Influence of sliver can spring load, coil position and storage time on yarn quality
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Abstract
Sliver can spring is considered as heart of a sliver can, which is subjected to fatigue loading, so with time spring stiffness reduces. Most of the spinning industries in developing countries including India are extensively using older sliver cans having low spring stiffness than normal, which may influence quality of material being stored and transported to subsequent machines. This paper reports on the experimental determination of the effect of spring load on quality of combed yarn manufactured from top, middle and bottom sliver coil position & at different storage time.

Keywords: Material handling, sliver can spring, spring load, coil position, storage time

1. Introduction
Material handling in a spinning industry is an imperative issue while processing, transportation and storage of material at different stages of yarn manufacturing. At preparatory stage, effect of poor material handling may not be noticeable but very much noticeable and magnified after the material being drafted over speedframe and ringframe. Poor material handling during storage & transportation of combed sliver may deteriorate yarn quality significantly due to low inter-fibre cohesion. Can spring is subjected to fatigue and surface fractures as a result of cyclic and intermittent loading-unloading, combined effect of humid environment, time and continuous loading-unloading cause reduction in spring stiffness[2]. These Older sliver cans of reduced spring stiffness are excessively used in spinning industries and material being stored inside such older sliver cans may influence ultimate yarn quality [1, 3].

This fact is confirmed by conducting an experimental study, using a three-factor–three-level Box-Behnken design of experiment that shows the individual as well as interaction effects of the spring load, sliver coil position and storage time of sliver in a sliver can on combed ring spun yarn quality. Storage and transportation of intermediate material are substantial cost factor in a mill further they often exert a quality reducing influence on the final product [4,5]. It has been believed that there is significant difference in quality of yarn manufactured from a material which is stored for different time period as a result of back stuff shortage, maintenance loss and power loss [6].

2. Materials and Methods
In the present study, Sliver can springs were tested for spring stiffness factor measured in Newton per cm, also spring load capacity of a group of 6 and 3 year older cans were determined along with a freshly supplied sliver can spring of same material. These sliver cans of different load capacity were analysed by storing 22 kg sliver each can, whole length of sliver stored is fragmented into bottom, middle and top position inside sliver can, as force applied by spring changes, depending on sliver coil position. We are aware of the fact that, in spinning unit sometime we have to keep sliver for storage due to poor batch planning, maintenance loss and power loss so to study the effect of storage time, material was being stored in different load capacity sliver cans for three time slots.

2.1 Materials
Samples were manufactured on finisher drawframe from 100% combed cotton with a blend of J34/ Mech 01 (70/30) proportion. Keeping all the speeds and settings constant, sliver samples were processed on speedframe and then ringframe to get 42* Ne combed yarn samples.

2.2 Experimental design
A three-variable factorial design proposed by Box & Behnken was used to investigate the combined influence of sliver can variables, namely spring capacity, coil position and storage time on combed yarn quality. The actual values of three variables corresponding to coded levels are given in table 1.

A few most relevant Quantative as well as qualitative change parameters were considered as show in Table I

2.2 Yarn testing:
The yarn samples of 42* Ne were then tested on Uster Tester SX-4 for yarn unevenness percentage and imperfections. Measurement of mass variations by
### Table 1: Factors and their corresponding level of variation

<table>
<thead>
<tr>
<th>Change Parameters</th>
<th>Levels</th>
<th>Factor</th>
<th>Nature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring capacity (Kg)</td>
<td>18</td>
<td>Variable 1</td>
<td>Quantative</td>
</tr>
<tr>
<td>Sliver Coil Position</td>
<td>Bottom (1500 m)</td>
<td>Middle (1500)</td>
<td>Top (1500)</td>
</tr>
<tr>
<td>Storage Time (Hrs)</td>
<td>0 Hr</td>
<td>4 Hr</td>
<td>8 Hr</td>
</tr>
</tbody>
</table>

### Table 2: Yarn testing results

<table>
<thead>
<tr>
<th>Runs</th>
<th>Change Variables</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Change Parameters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spring Load</td>
<td>Coil Position</td>
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<td>-1</td>
</tr>
<tr>
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<td>1</td>
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<td>3</td>
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<td>15</td>
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</table>

monitoring change in capacitance at testing speed of 400 m/min. Yarn samples were also tested for breaking force, elongation % and RKM on Uster Tensorapid 3 based on constant rate of elongation for single yarn strength at 500 mm gauge length & at 50 meter per minute speed allowing 20 ± 3 sec time.

3. Results & Discussion

It has been observed that effect of change variables is more prominent on yarn evenness, number of thin places and combined effect of all these thing results in variation in strength CV% as show in Table 2.

#### 3.1 Effect of spring load & storage time on U%

It has been observed that yarn samples made from low spring load sliver can springs and at high storage time gives higher value of unevenness as shown in figure 1. Reason being, at high storage time chances of fibre leaking from adjacent sliver coils are high. Uneven sliver results in uneven yarn after material being drafted over speed-frame and ring-frame.

#### 3.2 Effect of spring load & coil position on strength CV%

Bottom sliver coils from reduced spring stiffness of older sliver can gives higher strength CV%. During sliver deposition in reduced stiffness sliver can spring, after deposition of few sliver layers, most of free height gets compressed and length of sliver in hanging zone between coiler and top sliver layer will be more, sliver stretching may occur in this zone because of its own weight of sliver. Hence, long thin places may be introduced in final yarn and also influence strength of single combed yarn. Bottom sliver coils from low spring load sliver cans gives high strength CV% as observed figure 2.

#### 3.3 Effect of storage time & coil position on strength CV%

It has been observed that high storage time have an adverse effect on yarn quality. Strength CV% is high at

Figure 1 Effect of spring load & storage time on U %

Figure 2 Effect of spring load & coil position on strength CV%
higher storage time and effect is more prominent in case of bottom sliver position as observed figure 3. At high storage time bottom sliver coils stick with adjacent coils because these coils gets sandwiched between top sliver coils weight and force applied by spring through top plate. During withdrawal fibre leaking from one layer to another may occur and result in long thin places and high strength CV% in final yarn manufactured from this uneven feed sliver.

Figure 3 Effect of storage time & coil position on Strength CV%

3.4 Effect of storage time & coil position on thin places
it has been found that at high storage time, bottom position sliver coils will stick with one another because of low inter-fibre friction and more contact area of flattened sliver coils. Sliver splitting and stretching at speed-frame will be more in case of high storage time and its effect will be more prominent in case of bottom coils as observed figure 4. Number of thin places in yarn will be more if we allow high storage time to finished combed sliver.

Figure 4 Effect of storage time & coil position on thin places

3.5 Effect of Coil position and storage time on U%
U% of yarn have been found increasing with increase in storage time of a can sliver as observed from figure 5. At higher storage time, bottom sliver coils may experience compression forces applied by top coils sliver layer and reverse spring forces for longer period. As a result of this, sliver flattening of bottom sliver will take place and sliver stretching would occur at while withdrawing sliver at speed-frame, cause higher U% in yarn.

Figure 5 Effect of Coil position and storage time on U%

3.6 Effect of spring load and coil position on U%
Bottom coils stick with subsequent sliver layers, combined effect of low spring load for bottom coils result in higher U% in yarn, observed from figure 6. As discussed earlier, the main reason is disturbed structure of bottom sliver coils and then sliver stretching at creel zone of speed-frame.

Figure 6 Effect of spring load and coil position on U%

4. Conclusions
4.1 Effect of coil position and storage time is found significant whereas the effect of spring load is not that much significant on yarn unevenness.
4.2 Spring load, coil position and storage time has been found significantly influencing thin places -50%/km.
4.3 Only disturbed bottom sliver coil position is found influencing strength CV% of yarn. Effect of middle, top sliver coils, spring load and storage time on strength CV% is non-significant.
4.4 Sliver cans springs having low spring stiffness were found significantly influencing yarn quality because sliver stretching during deposition at finisher draw-frame sliver can and withdrawal of sliver from storage cans at speed-frame.

5 References

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