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Investigation of the Influence of the Delivery Speed of Carding on the Quality Properties of Yarn

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ABSTRACT: Carding is the very important process in yarn spinning. The setting of speed parameters need to be optimized to achieve better quality and productivity. In the spinning process, basically in the carding trials are generally taken due to continuous variation in the raw material. The carding process has a great effects on the quality of the sliver and also on the results of the quality properties of the yarn. Changes in the parameters of the carding process directly influence the quality and productivity of the yarn for further processing during the formation of the fabric. This study is conducted to substantiate the quality of yarn by changing the card delivery speed. The effect of changes in the quality characteristics of yarn produced at different the card delivery speed is analyzed by testing on laboratory equipment of the Uster® system. The main objective of this study is to determine the card delivery speed for yarn with a low linear density (mtex) using cotton fiber with good quality. A Zinser®72 ring spinning machine is used to obtain Ne 36/1 yarn. The yarn produced by spinning from a card sliver assembled with a different the card delivery speed shows the variable properties of the yarn with a change in the card delivery speed. The study mainly deals with analyzing the effect of licker-in, cylinder, flat and doffer (delivery) speed on yarn quality. The different speed trials have to be conducted to identify the yarn quality by changing the carding machine speed parameters and the changes in result of card sliver and yarn were checked by testing the samples on an AFIS and a UT- 5 tester to compare their properties.

KEY WORDS: carding, carding sliver, neps, delivery speed, quality, spinning.

I. INTRODUCTION

"What you comb through is what you spin out" is a well-known saying that is widely used among spinning process technologists all over the world [1]. The spinning process is considered the bases of the entire textile industry and the carding process is the heart of the spinning industry [2]. Any rotating mechanism or parts of the carding machine affect the quality of the resulting product; card sliver, yarn. Parameters of speed modes of the carding machine change the behavior of the fiber in subsequent processes; drafting, pre-spinning and also in spinning. Since 1965, the carding capacity has increased from about 5 kg/ h to 180 kg/h. [3]. The speed modes of the new generation of carding machines have increased threefold. The speed of the liker-in is from 700 min^{-1} to 2700 min^{-1}, the speed of the cylinder is from 350 min^{-1} to 900 min^{-1} and the speed of the flats is from 100 mm/min to 400 mm/min. Also with an increase in the working width of the carding machine (Rieter® C70) from 1,0 m to 1,5 m [4] allows you to increase the density of the produced tape from 3 ktex to 7 ktex. With an increase in the carding speed and working width of the carding machine, productivity was also achieved. With increasing productivity of carding machines, changes in the structure of finished products are also observed. Today for best production and quality of supplied material is necessary to optimize the parameters high-speed carding machines, such as the speed of the liker-in, the speed of cylinder, the flats speed and the delivery speed. Changing the quality parameters of the carding tape leads to failures in subsequent spinning processes. Optimization means defining standards for material produced at a certain quantity and speed.

The speed of the liker-in affects the removal of cotton waste, and can also cause damage to the fiber; the rotation speed of the cylinder affects the individualization of the fibers; the speed of the top flats is responsible for cleaning and removing short fibers and does not affect the uniformity of the product [5]. With the given set up of spinning machinery and available and raw material i.e. cotton. It is necessary for the spinner to spin best quality yarn. As all of us know that the effective and better carding means half of the good spinning. With this view in mind, a majority of the spinner wants to card at safe production rates. Does this really help? Carding is a very crucial machine where strict

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follow-up in terms of schedule replacement of wire and in maintenance activity like full cleaning and setting is of great importance. We know that in 3rd or 4th generation card because of the precision engineering and extra attachment like C cleaner, comb bar, licker-in carding plates, new type half closed and full closed cylinder under casing, reversal of flats and intermittent continuous removal of the waste has achieved much superior carding compared with conventional card at substantial higher production rate up to 75-100 kg per hour. In this card for better carding action cylinder speed are also maintained to the tune of 500 to 600 rpm.

For high-quality carding action, the rotation speed of the cylinder is recommended within 540 min^{-1} [6].

The experiment was carried out with four different speeds of production output on carding machines of Trutzschler [7] model TC-15, ranging from 70 to 80 kg/hour. The same mixture of cotton fibers 1-2 grades IV type class good [8] was processed from the blow room department to spinning processes.

II. METHOD AND MATERIALS

Fiber samples were selected based on the transitions of the spinning process with flowing materials by random sampling. The samples were tested on AFIS laboratory equipment [9]. The studied properties of the cotton fiber sample by transitions are shown in table 1.

Table 1.
Quality parameters of cotton fiber in the transition process
(data on the AFIS system)

Transition process		TotalNepCnt [Cnt/g]	Fiber Nep Cnt [Cnt/g]	SCNep Count [Cnt/g]	SFC (w) % 0.5in	SFC(n) % 0.5in	5% L(n) [in]	Fineness [mtex]	Maturity Ratio	IFC [%]
Uster Statistics-2018	**5%**	**103**	**97**	**4,7**	**2.8**	**13,2**	**33/34**	**177**	**0,96**	**3,7**
	25%	**160**	**151**	**8,7**	**4,3**	**16,4**	**33/34**	**170**	**0,92**	**4,7**
	50%	**237**	**224**	**13**	**5,7**	**19,7**	**33/34**	**162**	**0,89**	**5,8**
BDT 019/2300		237	218	19	6,4	19,3	33,2	172	0,9	5,7
CL-P		249	231	19	6,3	19,3	33,3	167	0,9	5,4
CLEANOMAT CL-U		289	261	28	6,8	20,4	33,5	169	0,92	4,9
CARD SHUT FEED		344	325	19	6,5	20	33	165	1	6
CARDING, TC-15		57	54	3	6,4	19	34	172	1	5
CLEANING EFFICIENTY, %		83	83	84	-	-	-	-	-	83
TD-9 1-Breaker draw frame		52	48	4	6,6	18,2	34,6	180	0,94	4,8
TD-8 finisher draw frame.		50	44	6	6,5	18,0	34,6	181	0,95	4,5

Table 1 shows changes in the quality indicators of the fibers that were used for this study. The table shows that in the process of opening and cleaning the fibers increase nodules-neps and shorten the fibers. This can be explained by the fact that in the process of opening and cleaning, the fibers are exposed to the impact of prick and needle drums, which in action leads to the grinding of large weeds and also igniting dead fibers into nodules and thus evils appear. These knots can create the main problem in the finished yarn, this will affect the increase in the IPI value [10]. And this contributes even more to the attention of researchers to this section of the spinning process.

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The carding slivers was selected at 4 different delivery speeds while retaining all other constant carding parameters. The selected card slivers were was processed through Trutzschler® TD-9 and TD-8 breaker and finisher draw frame machines.

After drafting and doubling, Then the single drawn sliver processed through roving Frame Zinser® 5M and then on a Zinser® 72 ring spinning machine [11]; working by the spindle speed at an average of 17,000 min^{-1}.
For spinning all samples: carding speed 180 m / min, 190 m / min, 200 m/ min, 210 m / min/ hour, spun with the nominal count Ne 36/1 at a constant 26.56 TPI.

III. PROCESS PARAMETERS

The main parameters of technological processes for transitions are shown below:
Table 2

Process type	Parameters	Process type	Parameters
Carding TC-15		**Roving Zinser 5M**	
Count (Ne)	0,092	Count of roving (Ne)	0,80
Speed of the liker-in, min^{-1}	1200	Speed of flyers, min^{-1}	1200
Speed of the cylinder, min^{-1}	540	TPI	0,96/1,16
The speed of the flats, mm/min	320	Condenser	Black
Delivery speed, m/min	180 / 190 / 200 / 210	Main draft	7,08
Density of feeder materials, g/m	500-600	Back draft	1,14
Draw frame TD-9		Condenser	12 mm
Count (Ne)	0,110	**SpinningZinser 72**	
Back draft	1,57	Main draft	37,5
Main draft	9,56	Back draft	1,19
Delivery speed, mm/min	650	Condenser	White
Doubling	8x8	Gauge between rollers	44/54
Gauge between rollers	A-49: B-42	Travelers type	6/0 Zh/Sh Lion brand
Finisher draw frame TD-8		Speed of spindels, min^{-1}	17000
Count (Ne)	0,115	TPM	1045
Back draft	1,24		
Main draft	6,26		
Delivery speed	550		
Doubling	6x6		
Gauge betweens roller	A-49: B-42		

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IV. RESULT AND DISCUSSION

These days equipment manufacturers and spinning technologists face difficulties in producing yarn of low linear density high quality with high carding speed and low fiber loss [12]. This is more important to solve these problems for specialists in cotton spinning, as they should get the potential with a significant profit.

In this study, the influence of the output speed of carding machines on the quality of yarn is analyzed. The developed yarns in spinning obtained from semi-finished products with four different speeds of carding release were tested on the laboratory equipment UsterTester-5 [13], the data of the test results are given below:

Table 3.

Comparative study of differences in quality parameters of yarn developed at 4 different carding speeds

Quality Parameters	**Carded ring spinning weaving yarn Ne 36 S^1**			
Process type	180 m/min	190 m/min	200 m/min	210 m/min
Count CV, %	1,18	1,22	1,23	1,26
U %	10,92	11,56	11,83	12,25
CVU%	13,73	14,55	14,87	15,40
Thin: (-)50	5	9	11	16
Thick: (+)50	62	96	105	121
Neps: (±)200	127	188	220	236
IPI	194	293	334	373
Hairiness(H)	4,2	4,5	4,8	4,8
RKM, cN/tex	16,82	16,68	16,34	16,18
Elongation, ἐ %	5,41	5,35	5,29	5,26

1) **The effect of the carding speed on the uniformity of the yarn, (U%).** The influence of the carding delivery rate and production speed does not significantly change the unevenness of the yarn [14]. From Fig. 1 on the graph, we can conclude that the unevenness of the yarn increases slightly with the rate of carding output. Increasing the speed of the delivery drum leads to a deterioration in the degree of random orientation of the fiber in the card and carding slivers.

2) The delivery speeds of the carding on the defects in yarn (IPI).

Defects include thick and thin place and neps. For Pic. 2the graph shows that the increase in the delivery rate from 180 to 210 m / min, there is a continuous increase in defects on the yarn. It is noticeable that the percentage of neps thick-thin places in the yarn increases, which leads to an increase in the overall defects index (IPI) of the yarn. The loading layer of fiber on the surface of the cylinder of the carding machine increases by increasing the speed of carding delivery. And the fibers are easily transferred from the cylinder to the delivery drum. At higher speeds of the cylinder, the carding action improves, which leads to a decrease in the total number of yarn defects [15].

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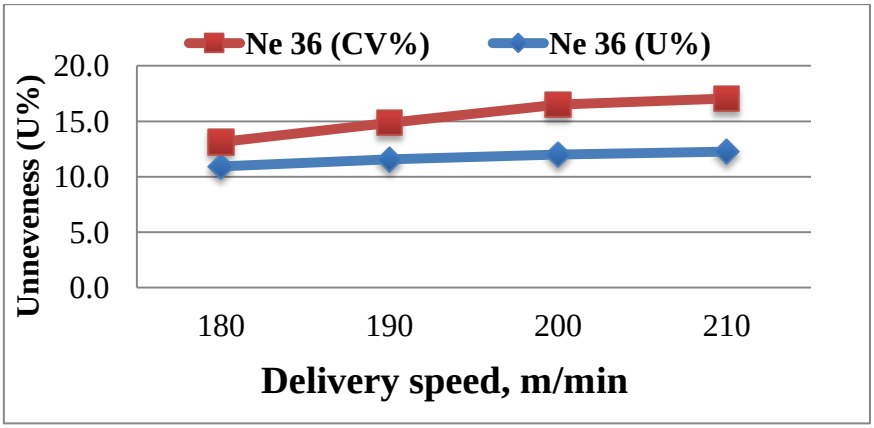
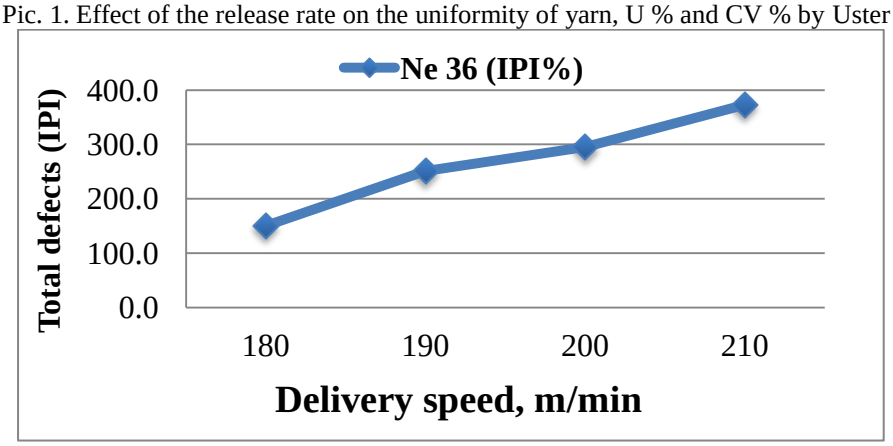


Pic. 1. Effect of the release rate on the uniformity of yarn, U % and CV % by Uster



Pic. 2. Effect of delivery rate on defects, yarn IPI

Effect of carding release rate on yarn strength (Rkm)

In this study, as initially with increasing speed of the delivery drum, the strength of the yarn decreases. A lower delivery rate results in poor carding and poor fiber passage from the cylinder to the removable one. A higher delivery rate increases the efficiency of fiber transfer in the carding process[8]. Greater fiber transfer efficiency results in less opening and parallelization of fibers on the carding sliver, which further affect the strength of the yarn. From Fig. 3 on the graph, it can be concluded that when the delivery rate increased, the RKM of yarn decreased.

Influence of the carding delivery rate on the yarn hairiness (H %)

In Pic. 4, you can see the effect of the carding delivery rate on the yarn hairiness index. It is noticeable that there are very few changes in the yarn hairiness index with an increase in the delivery rate. A small change may be observed due to poor carding action. Therefore, it can also be said that the effect of the delivery rate on the yarn hairiness index is insignificant.

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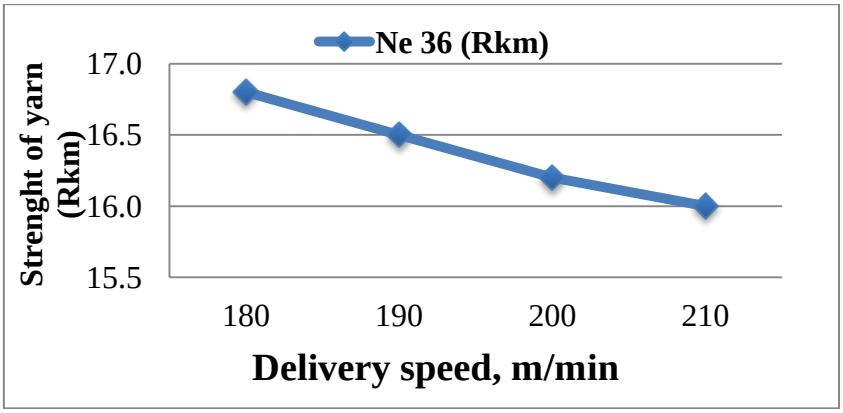
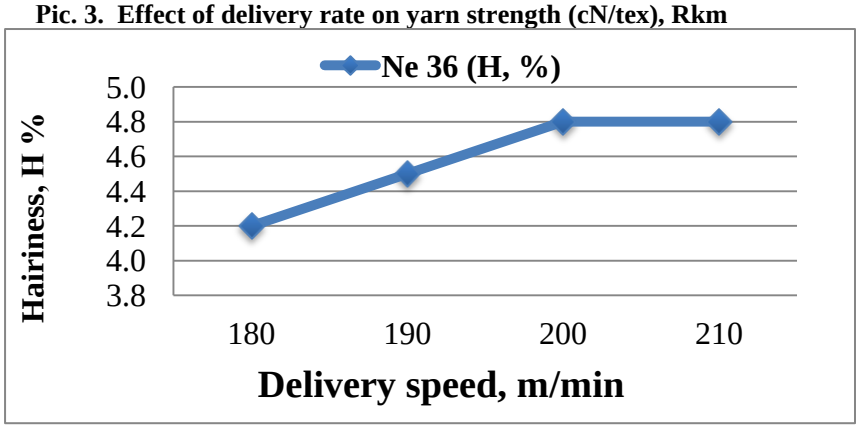
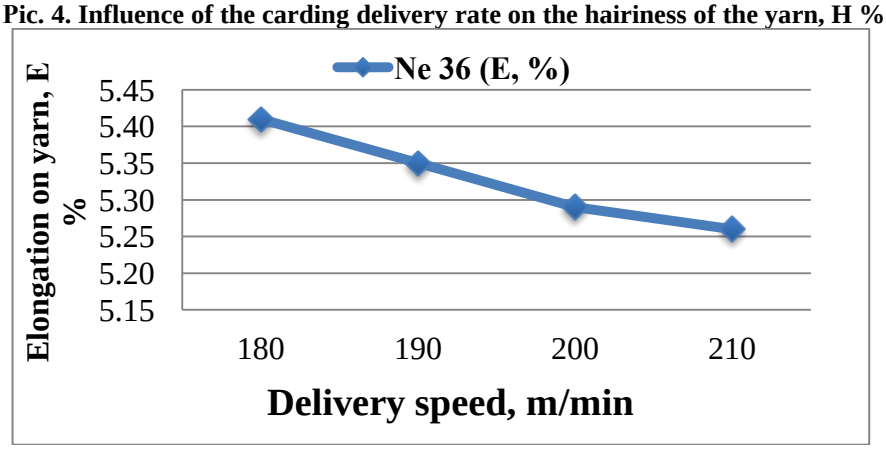


Pic. 3. Effect of delivery rate on yarn strength (cN/tex), Rkm



Pic. 4. Influence of the carding delivery rate on the hairiness of the yarn, H %



Pic. 5. The impact speeds of the carding on the elongation of the yarn, (*E %*)

For Pic.5 the graph shows the effect of the carding release rate on yarn elongation. It can be noted that there is very little change in the lengthening of the yarn when the carding release rate increases. Therefore, we can say that the effect of the delivery rate on the lengthening of the yarn is not significant.

IV. CONCLUSION

Grown cotton fiber in the Republic of Uzbekistan has an inflated micronaire index from 4,6 to 5,0 values, which makes it difficult to pass high-quality spinning production, but the use of high-tech modern equipment in the industry makes it possible to produce high-quality products.

To plan the quality characteristics of the yarn, you need to consider two factors that directly affect the quality of yarn: the first is the properties of the fiber and their change in transitions, and the second is the filling technological

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parameters of the equipment. The relationship between these factors plays an important role in the production of high-quality products. Numerous studies have been conducted to study the performance of carding machines to improve the properties of yarn. In the study of the impact of the release rate on the quality of yarn, it is observed that the change in the release rate of carding does not show a significant effect on the change in the coefficient of variation by yarn number, yarn unevenness, yarn elongation and the yarn pile index. While, the defects of the IPI yarn increases, and the strength of the single yarn decreases when the delivery rate has increased. In practice, it is also observed that to meet the demand of high production with good quality yarn, spinners always try to optimize both the carding speed and the quality of the yarn.

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