International Journal of Current Engineering and Technology
E-ISSN 2277 – 4106, P-ISSN 2347 – 5161

Available at http://inpressco.com/category/ijcet

Research Article

Impact of Card Production Rate on the Quality of Ring Yarn

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Accepted 10 Jan 2017, Available online 09 Feb 2017, **Vol.7, No.1 (Feb 2017)**

Abstract

The quality for any production process is usually inversely proportional to quantity. In the current work, this relationship has been shown in between the productivity of carding machine and the quality of respective it produced. Keeping the hank of delivery sliver constant (0.11 Ne here), card production rate (delivery speed of carding machine) was gradually increased from 60 -180 meter/min at five steps (60, 90, 120, 150 and 180 meter/min respectively). Subsequently 30/1 Ne carded ring knit yarns were produced with each sliver. The quality parameters of card sliver and yarns were studied by employing various instruments such as Uster AFIS (Advanced Fibre Information System), Uster evenness tester and yarn strength tester. It was found that with the increase of card production rate, the irregularity (Um% and CVm%) of card sliver and consequently the irregularity of yarn increased. Nep removal efficiency% of card decreases with increasing card production rate that directly reflected to high nep count in yarns. Thick and thin places of yarns are also reported higher with the increase of card production rate. Higher irregularity and imperfections of yarns caused from higher card speed resulted in the decrease in yarn strength. Nep removal efficiency of card, irregularity of sliver and yarn as well as imperfections (thick places, thin places and neps), yarn hairiness, yarn strength were found more satisfactory level at the card production rate of 60-120 meter/min. On the contrary nep removal efficiency of card, irregularity of sliver and yarn as well as imperfections, yarn strength, yarn hairiness at the card production rate of 180 meter/min were not found satisfactory. In this study card production rate 150 meter/min showed optimized delivery speed for satisfactory level of nep removal efficiency, irregularity as well as imperfections, hairiness and yarn strength.

Keywords: *Nep removal efficiency, Carding, Imperfections, Production rate, Ring yarn*

1. Introduction

Carding is the most important machine in spinning. It contributes a lot to the yarn quality. “The card is the heart of the spinning mill” and “Well-carded is half-spun” are two proverbs of the experts.

These proverbs inform the immense significance of carding in the spinning process. High production in carding to economize the process leads to reduction in yarn quality. Higher the production, the more sensitive becomes the carding operation and the greater danger of a negative influence on quality. The technological change that has taken place in the process of carding is remarkable. Production got from carding machine 5-10 kgs/hour up to 1970, at present latest carding machines produce the production rate of 60-100 kgs/hour.

Since carding is an intricate process, it involves a number of parameters and different technologies that improve the carding productivity. Improving the carding productivity has been made possible by the developments in several sciences and fields such as machinery, material science, automation and control. These developments permit several ways for increasing carding productivity. The carding quality primarily depends on the area of the cylinder. The revolving flat keeps an important role to maintain the carding quality. An optimal number of flat bar is responsible for cleaning as well as removing neps and short fibres in carding machine. The pre-carding area with its cleaning and carding elements perform for cleaning and removing neps and short fibres. The higher the pre-opening, the more intense the carding that resulting in high production. The object of high speed carding is to increase the card productivity without reducing carding quality, or even improve it. It had been thought that fibre breakage would increase due to the increase of card delivery speed, but there is no evidence to increase fibre breakage as card delivery speed increases.

It was necessary to increase the production rate of the carding machine due to new technologies with considerably higher production levels were started to

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be implemented. Carding action can be described as the combing of fibers between two surfaces, which carry a set of angled wires (card clothing) oriented in opposing directions, when their relative speed is greater than zero. Ishtiaque, S. M., Chaudhuri, S. and Das, A. observed the effect of fibre openness at carding and it has been found that yarn irregularity and tenacity are improved due to fibre openness only up to a certain level and then yarn irregularity and tenacity do not improve further increase of fibre openness at carding.

Card draft, coiler diameter and draw frame delivery speed are also found to have significant effect on yarn properties. It has been reported that yarn tenacity, breaking elongation, evenness and hairiness are upgraded due to increase in card coiler diameter and draw frame delivery speed, and yarn quality deteriorate due to the increase in card draft of carding machine beyond a certain point (Istiaque *et al, 2008*). If card coiler diameter, card draft, and draw frame delivery speed increase percentage of trailing, leading and total fiber hooks decrease (Istiaque *et al, 2009*). The card causes lap-ups in the cylinder of card and formation of too many neps due to excessive beating in the heavier lap (Salhotra *et al, 1989*).

Some researchers investigated that, the reduction in card production rate improves the removal of neps at carding stage significantly due to the intensive carding action. Neps level tends to increase further at the drawing with higher card production rate. Neps can generate at draw frame due to inferior quality of card sliver at the higher card production rate. The yarn tenacity improves at lower card production rate because of better carding quality (Rakshit *et al, 1985*).

Neps in the drawn sliver mainly increase due to inferior carding quality at higher card production rate. Neps do not generate after carding due to the number of draw frame passage. With the increase in card production rate thick places and neps in ring yarn also increase. However, with the increase in card production rate the yarn unevenness increases marginally (Rakshit *et al, 1983*).

2. Materials and method

One carding machine was selected for sample preparation and five samples were taken from the same carding machine with the card delivery speed of 60 m/min, 90 m/min, 120 m/min, 150 m/min and 180 m/min. Then each sample was taken to Uster AFIS PRO for testing neps per gm of sliver and Uster evenness tester for testing sliver unevenness. Each sample of card sliver was then fed in breaker draw frame to produce breaker drawn sliver.

Each breaker drawn sliver was taken for testing sliver unevenness with Uster evenness tester. Then each breaker drawn sliver was fed in finisher draw frame and producing finisher drawn sliver. Each sample of finisher drawn sliver was taken to Uster evenness tester for testing sliver unevenness. Then each finisher drawn sliver was fed in simplex machine for making roving. Each roving sample was taken to Uster evenness tester for testing roving unevenness.

After that all roving sample were fed in ring frame machine and producing $30^{S}/1$ carded knit yarn. All yarn samples were taken to Uster evenness tester for testing yarn unevenness, imperfections and hairiness and Lea Strength Tester for testing CSP (Count Strength Product). The linear densities of the prepared card sliver, draw frame sliver and roving were Ne 0.11, Ne 0.11 and Ne 0.81 respectively. Before testing, all the yarn samples were conditioned in the laboratory under standard atmospheric conditions of $20\pm2^{0}C$ and a relative humidity of 65±2% for 24 hours.

3. Results and discussion

Effect of Card Delivery Speed on Nep Removal Efficiency%

Nep Removal Efficiency% (NRE%)

$$=\frac{\text{Neps per gm in card mat}-\text{Neps per gm in card sliver}}{\text{Neps per gm in card mat}}\times 100$$

Table 1: Test result of NRE% (Nep Removal Efficiency %) of carding machine

Machine	Card delivery speed (meter/min)	Card mat (neps/gm)	Card sliver (neps/gm)	NRE (Nep Removal Efficiency) (%)
Carding	60	341	39	88.56
	90		41	87.97
	120		43	87.39
	150		51	85.04
	180		69	79.76

From table 1, it is observed that if the delivery speed of carding machine increases, nep removal efficiency% of carding machine decreases. As a result, poor quality sliver will be produced and yarn quality will be deteriorated.

Effect of card delivery speed on Um(%) and CVm(%) of card sliver

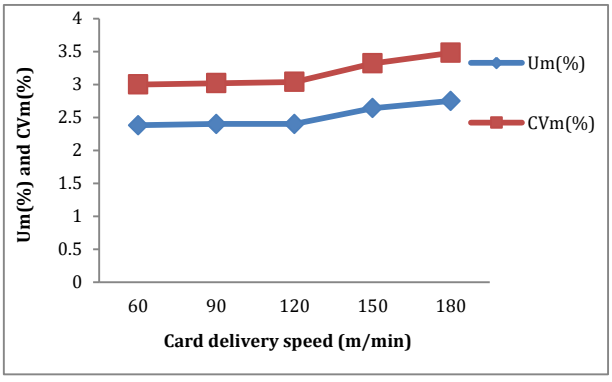

Figure 1: Card delivery speed vs Um(%) and CVm(%) of card sliver

From figure 1, it is observed that if card delivery speed increases, Um (%) and CVm (%) of card sliver also increases.

Effect of card delivery speed on Um (%) and CVm (%) of breaker draw frame sliver.

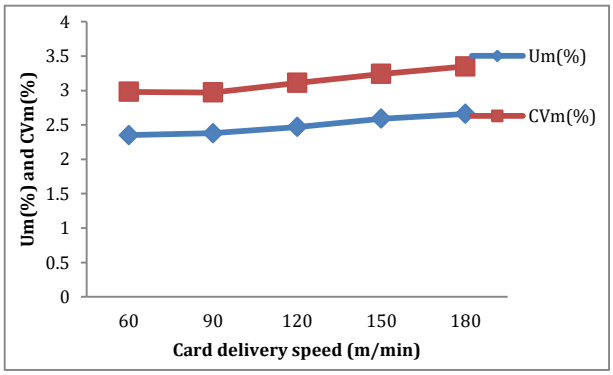

Figure2: Card delivery speed vs Um (%) and CVm (%) of breaker draw frame sliver

From figure 2, it is observed that there is no significant effect of Um(%) and CVm(%) in breaker draw frame sliver with increasing the card delivery speed. Since no variations in Um(%) of card sliver, so naturally no variations will arise in Um(%) of breaker draw frame sliver.

Effect of card delivery speed on Um(%) and Cvm(%) of finisher draw frame sliver

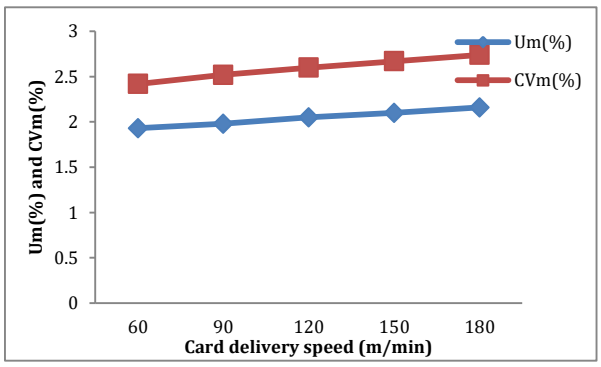

Figure3: Card delivery speed vs Um(%) and CVm(%) of finisher draw frame sliver

There is no significant effect of Um(%) and CVm(%) in finisher draw frame sliver with increasing the delivery speed of carding machine which is observed in figure 3. Moreover, autoleveller at finisher draw frame leveled the delivered sliver, so no variations occurred and reduced Um(%) of finisher draw sliver compared to breaker draw frame sliver.

Effect of card delivery speed on Um (%) and CVm (%) of roving

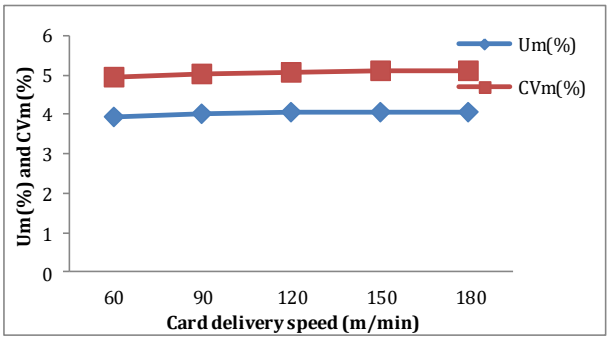

Figure 4: Card delivery speed vs Um(%) and CVm(%) of roving

With increasing the delivery speed of carding machine, there is also no significant effect of Um(%) and CVm(%) in roving which is observed in figure 4. But Um(%) of roving increases compared to Um(%) of finisher draw frame sliver with increasing the card delivery speed due to draft in simplex machine.

Effect of card delivery speed on Um (%) and CVm (%) of 30^s/1 carded ring knit yarn

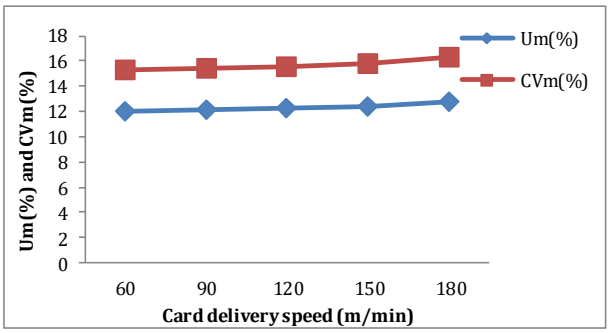

Figure 5: Card delivery speed vs Um (%) and CVm (%) of 30^S/1 carded ring knit yarn

From figure 5, it is observed that if the delivery speed of carding machine increases, Um(%) and CVm(%) of 30S/1 carded ring knit yarn also increases which produces poor quality of yarn.

Effect of card delivery speed on Imperfections of 30^s/1 carded ring knit yarn

Imperfections/km = [Thin places (-50%)/km + Thick places (+50%)/km + Neps (+200%)/km] (For ring yarn).

From table 2, It is observed that, if card production rate increases, thin places (-50%)/km, thick places (+50%)/km and neps (+200%)/km of 30^S/1 carded ring knit yarn also increases significantly due to improper carding action i.e. with increasing the card production rate of carding machine, imperfections of 30^S/1 carded ring knit yarn increases rapidly. So, delivery speed of carding machine should be kept as minimum as possible for producing better quality of yarn.

Table 2: Test result of Imperfections of $30^S/1$ carded ring knit yarn

Machine	Card delivery speed (metre/min)	Spindle speed (rpm)	TPI	Thin places (-50%)per km	Thick places (+50%) per km	Neps (+200%) per km	Imperfection/km (IPI/km)
Ring frame	60	15000	19.92	5	242	95	342
	90			7	280	118	405
	120			10	284	143	437
	150			17	305	177	499
	180			18	373	227	618

Effect of card delivery speed on Hairiness of $30^S/1$ carded ring knit yarn

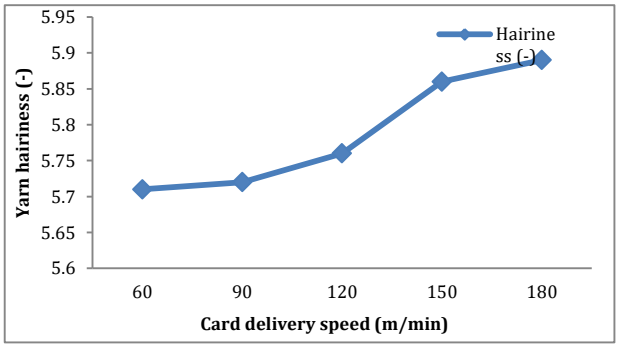

Figure 6: Card delivery speed vs. Hairiness of $30^S/1$ carded ring knit yarn

Fromthe above figure, it is observed that yarn hairiness increases with increasing the card delivery speed.

Effect of card delivery speed on CSP of $30^S/1$ carded ring knit yarn

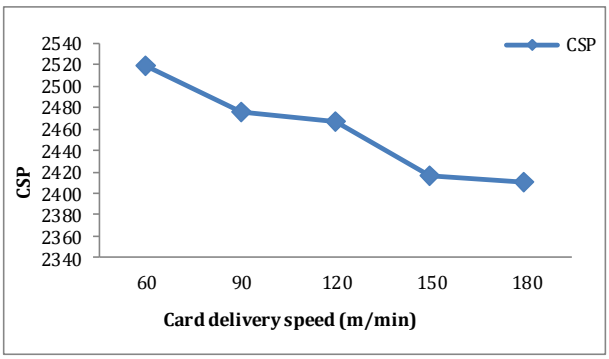

Figure 7: Card delivery speed vs. CSP of $30^S/1$ carded ring knit yarn

From figure 7, it is observed that there is no significant effect of yarn CSP with increasing the card delivery speed. Since higher IPI at higher card speeds, so CSP also lower which is also observed in this figure.

Conclusion

The increase in card production speed implying improper carding action causes the increase in irregularity of card sliver and decrease the nep removal efficiency that have direct impact on irregularity and imperfections (thick, thin and neps) of yarns. Alongside higher hairiness of yarns for higher card speed indicates lower integration of fibres with the yarn body. The higher irregularity, higher imperfections and lower integration of fibres with yarn result the yarn strength to be lowered. At the production rate of 60 to 120 m/min increases nep removal efficiency of carding machine, reduces irregularity (Um% and CVm%) of sliver and yarn, imperfections (thick places, thin places and neps), yarn hairiness and increases yarn strength. On the other hand card delivery speed 180 m/min produces lower nep removal efficiency of card and lower yarn strength, also produces higher irregularity of sliver and yarn, more imperfections and hairiness. The card delivery speed 150 m/min shows better nep removal efficiency of carding machine, better irregularity of sliver and yarn as well as better imperfections.

As a part of process optimization, the card speed should, therefore, be selected in accordance with the quality of fabric that will be made from respective yarns.

Acknowledgement

The author gratefully acknowledges the authority of Youth Spinning Mills Ltd., Gorai, Mirzapur, Tangail for giving the opportunity to conduct this study in the factory.

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