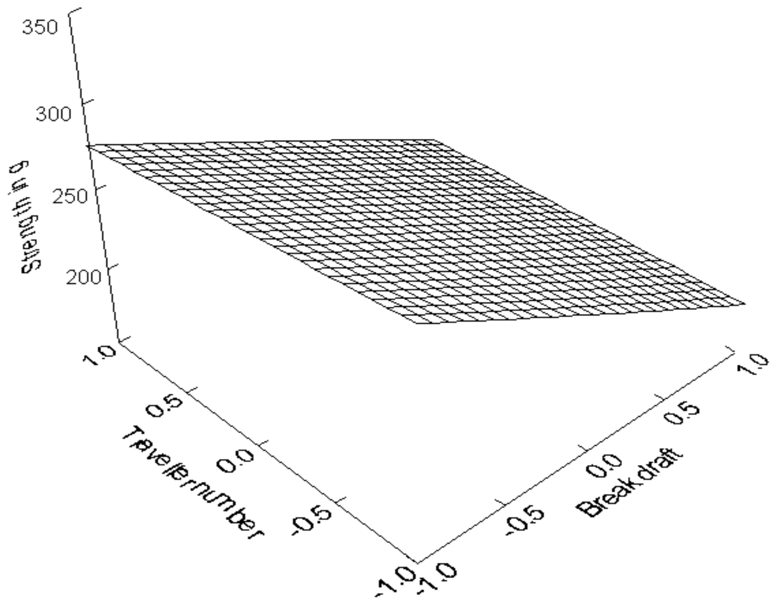
The yarn strength and elongation decreases significantly as the break draft increases whereas, the increase in total draft increases both strength and elongation of the yarn (Table 1 and Figures 4 to 7). This trend has been seen in cotton combed material but in polyester/cotton blends the strength and elongation decreases when the total draft increases. As the break draft increases the imperfection present in the yarn increases due to drafting wave, also the amount of edge fibres lose and freely twisted fibres on the yarn surface increases. These freely twisted edge fibres do not contribute to the strength of the yarn, as these fibres do not gripped by the other fibres. The increase in the total draft not only increases the amount of freely twisted fibres on the yarn surface but also the fibre strand width and hence, decreases the density of drafting strand. The decreases in the density of drafting strand reduces the drafting force that results in less drafting wave and enables fibres to migrate better at spinning triangle. Hence, the strength and elongation of the yarn increases as the total draft increases.

Effect of twist on yarn strength and elongation

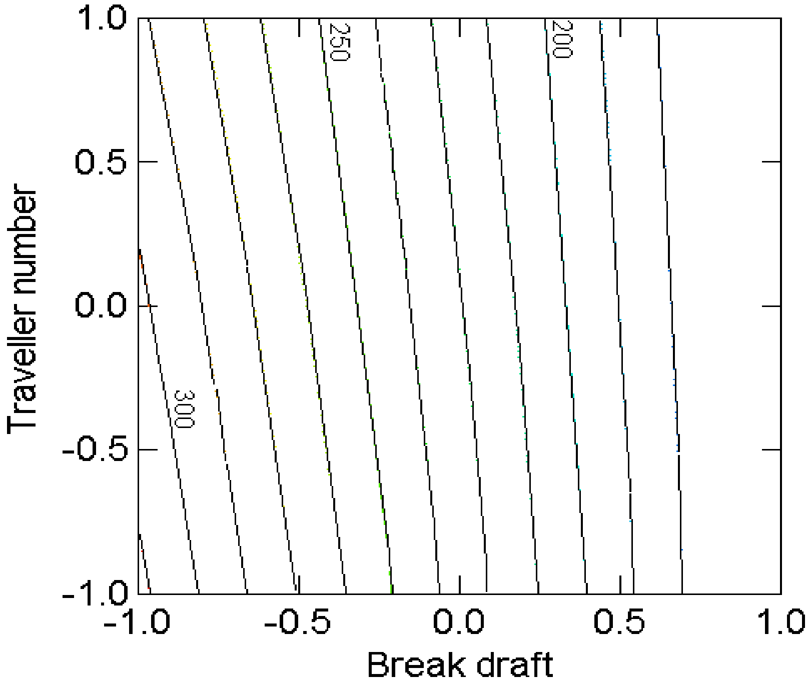
As the yarn twist increases, the yarn strength and elongation increases gradually to the maximum limit and then decreases (Figure 8). This is true for the yarn samples produced at different traveller weights and break drafts. When the twist increases, the lateral force given to the fibres increases at twisting triangle that gives better fibre migration and fibre packing. When the twist increases, the helix angles of the fibres increases gradually and that initially helps to bind the fibres compactly inside the yarn structure so that the yarn strength increases. Further increase in helix angle after obtaining the maximum possible cohesion in the yarn structure, the yarn strength starts to decrease (Coulson A.F.W. and Dakin G. (1957). This is due to the fact of decrease in contribution of fibres to the yarn strength (obliquity factor). When the load is applied to the yarn, the fibres that are present parallel to the yarn axis (i.e core fibres) will bear more loads and will decrease as the helix angle increases.

Effect of traveller weight on yarn strength and elongation

From the Figures 4 to 8, it is observed that the increase in traveller weight reduces the yarn elongation significantly whereas, no significant difference is observed in yarn strength. However, when more number of tests were carried out in yarn strength, the decrease in yarn strength with increase in traveller weight is observed. As the traveller weight increases the imperfection present in the yarn increases and the migration of fibres in the yarn decreases that causes to decrease in yarn elongation and strength.

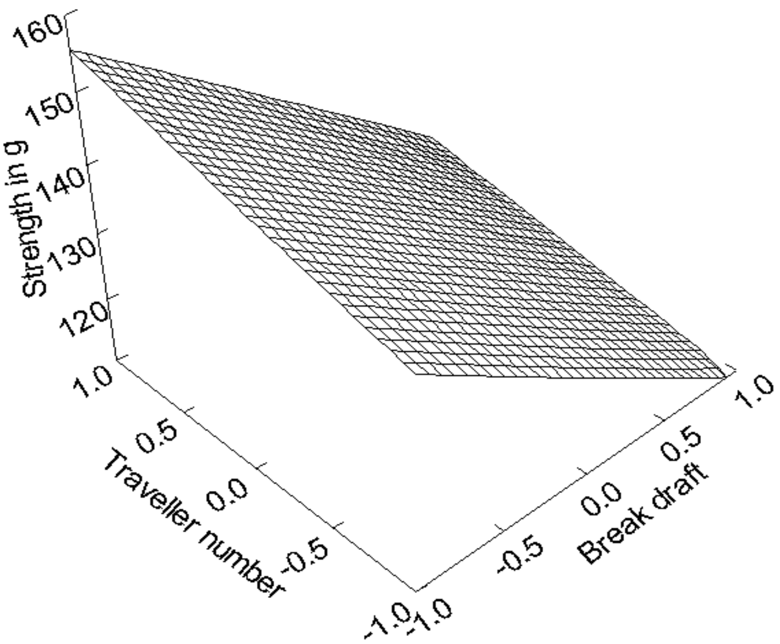


(4a)

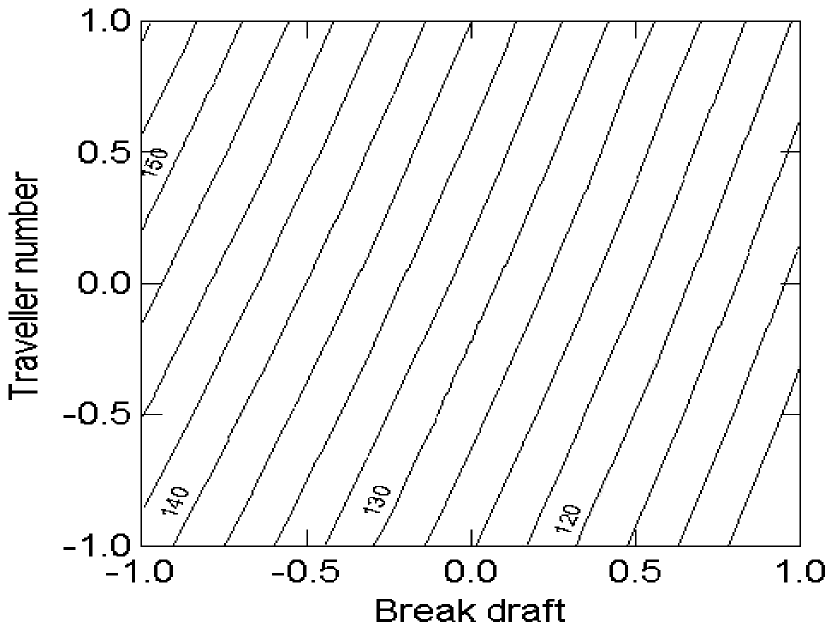


(4b)

Figure 4 Effect of break draft and traveller number on strength for 50 Ne combed yarn (a) 3D-graph (b) Contour graph

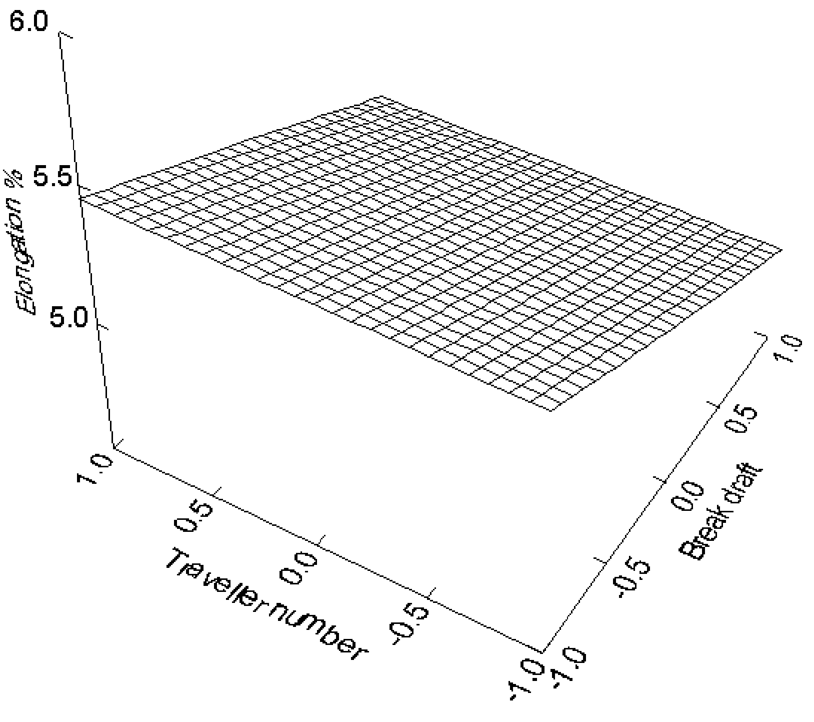


(5a)

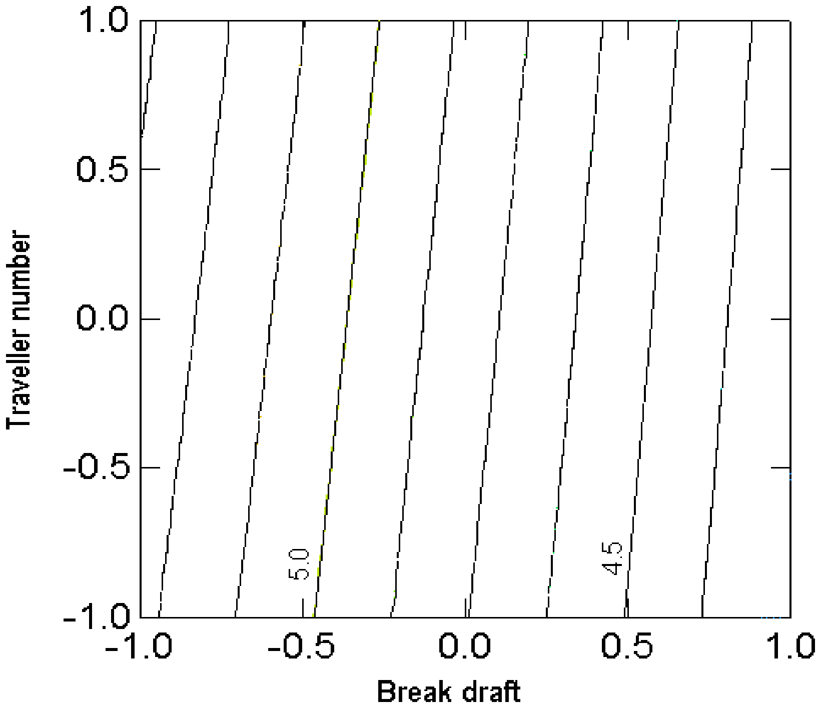


(5b)

Figure 5 Effect of break draft and traveller number on strength for 80 Ne combed yarn (a) 3D-graph (b) Contour graph

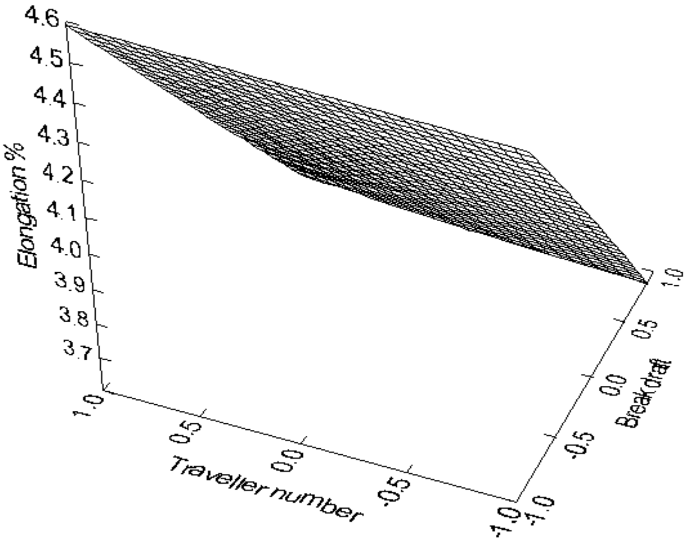


(6a)

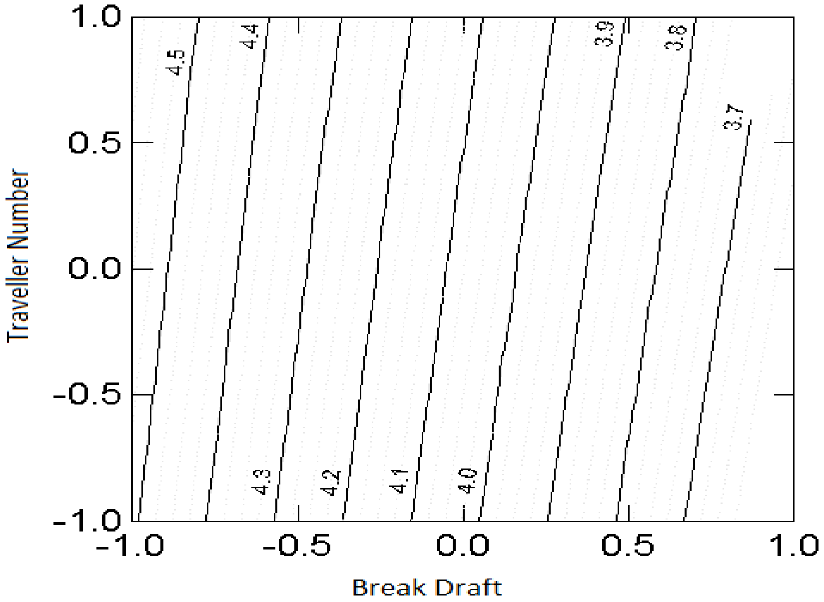


(6b)

Figure 6 Effect of break draft and traveller number on elongation % for 50 Ne combed yarn (a) 3D-graph (b) Contour graph

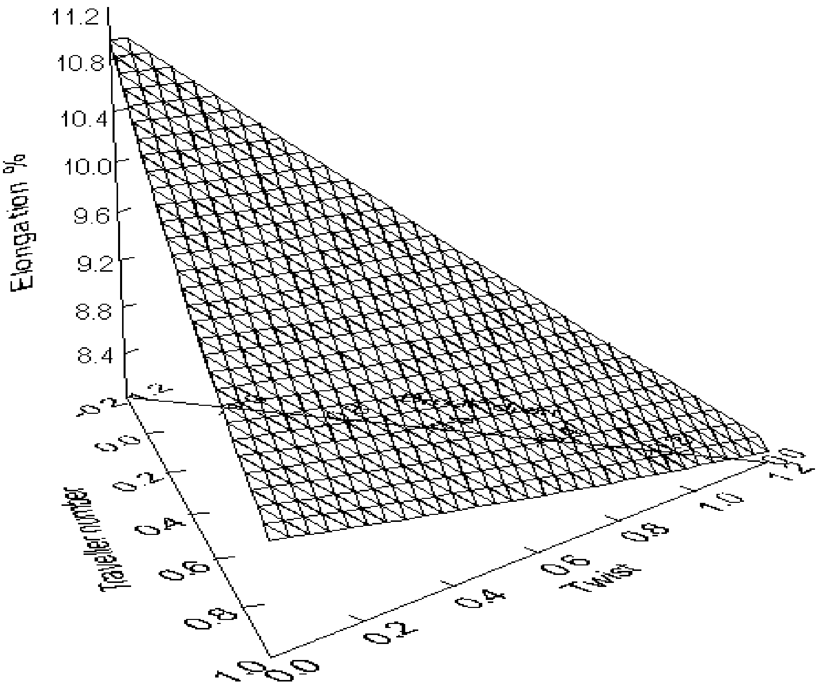


(7a)

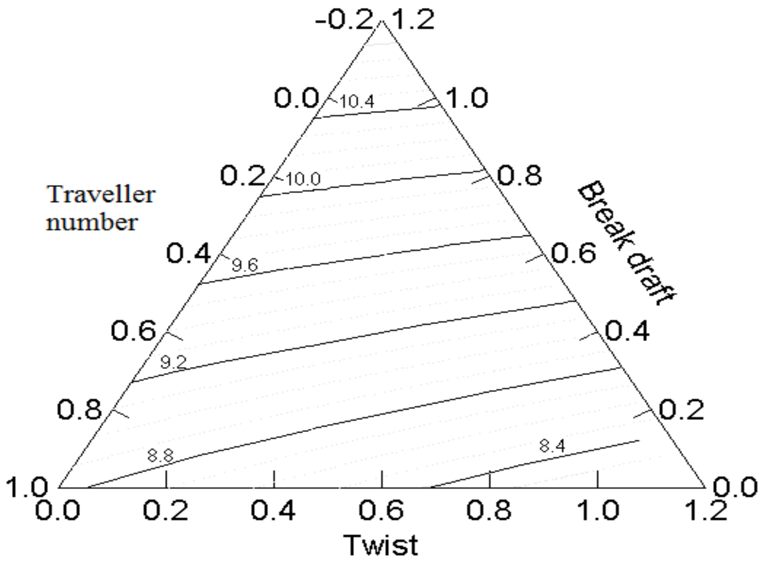


(7b)

Figure 7 Effect of break draft and traveller number on elongation % for 80 Ne combed yarn (a) 3D-graph (b) Contour graph



(8a)



(8b)

Figure 8 Effect of twist, break draft and traveller number on elongation % for 50 Ne polyester/cotton blended yarn (a) 3D-graph (b) Contour graph

Table 1 Effect of total draft (i.e roving hank) on the properties of 50 Ne cotton combed and 50 Ne polyester/cotton blended yarn

Yarn properties	50 Ne Polyester/Cotton			50 Ne Combed		
	Total draft (Roving hank in Ne)					
	25 (2.1)	29 (1.8)	35 (1.5)	29 (1.8)	35 (1.5)	43 (1.22)
U%	12.56	12.60	13.18	12.42	12.16	12.07
Strength in g	336.57	347.29	316.15	241.09	212.17	232.98
Elongation%	9.67	9.63	9.49	4.33	4.52	4.78

IV. Conclusion

The increase in break draft increases the unevenness% of the yarn. This trend has been seen in all the samples. The increase in total draft slightly decreases the unevenness% in 50 Ne cotton combed material. In 50 Ne polyester/cotton blended material there is no significant difference initially and then increases when the total draft increases. The increase in traveller weight increases the unevenness% in all the samples. The increase in yarn twist increases the yarn unevenness to the maximum level and then slightly decreases. The strength and elongation of the yarn increases when the unevenness value of the yarn decreases.

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