Short Communications

An innovative approach for energy conservation in ring spinning

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An attempt has been made to modify the spindle system – drive for minimizing the energy consumption to a maximum extent without compromising on the yarn quality, production and machine performance. It is found that the novel modification reduces the pulling load imposed on a prime mover and leads to 10.8% power saving.

Keywords: Energy conservation, Jockey pulley, Ring spinning, Spindle drive system

Energy is one of the most important ingredients in any industrial activity. Several research works on minimizing energy consumption for yarn winding in ring spinning process are still going on. Global energy crisis and high cost of fuels have resulted in more activities to conserve energy to a maximum extent. Amongst other industries, textile industry retains a record of the lowest efficiency in energy utilization and is considered to be one of the major energy consuming industries. The earlier reports illustrate the effect of yarn hairiness on energy consumption in rotating a ring-spun yarn package1,2. As far as spinning/weaving is concerned, power requirement is high, while in chemical processing thermal energy is considered as a very important requirement. It is known that thermal energy in textile mill is largely consumed mainly in two operations, namely heating and drying of water. Fuel consumption in textile mills is almost directly proportional to the amount of water consumed. Hence, consumption of water can be reduced to save the energy. Conservation of energy depends upon the process and machine modification, usage of proper chemical recipes, and implementation of new technologies. The possibilities of utilizing new energy resources like solar energy, wind power, tidal power and nuclear energy, are yet to be explored. The initial cost of production increases in step with the cost of oil, which makes development of such sources doubtful in terms of cost incurred. A study on the factors that affect labour and energy costs in ring - spun yarn production has been reported by Kog and Kuscuoglu3.

An analysis on the results of second stage energy conservation studies were carried over in a previous attempt.4 The key to achieve this is through energy efficiency, as it not only reduces the production cost, but also reduces the amount of impact on the environment.5 With this background coupled with the fact that previous studies are only concerned with certain types of energy conservation technology, system and process, such as cogeneration, air-conditioning, and dyeing processes, in this study an attempt has been made to develop an innovative method of modifying the spindle drive for minimizing the energy conservation without affecting the quality, production and machine performance.

Square rods, hexagonal bolts, nuts and plate washers were used for fabricating the modified bracket for one full ring frame machinery. The fabrication work was carried out by a local contractor. Guide jockey pulley and suitable nylon rings for jockey pulley were used for the guiding purpose with holding screw of dimension (18mm×5mm) along with spring and plate washer. Tension jockey pulley with the nylon rings was also used for imparting sufficient tension.

The modification was done for energy conservation based on the following three criteria:

(i) Design factors, e.g. type of drive system and selection of prime movers,
(ii) Process and production factors, e.g. count pattern and speed, and
(iii) Maintenance factors, e.g. cleaning, lubrication and overhauling.

Three types of drive systems like conventional system, modified spindle drive system I and modified spindle drive system II were framed and analyzed for the consumption of energy. The machine particulars and drive systems are discussed below:

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Make of the machine: Lakshmi Rieter, Coimbatore, Model: DJ5, No of spindles: 528 spindles, Prime mover: single motor (17.5 HP), Spindle drive system: tin roller, Ring diameter: 42mm and Gauge: 72 mm

Conventional system
Prime mover is rotated by means of electrical energy. The power is transmitted to tin-roller shaft or main shaft by means of pulley with the help of flat (or) V belt. The power is transmitted from tin-roller to 4 – spindles group through nylon sandwich tape with the help of tension jockey pulley.

Modified system I
In modification 1, the power is transmitted from tin-roller to 16 – spindles group through nylon sandwich tape with the help of tension jockey pulley and guide jockey pulley.

Modified system II
In modification 2, the same power is transmitted from tin-roller pulley to 16-spindles group through nylon sandwich tape with the help of tension jockey pulley.

The modified specifications are listed in Table 1. Modified bracket sketch with their dimensions is represented in Fig. 1. The spindle drive system is represented in Fig. 2.

The conventional trial was carried out and all performance quality and conservation analysis has been done. The modified bracket system was fixed on ring frame and the second phase trail was carried out like the previous one. All the conventional types of tin rollers were removed and tin roller pulley was fixed. The third phase trial was found to be same as that of the previous method. The results are shown in Table 2.

From the above set of observations, the modifications I and II prove to be highly effective in reducing the pulling load imposed by the prime mover, the mechanical load on the bearings and the resistance offered to the tape drive system in terms of air drag and ending resistance.

The modified bracket system helps the power to be transmitted from tin-roller to 16 – spindles group through nylon sandwich tape with the help of tension jockey pulley and guide jockey pulley which leads to high energy consumption comparatively to the power transmission done from tin-roller to 4 – spindles group of the conventional spindle-drive system. It also helps to reduce the vibration, noise level and tape length. The spindle speed, empty cop, net yarn weight and all other major findings are found to be closer with respect to the conventional system. Hence, the above modification is found to be successful with respect to productivity and machine performance.

The average time taken per doff is found to be 4.30 h. The unit consumed in modified systems I and II per doff is found to be 33.47 units which is comparatively less with respect to conventional system having the consumption of 37.47 units; this shows which brought considerable savings in units/ doff to four. The number of doff produced per day is 5.33 and units savings/ day/ frame is

<table>
<thead>
<tr>
<th>Table 1—Modification details</th>
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<tbody>
<tr>
<td>Description</td>
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<tr>
<td>No. of spindles/machine</td>
</tr>
<tr>
<td>No. of tin rollers used</td>
</tr>
<tr>
<td>Total tin roller pulley</td>
</tr>
<tr>
<td>Total weight of tin roller, kg</td>
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<tr>
<td>No. of jockey pulley</td>
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<tr>
<td>Length of one spindle tape, mm</td>
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<tr>
<td>Total length of spindle, m</td>
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<tr>
<td>Reduction in pulling load, kg</td>
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<tr>
<td>Reduction in tape length, m</td>
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</tbody>
</table>

TR — Tin roller, TRP — Tin roller pulley.

Fig. 1 — Modified bracket (Dimensions are in mm)

Fig. 2 — Spindle drive system
The payback period details are given below:

- E.B. tariff/unit: Rs.4.10
- Cost saving/day/frame: Rs.87.41
- Total modification cost/frame: Rs.52441.55
- Payback period for the modification cost: 600 days
- No. of years: 1.68

The above observations clearly prove that the modified system is so effective with respect to energy consumption angle.

The total end breakages are found to be on the lower side in the modified systems I and II with respect to the conventional system. Similarly, the end breakages/100 spindles are reduced in the modified systems I and II as compared to the conventional system. From Table 3, it is inferred that a saving of nearly 1000 units/day is possible in the modified system which proves to be more economical for a capacity of 25000 spindleage mills. There is no significant difference found with respect to quality parameters. Hence, the above modification is successful with respect to quality angle. The total material cost from tin roller to pulley conversion is estimated around Rs.40,000 and the cost for the spindle drive system is estimated around Rs.11,275.

The total tape length requirement/528 spindle frame is estimated around Rs.1166.55 and the grand total modification cost is found to be Rs.52,441.55. From Table 4, it is also inferred that an approximate saving of Rs.3830/day can be achieved in all the spinning mills which proves that both the modifications I & II do not influence major changes in the cost investment for fulfilling the requirements with respect to the conventional system.

The above approach in ring spinning offers considerable findings with respect to energy conservation in par with the conventional system. The above research analysis successfully proves that 10.8% of power saving in the spindle drive system in ring frame and reduction in pulling load to the prime mover (main motor) is possible. Reduction in vibration and noise level and tape length is found to be 58%. The method has an attractive payback period of 1.7 years. It can be incorporated easily in different models of ring and doubling frames. There is no need of any major changes in the basic design of ring or doubling frames and the total cost for 25000 spindles per day for conventional system is Rs.38,475 and for modified system is Rs.34,645. Hence, a total saving of about Rs.3830 per day is benefited.

References