Study on rotor deposition: Part I – Influence on quality and running performance of grey cotton yarn

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Deposition of trash particles inside the yarn forming rotor groove is highly detrimental in terms of spinning performance and quality of yarn. If the cleaning of rotors is not done after a certain interval of time, the fine dust particles go on depositing inside the rotor groove and thus the running performance and the quality of yarn deteriorate with the time. The residual trash content in finisher draw frame sliver has significant impact on rotor deposition, end breakage rate and yarn quality. The draw frame sliver with minimum level of residual trash content is desirable for rotor spinning. Speed and type of opening roller also have significant effect on the above attributes.

Keywords: Cotton yarn, Opening roller speed, Residual trash content, Rotor deposition, Yarn imperfections, Yarn irregularity

1 Introduction

The accumulation of fine dust particles in the rotor groove during spinning creates lot of problems in terms of deterioration in yarn quality, increased end breakage rate, rapid wear and tear of machinery components, etc. In ring spinning, the trash particles are ejected harmlessly from the spinning balloon, but in OE spinning these particles accumulate in the yarn forming groove of the rotor, displacing the fibres to the wider part of the groove so that the process of yarn formation becomes less precisely controlled. Many steps that have been suggested to overcome these problems include the use of improved blowroom and carding machineries, optimization of carding and drawing operations, coating of rotor surface with wear resistance finishes, application of rotors designed to have a self-cleaning mechanism, on-line monitoring devices which arrest the spinning action on detecting a deterioration in yarn quality, etc. Ultimately, the trash builds up to the point at which the process of yarn formation is interrupted and the end break starts occurring. After the rotor groove is fully loaded with the fine dust particles, the operator must stop the rotor

and clean it out with brush or air jet before piecing-up. During cleaning of rotor, care must be taken to avoid any damage to rotor surface. After cleaning of rotor at a certain interval, it is expected that the characteristics of the yarns are restored to their original levels, only to decline again as the trash builds up on the rotor once more.

The user of OE rotor spinning cannot afford to permit the trash to build up to the point at which the yarn quality deteriorates to an unacceptable level. Occasionally, a single large trash particle becomes lodged in the yarn forming groove of the rotor, causing a clearly defined periodic yarn fault whose wavelength is related to the circumference of rotor.

It is well understood that the microdust deposition inside the rotor groove has significant impact on running performance and quality of rotor yarn. However, not much work has been reported on the rotor deposition and its impact on running performance in large scale and actual running condition in industry. Thus, the present study was aimed at understanding the effect of running time, residual trash content in draw frame sliver and opening roller speed on rotor deposition, end breakage rate and yarn properties in an industry in large-scale running condition.

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2 Materials and Methods

A medium-grade cotton having the following specifications was used throughout the study:

- 2.5% SL : 24.25 mm
- 50% SL : 11.60 mm
- Bundle strength : 20.2 g/tex
- Micronaire : 4.1

The cotton fibres were processed through blowroom, carding and two passages of draw frame. The finisher draw frame slivers of linear density 5.37 ktx were fed to the OE spinning machine (Rietz M 2/1 Model). The rotor speed was kept at 50,000 rpm for all the samples and rotor diameter was 45 mm. All the yarns were spun in 59 tex count with TM of 5.0.

In all the studies, i.e. effect of time intervals, effect of residual trash content of draw frame sliver and effect of opening roller speed, two types of opening rollers were used, viz. saw toothed type (ST) and pin type (Pin). The yarns thus produced were tested for CSP, evenness and imperfections. Twenty cheeses were randomly collected for testing the properties of each sample. The results are shown in Tables 1-3. The residual trash contents of draw frame slivers were measured with the help of trash analyser.

2.1 Study on Effect of Time Interval

To study the effect of time interval on rotor deposition, end breakage rate and yarn quality, a wide range of time intervals (0.5 h - 100 h) was chosen. Before starting the study, all the rotors were cleaned properly and the yarns were pieced and allowed to run for a pre-determined time as shown in Table 1. After the stipulated time was over, the rotors were stopped and the deposits were cleaned and collected carefully from fifty randomly chosen rotors. Average weight of deposit per rotor for a particular time interval was calculated. It was ensured that in case of any end breakage no rotor cleaning was done within the stipulated time interval and piecing was done immediately. After certain time intervals, twenty open-end cheeses were collected randomly in each case and the yarn properties were measured. Similarly, the end breakage rate was also studied for full machine, i.e. for 220 rotors, after certain time interval without cleaning of any rotor. The opening roller speed was kept at 7500 rpm for all the samples and the draw frame sliver with 0.51% residual trash content was used.

2.2 Study on Effect of Residual Trash Content in Draw Frame Sliver

In order to get finisher draw frame slivers having same fibre properties but different levels of residual trash content, the cotton fibre lots from same variety with similar physical properties but variation in trash content were selected. Also, the trash extraction in the blow room and the flat speed of card were varied to get the draw frame sliver with wide range of residual trash content, as shown in Table 2. The yarns were then spun in rotor spinning machine from these slivers at opening roller speed of 7,500 rpm.

The average deposition per rotor and end the breakage rate were measured after five hours of continuous running in the similar way as described

| Table 1 — Effect of time interval on rotor deposition, end breakage rate and yarn quality |
|---|---|---|---|---|---|---|---|---|---|
| Time interval (h) | Av. wt. of rotor deposition (g) | End breakage rate (Breaks/100 rotors/h) | CSP | Irregularity (U%) | Yarn imperfections/1000 m |
| | ST | Pin | ST | Pin | ST | Pin | ST | Pin | ST | Pin |
| 0.5 | 0.014 | 0.028 | 2.62 | 2.16 | 1707 | 1830 | 10.44 | 10.31 | 1 | 0 |
| 1.0 | 0.021 | 0.041 | 2.59 | 3.10 | 1688 | 1832 | 10.44 | 10.28 | 0 | 0 |
| 2.0 | 0.057 | 0.090 | 2.93 | 4.44 | 1684 | 1822 | 10.57 | 10.47 | 1 | 1 |
| 3.0 | 0.077 | 0.105 | 3.25 | 4.72 | 1696 | 1824 | 10.62 | 10.46 | 2 | 0 |
| 5.0 | 0.156 | 0.168 | 4.87 | 6.90 | 1692 | 1816 | 10.96 | 10.80 | 3 | 2 |
| 10.0 | 0.162 | 0.168 | 12.99 | 14.28 | 1644 | 1812 | 11.53 | 10.82 | 2 | 0 |
| 20.0 | 0.166 | 0.172 | 14.38 | 16.38 | 1621 | 1793 | 11.62 | 11.21 | 4 | 3 |
| 50.0 | 0.164 | 0.175 | 15.62 | 16.92 | 1620 | 1794 | 11.60 | 11.30 | 3 | 2 |
| 100.0 | 0.169 | 0.173 | 15.44 | 16.88 | 1614 | 1781 | 11.71 | 11.38 | 3 | 2 |

ST — Saw toothed type opening roller; and Pin — Pin type opening roller.
earlier. No rotor cleaning was done during the study even in case of any end breakage.

2.3 Study on Effect of Opening Roller Speed
To study the effect of opening roller speed on rotor deposition, end breakage rate and yarn quality, five different opening roller speeds in the range 6500 - 8500 rpm were selected. The yarns were spun from draw frame slivers with 0.51% residual trash content to study the end breakage rate and yarn properties after time interval of five hours. The average deposition per rotor and the end breakage rate were measured as discussed earlier.

3 Results and Discussion
3.1 Effect of Time Interval
Table 1 and Fig.1 show that the amount of rotor deposits increases with the increase in time interval, initially at a very rapid rate, slow down after 5 h and almost stabilize after 10 h, both for saw toothed and pin type opening rollers. During the action of opening roller the fibres are opened thoroughly to an individualized state, where the dust particles are also free to move. Most of the dust particles go to the dust chamber and the remaining particles move along with the fibres and are deposited inside the rotor groove. These dust particles go on depositing inside the rotor groove with the time and saturation is reached when the rotor groove gets completely filled with the microdust.

It is also clear that the amount of rotor deposit for pin type of opening roller is higher than that for saw tooth type. This is due to the fact that the pin type opening roller performs better opening and individualization of fibres which results in better extraction of microdust. The separated microdust thus gets deposited quickly on rotor grooves in case of pin type opening roller.

As the microdust goes on depositing inside the rotor groove with the time, the end breakage rate increases (Table 1 and Fig.2). This is due to the improper laying of individualized fibres inside the wider part of rotor groove in place of actual yarn forming rotor groove which has already been filled with microdust. A similar trend was observed in earlier studies also. It is also observed that the rotor deposition and end breakage rate have positive correlation.

The yarn quality is also found to be deteriorated with the time interval (Table 1) due to the increase in rotor deposition, which is in agreement with the reported studies. The yarns produced from pin type of opening roller show better quality than those produced from saw toothed type. This may be due to the better opening and combing action, which results in better individualization and proper alignment of fibres in rotor groove and less fibre breakage even though the rotor deposition is higher.

3.2 Effect of Residual Trash Content in Draw Frame Sliver
The effect of residual trash content in finisher draw frame sliver on rotor deposition, end breakage rate and yarn quality is shown in Table 2. It is clear that the higher amount of trash in sliver is accompanied by
the higher number of end breaks, which is due to the deposition of more microdust inside the rotor groove when the residual trash content in sliver is more. A similar trend was also observed by earlier workers.\(^6,7\) Rotor deposition in case of pin type of opening roller has been found to be high for all levels of residual trash content. The reason has already been explained earlier.

Fig. 3 shows the effect of residual trash content of sliver on yarn CSP. It is observed that the yarn CSP steadily deteriorates with the increase in trash content in sliver, which is due to the improper laying of fibres inside the rotor groove because of the interference of trash particles. The irregularity also increases with the trash level of sliver (Table 2). The build-up of trash particles in the rotor groove prevents fibres from occupying the narrowest part of the collecting groove. The strand of fibres is, therefore, wider and less precisely positioned which causes erratic yarn formation, resulting in uneven yarn. The residual trash in sliver also results in higher yarn imperfections.

### 3.3 Effect of Opening Roller Speed

Table 3 shows the effect of opening roller speed on rotor deposition, end breakage rate and yarn quality. It is evident from Fig. 4 and Table 3 that the amount of accumulated trash particles in the rotor groove increased with the increase in opening roller speed, which is due to the two factors: (i) an increased freeing of trash particles through better fibre individualization, and (ii) the greater impact of the opening roller clothing causes fibre breakage. A similar trend was also observed by earlier workers.\(^8,9\)

The end breakage rate shows initial slight reduction and then abrupt increase as the opening roller speed increases (Table 3). The initial marginal reduction may be due to the better fibre opening. After opening roller speed of 7500 rpm, the end breakage rate
increases due to more trash accumulation in the rotor groove and higher fibre breakage.

The yarn CSP increases initially and then decreases as the opening roller speed increases (Table 3). The initial increase in CSP is due to the better axial orientation of fibres in the yarn but beyond a certain limit, due to the excessive opening roller speed, fibre breakage occurs, which is responsible for lower CSP. A similar observation was reported by earlier researchers.

The irregularity of yarn initially decreases as the opening roller speed increases due to the better opening of the fibres, but after a certain level, it again starts increasing which may be due to the higher rotor deposition and fibre breakage. A similar trend was also observed in case of thick places and neps (Table 3).

4 Conclusions
4.1 The rotor deposition increases with the time interval until it reaches a steady level.
4.2 The increase in rotor deposition results in deterioration in yarn quality and increase in end breakage rate. So, after a certain interval of time, the rotors should be cleaned to restore the yarn quality.
4.3 Residual trash content of finisher draw frame sliver has a significant effect on running performance and yarn quality. Higher the residual trash content in slivers, the higher is the end breakage rate and poorer the quality due to the higher rotor deposition.
4.4 The increase in opening roller speed results in increase in rotor deposition. The end breakage rate initially decreases marginally and then increases with the increase in opening roller speed.
4.5 Yarn properties in terms of strength, irregularity and imperfections improve initially with the increase in opening roller speed and then deteriorate after a certain level.
4.6 The quality of yarn produced from pin type opening roller is always better than that produced from saw toothed type opening roller.

References
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