# Influence of carding variables on openness and other properties of cotton fibres

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"The influence of fibre openness at carding on characteristics of cotton fibres has been studied. It is observed that the openness at card increases with the increase in licker-in speed, cylinder speed and cylinder-flat settings. A steady increase in card cleaning efficiency is observed with the increase in openness of card web, which is due to the fact that the better opening creates more scope for trash to get exposed and released easily from the fibre. Fibre tenacity improve with the increase in openness only up to certain extent and then deteriorate. Other fibre characteristics like 2.5 % span length, short fibre %, neps, sliver irregularity etc. are also affected by openness of fibres".

**Key Words:** Carding variables, fibre openness, fibre characteristics.



## 1. Introduction

The opening and cleaning of fibre tufts at card1 play a vital role in the preparation of a quality sliver which is essential for the production of good quality yarn. With the increasing demand on yarn quality and the ever increasing deterioration in quality of cotton due to the presence of high amount of trash and other contaminants, it is necessary to pay attention to the degree of opening to be given to the cotton to provide the best quality product to the customer.

It is also important to give the due importance to the extent of opening at card and its influence on yarn quality. Some of the quality characteristics likely to be affected directly or indirectly are cleanliness, neps, 2.5 % span length, short fibre %, sliver linear density. A very good opening place is card itself where the cotton tufts are suppose to breakup into almost individualized fibre stage. The carding process is an opening and orientation function. So the fundamental opening considerations also apply here.

High degree of opening of fibres is essential for good quality yarn but how does this opening occur is also equally important. The yarn quality can not be continuously enhanced with simultaneous increase in degree of opening, since the possible chances of over beating the fibres and damaging and stressing them must also be avoided. This necessitates the consideration of both the positive and negative aspects of degree of opening and hence demands an optimum value of openness of fibres. For the purpose it is necessary to measure the extent of opening achieved and then to observe the other fibre characteristics. Various workers2-6 have devised methods of measuring the openness of fibres and defined openness in different ways.

The carding parameters7 which are responsible for the openness of fibre could be either process or machine related. The process parameters can be classified in to speeds, settings between various interacting organs and linear densities of feed and delivered material. There are some studies 8-9 on the effect of licker-in speed on tuft size and subsequently the yarn quality. In the present work, an attempt has been made to measure the different degrees of opening of cotton fibre brought about by changing the intensity of of opening at card and hence to study the influence of fibre openness on various fibre characteristics. Attempt has also been made to optimize the degree of opening at card so as to achieve consistent quality product at optimum productivity level.

## 2. Material and methods

The present study was carried out in a modern industry and the same mixing (J-34 S/G card selected 36.36% and J-34 S/G good average 63.64%) as used by the industry was taken for the study. The fibre quality of the resultant mixing was: 2.5% span length- 26.88 mm, bundle strength- 27.58 gpt, micronair- 4.3, uniformity ratio- 81.18. The mixing was then processed in modern blow room line with MBO, Mono-cylinder, ERM keeping the setting and speed unchanged for all the samples. The opened flocks were run through modern chute feed system of cards where three card parameters were changed to vary the opening intensity and hence the degree of opening of card web. A three variable factorial design proposed by Box & Behnken (Table-1.), was used to investigate the influence of carding parameters, hence the degree of opening at card, on the other fibre characteristics. The actual values of three variables and their coded levels are given in table-2.

**Table-1: Box and Behnken design for three factors at three levels**

| | Variables | | |
|---|---|---|---|
| **Experimental combination no.** | **X1** | **X2** | **X3** |
| 1. | -1 | -1 | 0 |
| 2. | 1 | -1 | 0 |
| 3. | -1 | 1 | 0 |
| 4. | 1 | 1 | 0 |
| 5. | -1 | 0 | -1 |
| 6. | 1 | 0 | -1 |
| 7. | -1 | 0 | 1 |
| 8 . | 1 | 0 | 1 |
| 9. | 0 | -1 | -1 |
| 10. | 0 | 1 | -1 |
| 11. | 0 | -1 | 1 |
| 12. | 0 | 1 | 1 |
| 13. | 0 | 0 | 0 |
| 14. | 0 | 0 | 0 |
| 15. | 0 | 0 | 0 |

### *2.1. Sample Preparation*

The cotton flocks received from blow room were processed at card with altering the carding parameters at three levels like licker-in speed, cylinder speed, cylinder-flat setting. Sliver was produced for each of the fifteen combinations as shown in table-1. All these samples were placed very carefully for further testing.

### *2.2. Fibre Testing*

Fibres taken after the card were tested for measurement of openness and estimated level of trash. NITRA openness tester4 was used to measure the degree of opening of fibres in card web using following formula:

$$\text{Degree of opening} = \frac{\text{Coeff of (Compression - Recovery)}}{\text{Coeff of Compression}}$$

The trash % in card web, 2.5 % span length, short fibre %, fibre bundle strength were estimated by using Premier HVI. Neps in card web were counted manually in form of neps / gm. Irregularity in card sliver was measured by using Uster (UT-3).

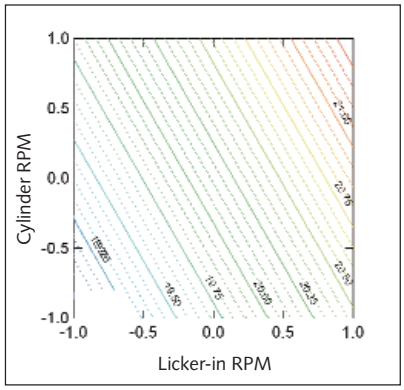


Fig-1: Fibre openness at Flat-Cylinder Setting(-1).

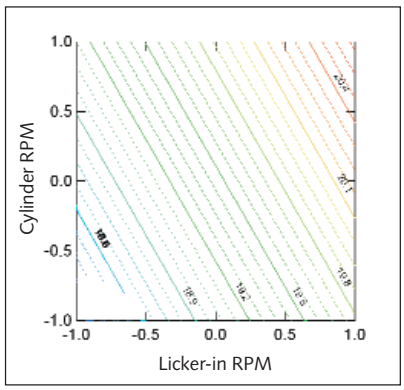


Fig-2: Fibre openness at Flat-Cylinder Setting(0).

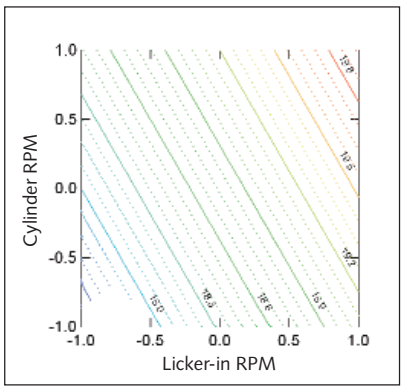


Fig-3: Fibre openness at Flat-Cylinder Setting(+1).

## 3. Results and Discussion

Table- 3 shows the Influence of experimental Variables on processibility of cotton fibre and Table- 4 shows the response surface equations at 95 % level of significance.

### *3.1. Effect on Openness of Fibres*

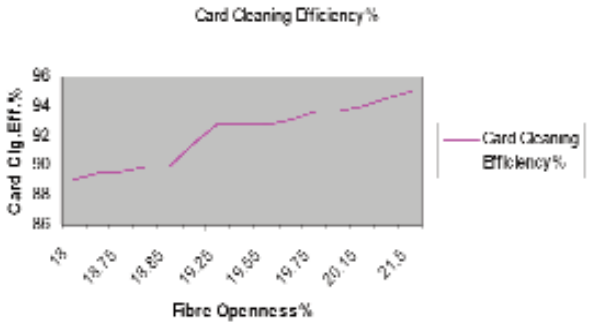
It is observed from the response surface equation in table-4 that the openness of fibres have very significant correlation (R2 = 0.800) with the licker-in speed, cylinder speed and flat-cylinder setting. The response surface equation in table-4 and contours in figs 1-3 clearly shows that with the increase in licker-in speed, the fibre openness in card web increases.

This is mainly due to combing action as degree of combing10increases with the increase in licker-in speed. Also opening intensity can be improved by enhancing the licker-in speed. Ishtiaque et al.7 observed that increase in openness can be achieved by increasing licker-in speed.

Contours in figs 1-3 also show that increase in cylinder speed result in increase in fibre openness. This is due to reduction in cylinder load with concomitant increase in transfer coefficient. Bhaduri11 also reported similar findings

It can be depicted from contours that decrease in setting between flat-cylinder increases openness. The main reason for this is that the reduction in flat-cylinder setting increases penetration of the teeth in to the tuft due to higher compression force resulting intensive carding action with concomitant increase in carding force.

The linear relationship between carding force and flat setting was also observed by Artz and Schreibn12 and Ishtiaque et al.7.



Graph-1.

**Table-2: Actual values of variables and their coded levels**

| Variables | Coded level | | |
|---|---|---|---|
| | -1 | 0 | +1 |
| X1- Licker-in (rpm) | 650 | 800 | 950 |
| X2-Cylinder (rpm) | 250 | 350 | 450 |
| X3- Flat cylinder setting (Thou) | 8 | 10 | 12 |

**Table-3**

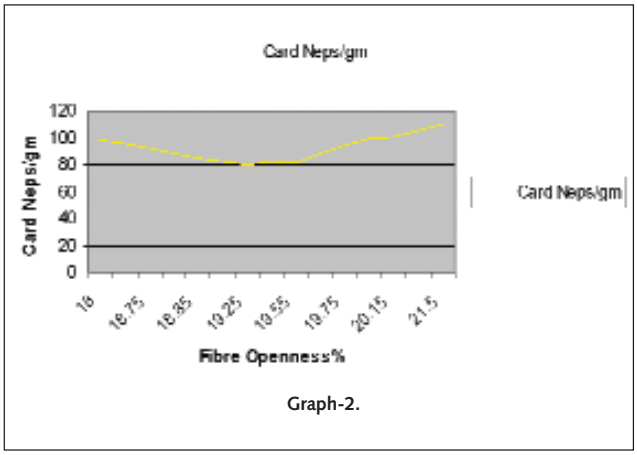
| S.N. | X1 | X2 | X3 | Openness of web |
|---|---|---|---|---|
| 1. | -1 | -1 | 0 | 18 |
| 2. | 1 | -1 | 0 | 18.75 |
| 3. | -1 | 1 | 0 | 19 |
| 4. | 1 | 1 | 0 | 21 |
| 5. | -1 | 0 | -1 | 19.65 |
| 6. | 1 | 0 | -1 | 21.5 |
| 7. | -1 | 0 | 1 | 18.25 |
| 8. | 1 | 0 | 1 | 19.75 |
| 9. | 0 | -1 | -1 | 19.85 |
| 10. | 0 | 1 | -1 | 20.15 |
| 11. | 0 | -1 | 1 | 18.85 |
| 12. | 0 | 1 | 1 | 18.8 |
| 13. | 0 | 0 | 0 | 19.45 |
| 14. | 0 | 0 | 0 | 19.55 |
| 15. | 0 | 0 | 0 | 19.25 |

**Table-4: Response Surface equations**

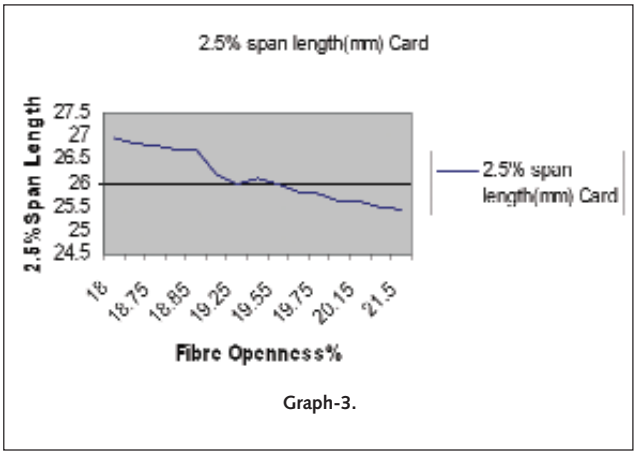
| S.N. | Stage | Equation | R2 |
|---|---|---|---|
| 1. | Openness of web | Y=19.453+0.762X1+0.437X2-0.688X3 | 0.800 |

### *3.2. Effect on Cleaning Efficiency of Card*

Graph-1. Shows a steady and almost linear increase in card cleaning efficiency, thus sliver purity, with the increase in openness of card web. Better opening creates more scope for trash to get exposed and released easily from the fibre. The graph also shows that the maximum cleaning was achieved at maximum opening which was obtained through combination of close flat-cylinder setting, high licker-in speed and cylinder speed up to 400 rpm. The high licker-in speed cause intensive opening, providing more scope for trash to get exposed. Moreover the high centrifugal force experienced by the tufts on the licker-in facilitates ejection of trash particles.




Graph-2.




Graph-3.

### 3.1. Effect on Neps in card web

Graph-2 shows the influence of openness of card web on nep count. From graph it is observed that minimum nep counts are observed at particular level of openness. Below of which the nep count increases.

Thus there is an optimum set of parameters corresponding to an optimum value of openness. From graph it is also clear that minimum nep count was achieved at optimum value of openness of fibres which was obtained through combination of licker-in speed 755.29 rpm, cylinder speed 372.16 rpm and flat-cylinder setting 10.34 thou. The treatment appears to be too harsh for the fibres with the increase in number of neps.

### 3.2. Span Length 2.5%

Graph-3. shows a steady and almost linear decrease in 2.5 % span length with the increase in openness of the card web. This is due to high licker-in speed, cylinder speed and close setting between flat and cylinder. Maximum downfall in span length is due to most intensive opening tool with closest flat-cylinder setting and highest licker-in speed.

### 3.3. Short Fibre %

Graph-4 indicates about trend of short fibre % with respect to fibre openness %. Graph shows that the short fibre content increases steadly with the increase in openness. This is due to the intensive opening action as already seen and discussed in the case of span length. On the basis of trend, it can be concluded that the intensive plucking and tearing of fibres generate short fibres.

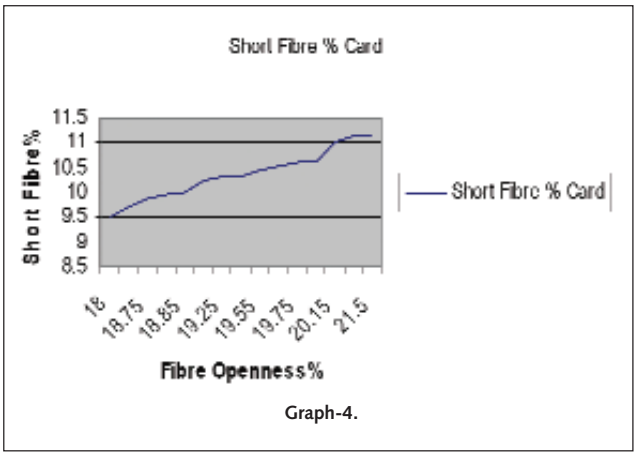
### 3.4. Card Sliver Irregularity

It can be seen from graphs-5 & 6 that the card sliver irregularity decreases with the increase in openness. The initial decrease in card sliver irregularity may be due to better opening of fibre tufts fed to cylinder and then fibres are more evenly distributed over the cylinder surface.

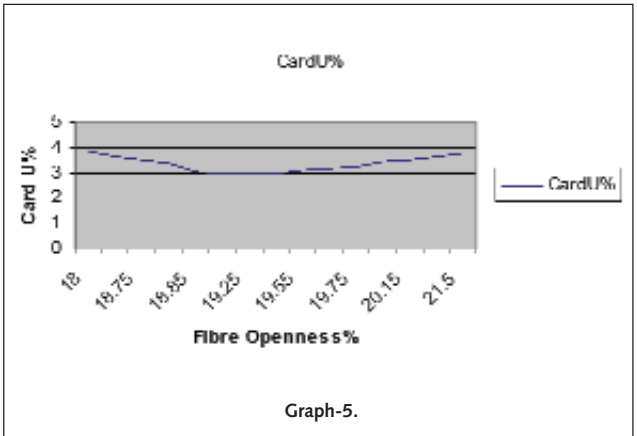
Further increase in openness leads to increase in sliver irregularity due to increase in short fibre % and decrease in span length at high speed of licker-in.

### 3.5. Fibre Bundle Strength

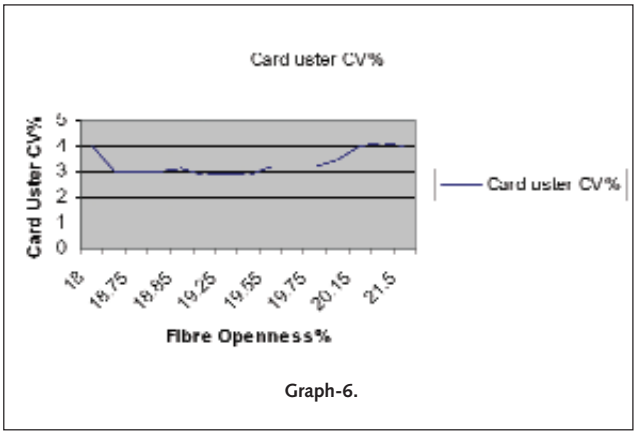
Graph-7. on the next page shows that the fibre bundle strength first gradually increases and then decreases with the further increase in openness. This is because increase in openness of fibres at high licker-in speed and close flat-cylinder setting leads to fibre rupture.




Graph-4.




Graph-5.

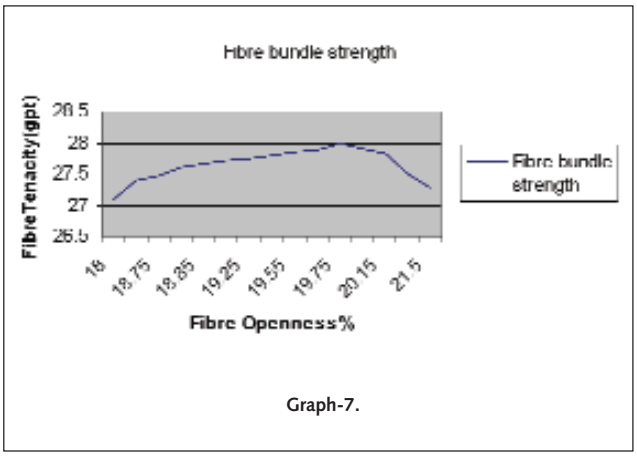



Graph-6.

## 4. Conclusions

Above results and discussion is concluded in following manner:

1. Fibre openness increases with increase in licker-in speed, cylinder speed and close setting between flat-cylinder.
2. Cleaning efficiency in carding linearly increases with increase in openness of fibres which is achieved at high licker-in speed, slightly increase in cylinder speed up-to 400 rpm value and close setting of flat-cylinder.
3. With the increase in openness of fibres in carding, 2.5 % span length reduces and the short fibre content increases. These changes are highly highly correlated.
4. Card sliver irregularity and its CV% decreases with the increase in openness but at a very high level of openness the irregularitiy increases.
5. Nep count decreases to a minimum value and then increases for higher fibre opening. Minimum nep count was achieved at optimum value of openness of fibres which was obtained through combination of licker-in speed 755.29 rpm, cylinder speed 372.16 rpm and flat-cylinder setting 10.34 thou.
6. Fibre bundle strength first gradually increases and then decreases with the further increase in openness.




Graph-7.

## 5. References


1. Ishtiaque S M, Das A & Chaudhuri S, Influence of fibre openness on processibility of cotton and yarn quality: Part I- Effect of blow room parameters, Indian J Fibre Tex res,28 (2003) 399.
2. Bostock W, Freeman S M, S A & Williams T C, J Text Ins, 46 (1955) T 171.
3. Chellamani K P, Shanmughanandam D & Karthikeyan S. Indian Text J, June (1988) 76.
4. Ishtiaque S M, Nishkam A & Tripathi V, Design and fabrication of openness tester, Proceedings, 40th Joint Technological Conference of ATIRA, BTRA, SITRA and NITRA (SITRA, Coimbatore), 1999, 25.
5. Bhaduri S N, Effect of openness of cotton on subsequent processing, Proceedings, Joint Technological Conference of ATIRA, BTRA and SITRA (ATIRA, Ahmedabad), 1959.
6. Rutkowskii J, Fibres Text Eastern Eur, (1995) 39.
7. Ishtiaque S M, Das A & Chaudhuri S, Influence of fibre openness on processibility of cotton and yarn quality: Part II- Effect of carding parameters, Indian J Fibre Tex res,28 (2003) 405, 407, 409.
8. Artz P & Schreiber O, Melliand Textilber (Engl Edn), October (1973) 781.
9. Chattopadhyay R, Optimizing carding: Process and machine parameters, Spinning- Blow Room and Card (NCUTE, New Delhi), 1998.
10. Chattopadhyay R, Lecture notes on carding (Indian Institute of Technology, New Delhi), 22, 24, 26, 180.
11. Bhaduri S N, Final Technical Report on Project – investigation of means to minimize fibre hook ends increased utilization of cotton, ATIRA, 1968.
12. Artz P, Schreibn O, Melliand Text. No. 4, 1974,317.◆