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Power Consumption of Ring Spinning Frame Using Plastic T-in Cylinder

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Abstract

Spinning factory consumes the highest amount of electrical power than Weaving, Knitting, Dyeing and Garment unit of Textile Industry. A typical spinning unit of 20000 spindles requires about 2 Megawatt (MW) connected power to run the process machinery. Power is also a major cost component of yarn production after raw materials and hence reduction of power cost is an utmost concern for the management of spinning unit. This investigation aims to reduce power consumption of Ring frame using Plastic T-in cylinder. 2850 meters length of a 30 Ne yarn fineness was spun in a Ring frame with T-in cylinder, and the same length of that yarn was also produced by a Ring frame with Metallic T-in cylinder from the same feed material (Roving). Power consumption was measured by a Digital power meter during the production of yarn at different set lengths. The power consumption was 39.5 KWH and 37.3 KWH corresponding to Metallic and Plastic T-in cylinder. The reduced power consumption suggests that the setting up of new spinning unit can be considered to be designed with Ring frame with Plastic T-in cylinder.

Keywords: Energy Conservation, T-in Cylinder, Power cost, Ring frame.

1. Introduction

Textile and Readymade Garment (RMG) industry are one of the largest manufacturing industries that supplies clothing and other related products for human being [1]. This industrial sector is also the economic back bone of many developing countries [2]. The developing countries faces many problems related to the supply of fuel to the Textile and RMG industry. Textile and RMG Industry generally uses natural gas to convert it into electrical power by gas generator [3]. The availability and cost of the supply gas is also a factor for the efficient running of the Textile and RMG industry. The fuel cost of other sources is also higher than the natural gas [4]. Natural gas is a non-renewable energy source, and extracted by drilling into the earth [5]. In order to reduce the use of natural gas and power consumption by the Textile industry and especially Ring spinning has to put attention on it. Spinning is a such kind of production unit that requires substantial amount of power to run the process machinery. For instance, 2MW power is required to run the process machinery of a Ring spinning unit having 20000 spindles capacity. Fig. 1 shows the power requirement for various process machinery of a Ring spinning unit [6-7]. It is evident that Ring section of a Ring a spinning unit consumes around half of the installed power among all processes. Spindles of the Ring frame runs at 15000-20000 rotation per minute (rpm) for inserting twist in yarns. Many efforts have been paid in the recent decade in order to reduce power consumption of the Ring frame. Electrical inverter has been using in Ring frame to control electrical frequency for adjusting the rotational speeds of the spindles required as per specific diameter of the yarn carriers (cops; bobbin to store or wind yarns on it) [8].

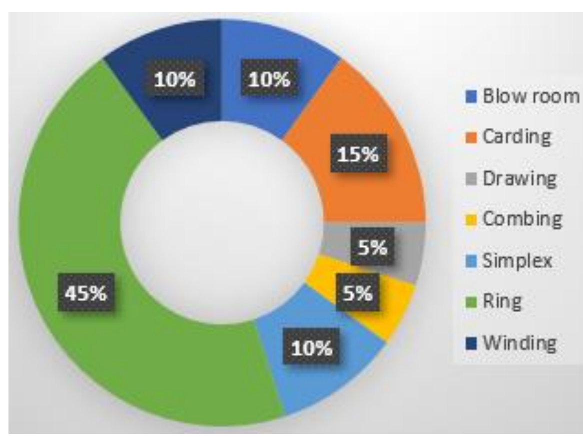

Fig. 1. Distribution of Power Requirement for various processes of a Ring spinning unit.

Ring frame manufacturers like Rieter, Marzoli, Toyoda, Lakshmi, Jingwei and others have developed Ring frames with multiple motors and large number of Spindles [9]. World leading spindle manufacturers such as Novibra and

Texparts have introduced spindles with less wharve diameter for achieving increased rotational speeds of spindles with same energy consumption or the spindles can run with the same rotational speeds utilizing less electrical power [10]. Power monitoring system has also been developed by the manufacturer like Pinter-Caipo, Premier, Datalog and Mag Solvics for real time monitoring of the power consumption of Ring frames so that the management can understand how well the Ring frame is being maintained, whether the Ring frame is consuming higher energy than usual due to the faults of motor, bearings and other power transmission systems and accordingly the mill management can take preventive measures to avoid unnecessary loss of electrical powers [11]. Ring frames are designed with T-in cylinder that drives the spindles.

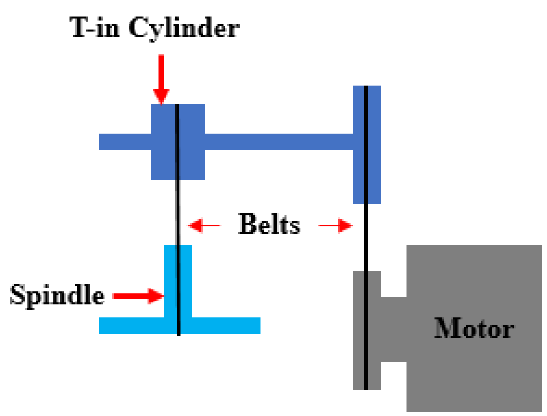

Fig. 2. Driving structure from motor to Spindle of a Ring frame. Motor drives the shaft containing T-in cylinder, and T-in cylinder finally rotates the spindle.

Fig.2 shows the driving structure from Motor to Spindles of a Ring frame. Motor has a pulley that uses electrical power to drive T-in cylinder. The mass of the T-in cylinder determines the power required for driving motor. It can be noted that as of today all commercial Ring frames are normally supplied with metallic T-in cylinder. It was necessary to equip metallic T-in cylinder due to its strength of the materials and lack of availability of other materials of similar strength. Plastic industry and polymer-based composites have gained much attention to the use of alternative materials to metals [12]. Very recently, Ring frame manufacturers can supply their machine with Plastic T-in cylinder considering the global crisis of energy as well as sustainable environment [13].

Many researchers tried to reduce energy consumption of Ring frames with respect to the installation of new type of bearings [14], Speed change [15], Package diameter [16] and implementation of timing belt [17]. All efforts were successful to the reduction of power consumption but spinning units are still struggling in reducing power consumption of Ring frames to a greater extent [18-19]. This study has investigated the opportunity of using Plastic T-in cylinder in Ring frame. The objective of this study is to find out the amount of energy consumption of Ring Frame equipped with Plastic Tin cylinder compared to Metallic one.

2. Methodology

2.1 Raw Materials

Dope dyed viscose and cotton fibres were used at ratio a 90:10 respectively.

2.2 Process Machinery

Rieter automatic mixing and blending, and carding machine were used for opening and individualization of fibres. Mixed fibres were passed through the Rieter Drawing for the production of sliver. Finally, the sliver was used to produce roving by the China simplex machine.

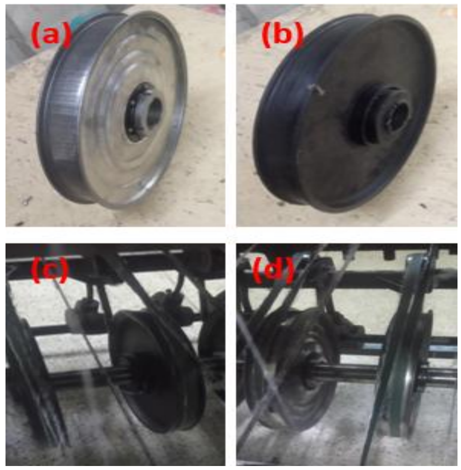

Fig. 3. Metallic T-in cylinder (a), Plastic T-in cylinder (b), Plastic T-in cylinder mounted in Ring frame (c) and Metallic T-in cylinder mounted in Ring frame (d).

A Ring frame with 516 spindles of Jingwei brand and another Ring frame with same number of spindles and brand were used to produce yarns of 30 Ne fineness. Metallic T-in cylinder was used in one Ring frame and Plastic T-in cylinder was used in another Ring frame as shown in Fig. 3. Yarn length was fixed as 2850 meters for both Ring frames. Similar Spindles speeds (%) corresponding to yarns length (%) to be wound on cops were programmed in the Inverter for the production of yarns.

2.3 Measurement of Power Consumption

A digital power meter was used to take the readings of power consumption. Several numbers of readings were taken from the power meter with respect to yarn production length (%) during the winding of three and half hours for both cases of Plastic and Metallic T-in Cylinder. Three phases electrical line were connected to the Ring frames.

3. Results and Discussions

3.1 Effect of Spindle Speed Pattern on Power Consumption

Yarn package diameter affects the speed of the Spindles. At initial point of winding, the diameter of the cops is less and the angle of winding of yarn to cops is less that produces excessive winding tension to yarns causes higher yarn breakage. In order to avoid yarns breaks, spindle speed is kept as low as possible at the beginning of winding. Fig. 4 shows the spindle speed profile with respect to yarn length from initial point of winding (0%) to set length of yarn. A linear relationship is found between the spindle speed and power consumption up to the point where spindle speed reaches to its maximum.

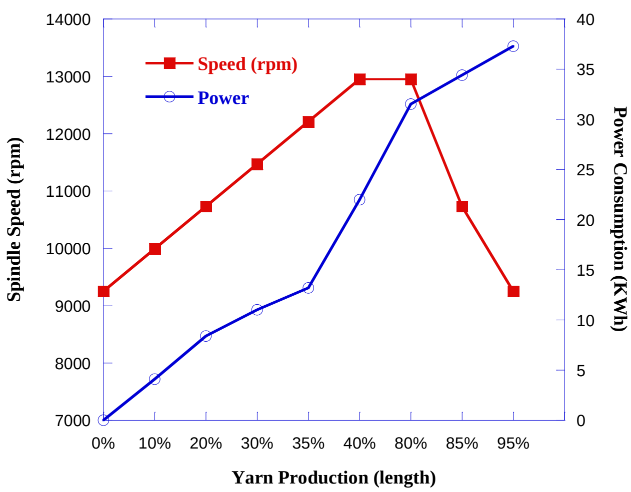

Fig. 4. Power consumption against the pattern of Spindle speed.

Gradual increase in spindle speed was possible due to increase of winding angle of yarn to the cops. When diameter of the cops starts to become large then again winding tension increases because of the excessive cops diameter. At this stage, spindle speed is to reduce to minimize the yarns breakage rate. Power line of the figure shows the gradual accumulation of power from beginning to end which is almost linear.

3.2 Effect of Metallic and Plastic T-in Cylinder on Power Consumption

Fig. 5 depicts the power consumption of Metallic and Plastic T-in cylinder as a function of yarn production of set length as percentage. Metallic and Plastic T-in cylinder both shows liner progression of power consumption as explained by Fig.4 The power consumption of Plastic T-in cylinder was less than that of the Metallic T-in cylinder at most of the point of winding of yarn to cops. Power consumption for Metallic T-in cylinder and Plastic T-in cylinder were 39.5 KWH and 37.3 KWH respectively during the yarn production of 3.5 hours. The amount of power savings was 2.2 KWH (39.5-37.3). This is due to the weight difference between the Metallic and Plastic T-in cylinder. The weight of the Metallic cylinder was 1120 grams, and the Plastic T-in cylinder was 540 grams. As the weight of the Metallic T-in cylinder was higher, the power requirement to drive it by the motor was also higher and similarly the power consumption was less in case of light weighted Plastic T-in cylinder. In order to find the effect of brand of Ring frame, Marzoli and Jingwei Ring frame were used to compare.

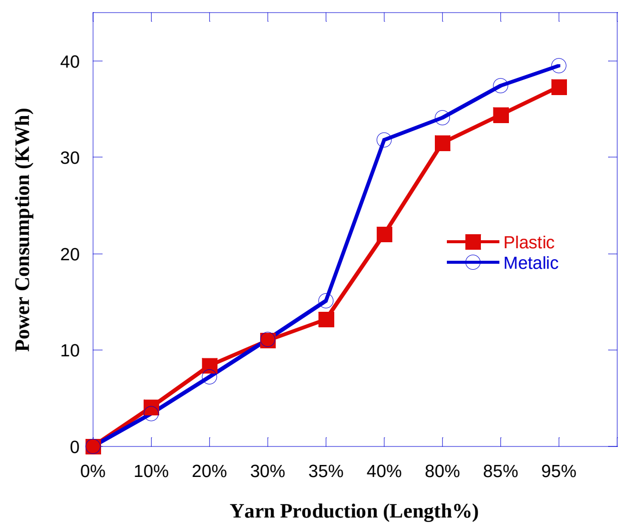

Fig. 5. Power consumption of Metallic and Plastic T-in Cylinder with respect to yarn production length.

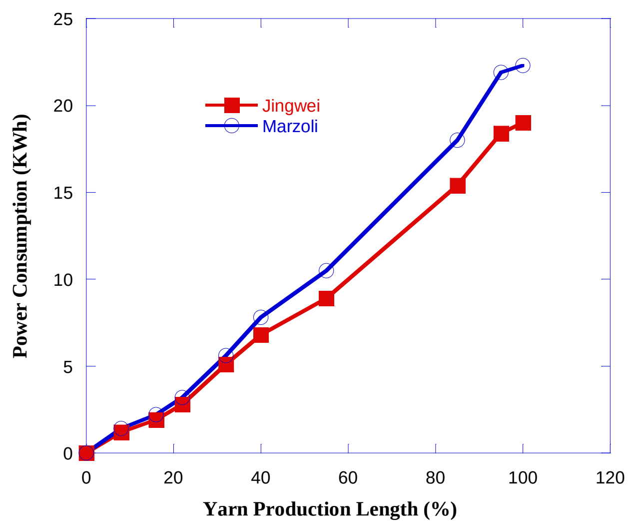

Fig. 6. Power consumption of Jingwei and Marzoli brand Ring frames using Metallic T-in cylinder for the production of yarn length of 1850 meters.

Fig.6 shows the effect of power consumption on the type of brand of Ring frame. Jingwei brand Ring frame results less power consumption as compared to Marzoli brand Ring frame. This result also suggests that structure of the Ring Frame with respect to bearings, motor, lubricant applied to the machine, maintenance of the machine and others factor can influence the results.

3.3 Effect of Yarn Production length (Doff) on Power Consumption

Doff length is the length of yarn to be produced and wound it to empty to full cops.

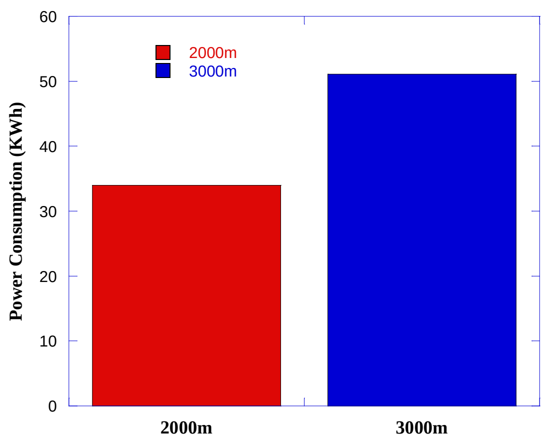

Fig. 7. Variation in Power Consumption of Jingwei brand Ring frames with two different doff lengths.

Normally spinning units want to set higher doff length in order to reduce the frequency of Ring frame stoppage. A Ring frame of Jingwei brand was used to produce yarns of two different doffs length of 3000 and 2000 meters. 3000 meters doff length shows higher power consumption than that of 2000 meters. As 3000 meters doff length requires more running time of Ring frame, and consumes more power than 2000 meters doff length. Though power cost can be saved by lower length of doffs but the cost of production loss is higher than the power saving and hence higher doff length is always desirable.

4. Conclusions

Price hike and shortage of gas supply initiates spinning units to save power cost as well as yarn production cost. This study successfully compared the power consumption between the Metallic and Plastic T-in cylinder of Ring frame, and revealed that Plastic T-in cylinder consumes less power that of Metallic. Modification of existing Ring frames equipped with metallic T-in cylinder by the Plastic T-in cylinder will not bring that much benefits but if new spinning unit is built, Ring frames with Plastic T-in cylinder would be prospective for the reduction of power consumption of Ring spinning units.

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