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Effect of cylinder speed of carding machine on card waste and card sliver quality

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Abstract

In the carding machine, waste elimination takes place under the taker-in and the carding action takes place between the segment of cylinder and flats. The speed of taker-in affects the elimination of impurities and amount of waste generation. The speed of cylinder affects the degree of carding, waste generation and sliver quality. In general, high cylinder speed results high production. Increasing the cylinder speed is a sensitive operation as it has higher risk of negative influence on waste generation and sliver quality. Exceeding higher cylinder speed can lead to good fiber breakage, good fiber damage and higher neps generation which decreases the quality of card sliver. Again, lower cylinder speed increases the quality of card sliver but reduces the rate of production which is not financially viable. In this paper, it is intended to establish cylindrical speed relationships with card waste and card sliver quality produced by cotton carding machine.

Keywords: Card cylinder, card waste, taker-in, card flat, card sliver, neps.

Introduction

The significance of carding machine at spinning process could be realized with these two proverbs - "Carding is the heart of spinning" and "well carded is half- spun"[1]. In card yarn manufacturing process the carding machine eliminates neps, seed coat neps and the remaining other impurities. In modern carding machine the rate of production can be improved through various machine settings but it could have negative impact on the degree of carding, the rate of production and the quality of produced card sliver.

Higher production rate in carding is a sensitive operation that increases card sliver production rate. But, it increases the card waste and decrease quality of card sliver. Again, exceeding higher cylinder speed can lead to good fiber breakage, fiber damage, and generation of more neps.

Some good fibers also break down into short fibers at higher speed thus increasing loss of good fibers. But, lower cylinder speed will reduce the rate of production which is not profitable. Carding waste is being eliminated by the carding action between the segment of cylinder and flats. In general, the high cylinder speed and the high flat speed are processed by the high production carding machine.

The elimination of impurities and amount of waste generation are affected by the speed of taker-in. In the carding process, amount of waste generation and sliver quality are directly affected by speed of cylinder. So, an optimum speed can be considered to get desired rate of production with minimum waste generation and suitable quality of card sliver.

Methodology

The cotton chute mat is supplied from the blow room via ducting pipe into the feed chute of the carding machine. It is forwarded to the feed arrangement by a transport roller. The feed arrangement consists of a feed roller and feeder plate. They push the sheet of fiber slowly into the taker-in. The taker-in combs the projecting sheet from the feed roller and opens it into tufts. These tufts pass through the grid equipment. While passing the material loses majority of its impurities by the action of past mote knives, grids, carding segment etc.

The suction device carries away the impurities and the waste are carried away by the suction ducts. Then the tufts are transferred to the cylinder. They are opened up to individual fibers between the cylinder and the flats by the carding action. The flats are located over the carding position allied to the cylinder; the rest are on return run. During this return, the fibers, neps and foreign matter cling to the bars are striped by a cleaning unit. The underside of the cylinder is enclosed by the grid or cover plates. These fibers have substantially lower peripheral speed relative to the cylinder. The doffer combines these fibers into a web. The web from the doffer are draw by as tripping device. Then it is compressed it to sliver to some extent by calendar roller, the coiler deposits it in cans[2].

While feeding the speed of cylinder was changed for three times. The speeds were 750 rpm, 800 rpm and 850 rpm. For every speed three observations were considered. For every observation card waste (dropping-1) and card sliver were collected directly from the carding machine individually.

Experimental Procedure: i. 100% cotton bales are fed to the Automatic Bale Opener[3] of Trutzschler Blow Room[4] machine. ii. Cotton Chute Mat from Trutzschler[3] Blow Room was fed into the RIETER carding[5] machine for 10 minutes per observation. Three observations were considered for each speed. iii. The cylinder speed was changed for three times as 750 rpm, 800 rpm, 850 rpm. Card Setting for this experiment remained same and given-feed roller speed: 17-30 rpm, flat speed: 320 mm/min, taker-in speed: 1580 rpm, draft: 98, opening roller speed: 850 rpm, delivery roller speed: 220 m/min, doffer Speed: 61 rpm, delivery sliver weight: 70 grain/yard, production: 65 Kg/hr. iv. Checked that the card web was properly condensed and sliver was delivered. v. Different signal lamps used in machines were followed and the stop motions were understood. vi. Checked whether the carding machine was functioning properly by the control panel. vii. Checked whether the material was properly fed in the carding machine via chute feed system. viii. Identified sliver breakages and piece the sliver during breakage. While piecing the sliver was not too soft or too hard piecing. ix. Segregated the sliver waste & card drop waste. x. Checked that the carding machine had correct color-coded can to collect card sliver. xi. Immediate action was taken if any abnormality detected. xii. Three observations were considered for each cylinder speed and samples of card waste (dropping-1) were collected individually to test on USTER HVI 1000[8] and USTER AFIS PRO 2[9] machines. xiii. Three observations were considered for each cylinder speed and samples of card sliver were collected individually in different colored sliver can to test on USTER Tester 6[10] machine.

Result and discussion

Report Data Analysis of Card Waste (dropping-1) on USTER HVI: For every observation, approximately 10 inch[6] in length of sample sliver made of card waste (dropping-1) was taken to test on USTER HVI 1000 machine individually. The test report data of card waste (dropping-1) obtained on various quality aspect[8] by changing the cylinder speed were summarized and shown in Table-1 to Table-3.

Table-1: Card Waste (dropping-1) Test Result (Cylinder Speed 750 rpm).

No.	SCI	Mst %	Mic	Mat	UHML mm	UI %	SFC %	Str g/tex	Elg %	Rd	+b	CGrd	TrCnt Cnt/g	TrAr %	TrID TrGrd	Amt
1	121.4	5.6	3.79	0.84	30.73	77.3	8.2	24.6	5.5	67.0	8.2	43-3	59	0.41	3	490
2	129.6	5.6	3.82	0.87	31.45	78.5	7.4	22.5	5.9	66.9	8.7	43-3	64	0.30	4	470
3	120.7	6.3	3.74	0.82	30.99	83.0	9.1	24.0	5.6	65.6	8.6	43-3	58	0.43	4	488
Mean	123.9	5.8	3.78	0.85	31.1	79.6	8.7	23.7	5.7	66.5	8.7	43-3	62	0.38	4	485

Table-2: Card Waste (dropping-1) Test Result (Cylinder Speed 800 rpm).

No.	SCI	Mst %	Mic	Mat	UHML mm	UI %	SFC %	Str g/tex	Elg %	Rd	+b	CGrd	TrCnt Cnt/g	TrAr %	TrID TrGrd	Amt
1	129.4	6.3	3.85	0.89	31.06	77.2	8.8	29.8	5.9	66.8	8.1	43-3	70	0.46	4	499
2	132.0	6.4	3.74	0.88	30.84	79	9.2	30.0	6.3	66.9	8.0	43-3	65	0.41	3	484
3	133.8	6.1	3.34	0.88	29.66	78.5	9.5	26.9	6.0	61.0	8.8	43-3	93	0.63	6	494
Mean	131.7	6.2	3.64	0.88	31.52	78.2	9.3	28.9	6.1	64.9	8.5	43-3	76	0.50	4.3	491

Table-3: Card Waste (dropping-1) Test Result (Cylinder Speed 850 rpm).

No.	SCI	Mst %	Mic	Mat	UHML mm	UI %	SFC %	Str g/tex	Elg %	Rd	+b	CGrd	TrCnt Cnt/g	TrAr %	TrID TrGrd	Amt
1	130.4	6.0	3.25	0.88	31.01	75.9	10.3	32.2	6.1	64.6	8.2	43-3	86	0.49	4	459
2	136.3	6.7	3.22	0.89	31.66	78.1	10.2	30.3	6.5	62.8	8.1	43-3	92	0.63	4	462
3	134.7	6.4	3.78	0.89	30.84	76.4	9.7	28.7	6.3	63.9	8.7	43-3	95	0.62	6	471
Mean	133.8	6.3	3.27	0.89	31.17	76.8	10.2	31.4	6.4	63.7	8.3	43-3	91	0.58	4.7	465

Figure-1 shows that uniformity index of card waste decreases with increase of cylinder speed. Figure-2, 3, 4, 5, 6 shows that short fiber content, strength, elongation, trash content and trash amount of card waste increases with increase of cylinder speed.

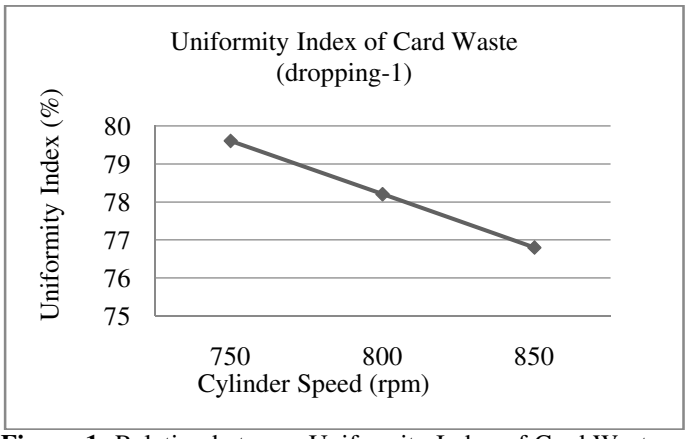

Figure-1: Relation between Uniformity Index of Card Waste vs Cylinder Speed.

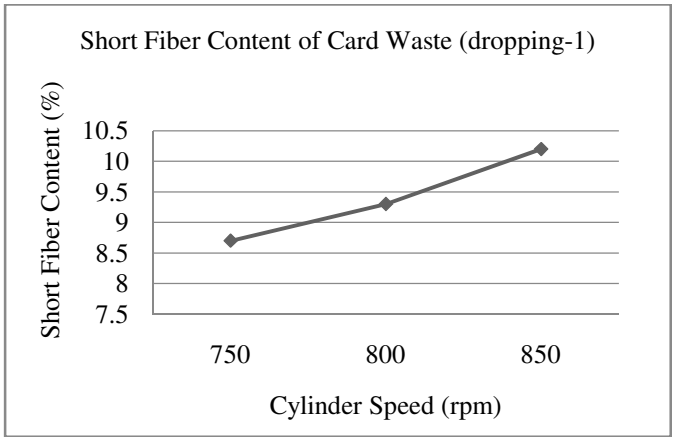

Figure-2: Relation between Short Fiber Content of Card Waste vs Cylinder Speed.

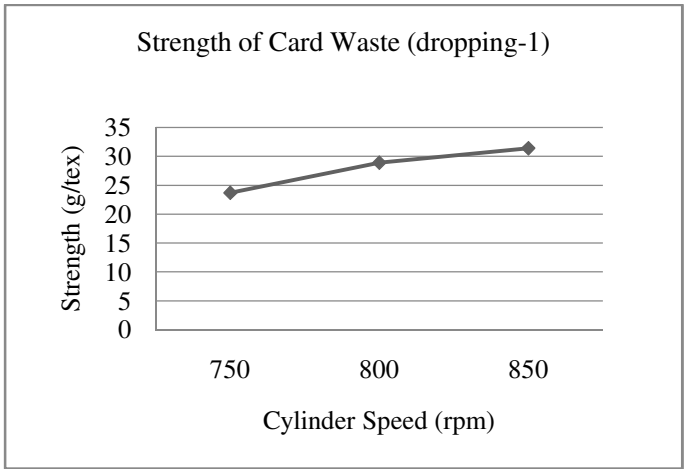

Figure-3: Relation between strength of card waste vs cylinder speed.

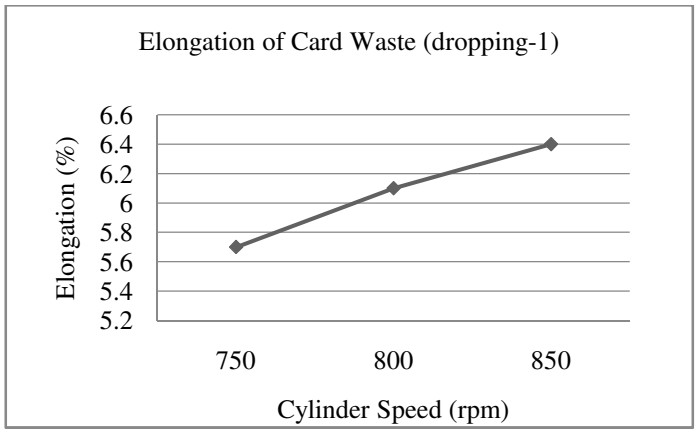

Figure-4: Relation between Elongation of Card Waste vs cylinder speed.

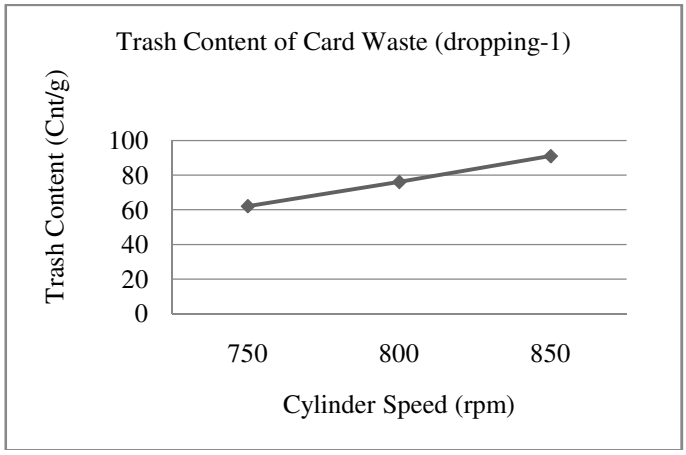

Figure-5: Relation between Trash Content of Card Waste vs Cylinder Speed.

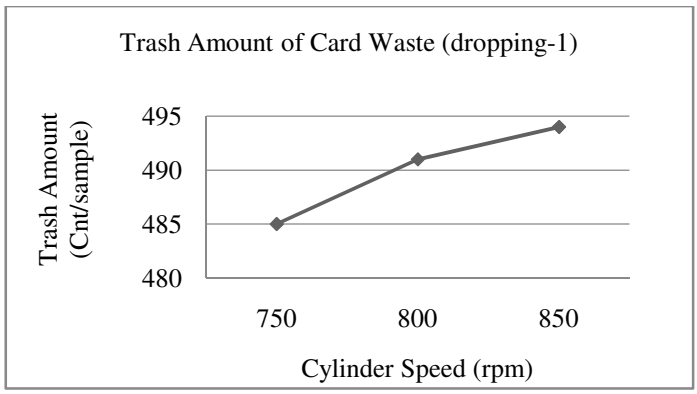

Figure-6: Relation between Trash Amount of Card Waste vs Cylinder Speed.

Report Data Analysis of Card Waste (dropping-1) on USTER AFIS: For every observation, approximately 9.5 to 10.0 gm^6 sample of card waste (dropping-1) was taken to test on USTER AFIS PRO2 machine individually. The test report data of card waste (dropping-1) obtained on various quality aspect[9] by changing the cylinder speed were summarized and shown in Table-4 to Table-6.

Table-4: Card Waste (dropping-1) Test Result (Cylinder Speed 750 rpm).

No.	Nep Cnt [Cnt/g]	Nep Mean Size [µm]	Fiber Nep Cnt [Cnt/g]	FibNep Mean Size [µm]	SCNep Count [Cnt/g]	SCNep Mean Size [µm]
1	959	743	725	689	219	958
2	954	750	733	678	227	955
3	950	744	731	683	224	950
Mean	953	746	730	684	223	954

Table-5: Card Waste (dropping-1) Test Result (Cylinder Speed 800 rpm).

No.	Nep Cnt [Cnt/g]	Nep Mean Size [µm]	Fiber Nep Cnt [Cnt/g]	FibNep Mean Size [µm]	SCNep Count [Cnt/g]	SCNep Mean Size [µm]
1	857	731	706	672	182	945
2	866	722	696	682	174	940
3	860	729	702	676	179	948
Mean	861	727	701	677	178	944

Table-6: Card Waste (dropping-1) Test Result (Cylinder Speed 850 rpm).

No.	Nep Cnt [Cnt/g]	Nep Mean Size [µm]	Fiber Nep Cnt [Cnt/g]	FibNep Mean Size [µm]	SCNep Count [Cnt/g]	SCNep Mean Size [µm]
1	854	720	662	656	156	937
2	843	723	664	661	161	929
3	847	713	676	664	167	932
Mean	848	718	670	660	161	933

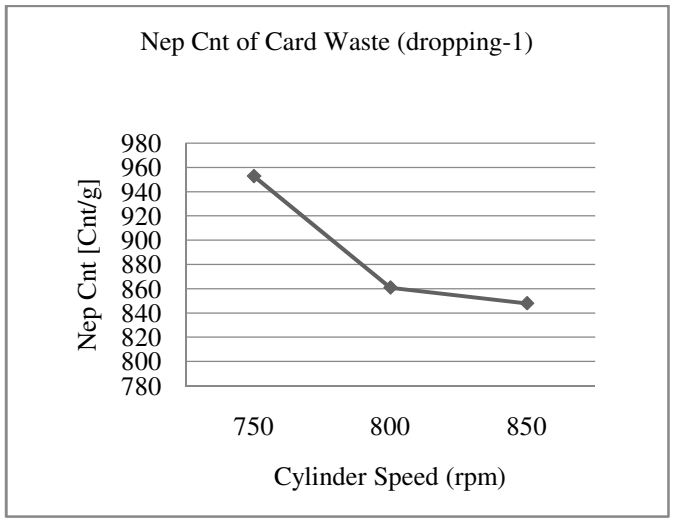

Figure-7: Relation between Nep Cnt of Card Waste vs Cylinder Speed.

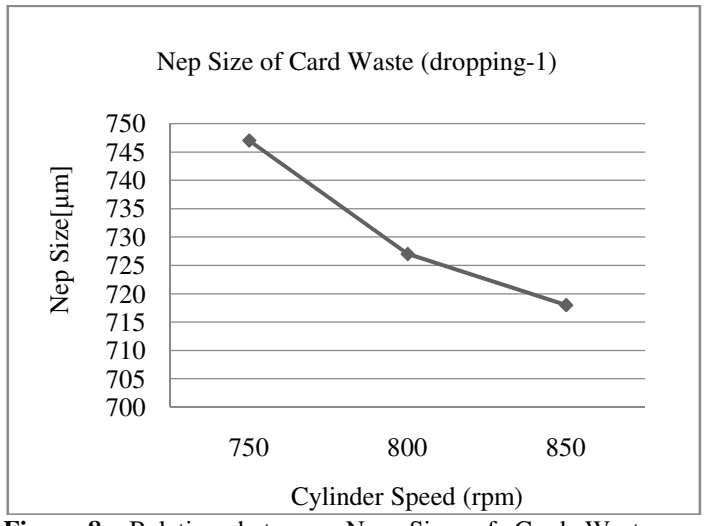

Figure-8: Relation between Nep Size of Card Waste vs Cylinder Speed.

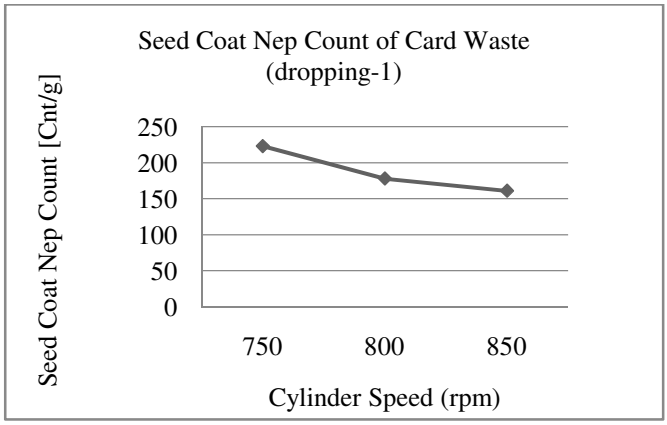

Figure-9: Relation between Seed Coat Nep Count of Card Waste vs Cylinder Speed.

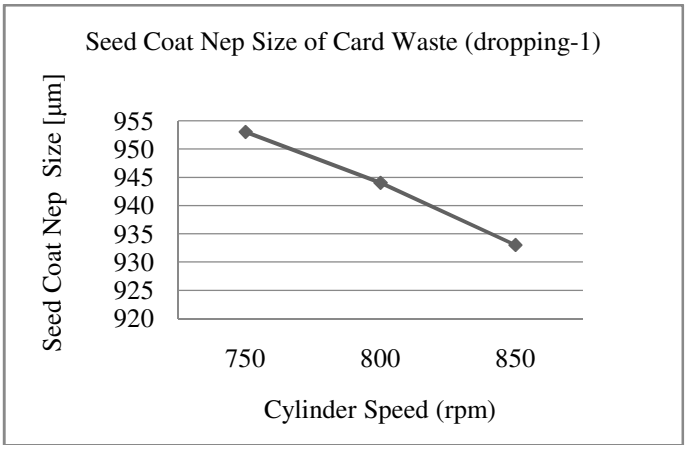

Figure-10: Relation between Seed Coat Nep Size of Card Waste vs Cylinder Speed.

Figure-7, 8, 9, 10 shows that nep content, nep size, seed coat nep count, seed coat nep size of card waste decreases with increase of cylinder speed.

Report Data Analysis of Card Sliver on USTER Tester: For every observation, approximately 50m[6] in length of card sliver sample was taken from different colored sliver cans for evenness[7] testing on USTER Tester6 machine individually. The test report data of card sliver obtained on various quality aspect[10] by changing the cylinder speed were summarized and shown in Tables-7 to Table-9.

Table-7: Card Sliver Test Result (Cylinder Speed 750 rpm).

No.	U%	CVm%	CVm% 1m	CVm% 3m	CVm% 10m
1	2.03	2.54	1.14	0.75	2.48
2	2.06	2.57	1.15	0.77	2.45
2	2.04	2.55	1.18	0.74	2.43
Mean	2.03	2.54	1.16	0.75	2.46

Table-8: Card Sliver Test Result (Cylinder Speed 800 rpm).

No.	U%	CVm%	CVm% 1m	CVm% 3m	CVm% 10m
1	2.25	2.81	1.69	1.25	2.57
2	2.23	2.83	1.66	1.27	2.58
3	2.24	2.80	1.68	1.25	2.60
Mean	2.25	2.81	1.69	1.25	2.59

Table-9: Card Sliver Test Result (Cylinder Speed 850 rpm).

No.	U%	CVm%	CVm% 1m	CVm% 3m	CVm% 10m
1	2.62	3.35	1.68	1.37	2.84
2	2.64	3.34	1.75	1.35	2.83
3	2.69	3.29	1.72	1.32	2.84
Mean	2.65	3.33	1.73	1.34	2.85

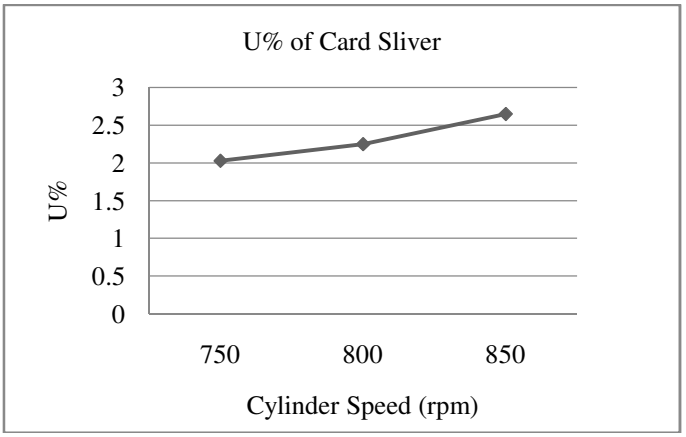

Figure-11: Relation between U% of Card Sliver vs Cylinder Speed.

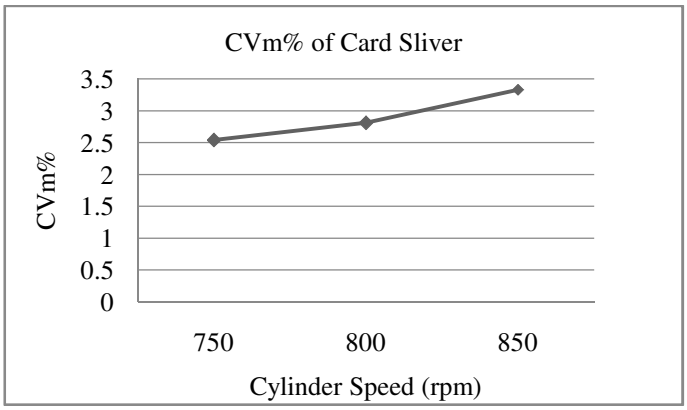

Figure-12: Relation between CVm% of Card Sliver vs Cylinder Speed.

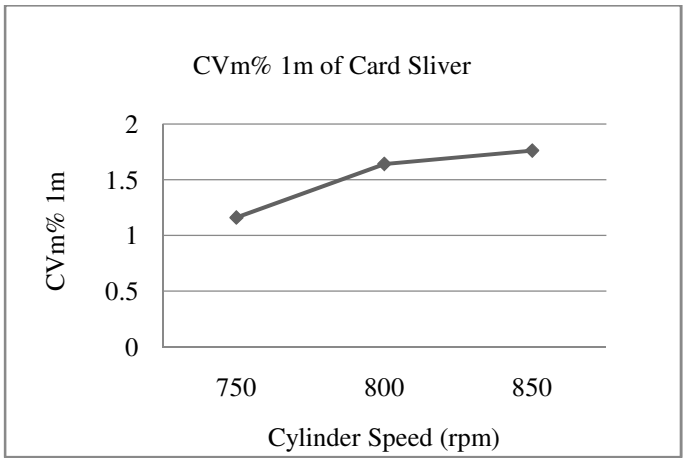

Figure-13: Relation between CVm% 1m of Card Sliver vs Cylinder Speed.

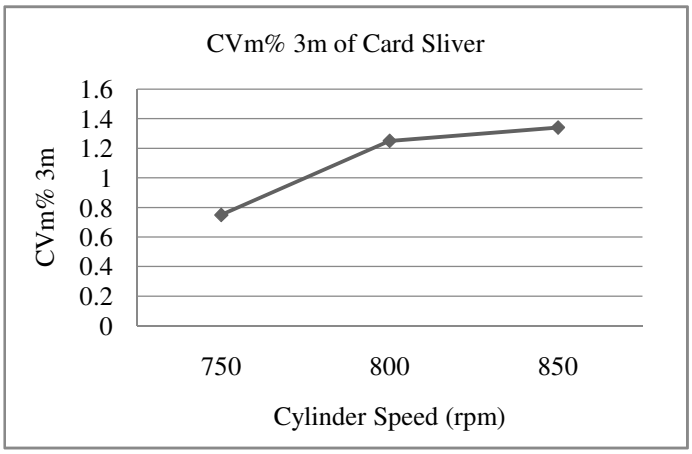

Figure-14: Relation between CVm% 3m of Card Sliver vs Cylinder Speed.

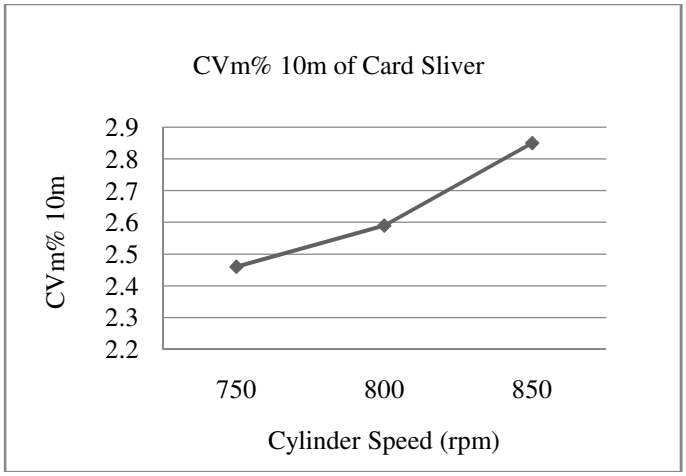

Figure-15: Relation between CVm% 10m of Card Sliver vs Cylinder Speed.

Figures-11, 12, 13, 14, 15 shows that U%, CVm%, CVm% 1m, CVm% 3m, CVm%10m of card sliver increases with increase of cylinder speed.

Conclusion

A clear relationship of cylinder speed with the amount of production, the waste generation and the quality of sliver have been observed through the experiment. It is found that uniformity index, nep content, nep size, seed coat nep count, seed coat nep size of card waste decrease with increase of cylinder speed. Again, short fiber content, strength, elongation, trash content and trash amount of card waste increases with increase of cylinder speed. It is also found that U%, CVm%, CVm% 1m, CVm% 3m, CVm% 10m of card sliver increase with increase of cylinder speed. So, there is an opportunity to increase the productivity of the carding machine with minimum card waste and maximum sliver quality. The optimum speed of the cylinder can be set as800 rpm.

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