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An Investigation on the Effect of Top Roller Cot Grinding and its Pressure on Yarn Quality

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Abstract:- The critical part of ring spinning machine, at which yarn evenness and tensile strength can be greatly influenced is by the drafting arrangement. The main components in drafting have been subject to various studies in order to make a uniform even yarn. In this study an investigation was done on altering the front top roller cot diameter by grinding and adjusting top roller pressure. The study was undertaken in an industrial setup, 15 different combinations of rubber cot diameter and top roller pressure were tried to optimize the utility of rubber cots with enhanced cot service life without compromising the yarn quality to benefit Bahir Dar Textile Share Company, Ethiopia. The unevenness and tensile strength of 20s Ne 100% cotton yarn were investigated. The test results were subjected for statistical analysis and the worldwide quality standard of the results was also determined by USTER ® STATISTICS 2013 v1.1. The result showed that, the decrease in cot diameter by grinding critically influences the mass unevenness and imperfection of the yarns. It does not apparently influence the yarns tensile strength. Accordingly, cot diameters of 29.9mm and 29.6mm at pressure of 2.2bar and 29.3mm at pressure of 2.3bar was found as optimal pressure and cot diameter combinations which can be able to maintain consistency of yarn unevenness and extends the service life of the rubber cot.

Keywords:- *Rubber cot, Grinding, Roller pressure, Uster statistics, evenness, and Tenacity.*

I. INTRODUCTION

Yarn quality as a combination of four basic elements: the consistency (yarn evenness and appearance integrity by means of thick places, thin places and neps), the bulk integrity (count, density and twist), the surface integrity (hairiness, diameter and shape) and purity (Harpa, 2011).

Among the yarn quality parameters, imperfection index (+50% thick, -50% thin, and +200% nep) values, the mass uniformity, hairiness, and tensile strength of the yarn are the most important factors in determining its quality and performance in the subsequent process (R. Furter, 2009).

The analysis of the factors that may affect the evenness of the linear density of ring spun yarns in actual spinning circumstances is related to the structure and operation of the drafting systems. The lack of correlation of the processed raw material with all these factors in drafting parameters it may turn into disturbance that can affect the yarns evenness (Bona, 1993, Kane and Ghalsasi, 1992).

Drafting rollers cot and aprons are the essential components of the drafting system; they have great importance in determining process efficiency and final yarn quality. The influence of the cots material on the final yarn quality has been established as these components are in a direct contact with the fibers (Majumdar and Majumdar, 2004).

Study's on the relationship between the quality and condition of the rubber roller on the results of unevenness of yarn. As it is well known that the flatness of a rubber roller will affect the quality of its yarns. Rubber rollers have many obvious defects which will result in conditions that are less yarn perfectly. In the event of the stretch, then for rubber rollers that are too soft, it will generate the conditions position the fibers in the yarn uneven. Looking for rubber rollers condition that the degree of hardness is too high or hard, can result in broken fibers, as if stretching occurs when the force's executioners (Akbaret al., 2017, Moeliono et al.) Special rubber compounds with shore hardness ranging from 63^0 to90^0 are used for spinning cots (Subramaniam and Peer Mohamed, 1991).

Improving yarn values such as unevenness (thin places, thick places and neps) require a high quality cot and the performance of this cot largely depends on the proper preparation of the cot surface. Therefore, the cracks and damage on the cot surface must have to be removed, the common way to remove the cracks and roughness of the cots surface is by grinding the surface of the cot using grinding machine this process is called buffing (Ghane et al., 2008)

Top rollers are attached to a given loading condition this is also associated with large or small diameter of rubber roller. High roller pressure causes strong compression and a correspondingly long friction field, but only up to an optimum pressure. If influence is to be exerted on the friction field, this should be by adjustment of individual parameters, then it should be borne in mind that strong interactions are found throughout the whole drafting process which helps to spin uniform strand (Moeliono et al., Lawrence, 2003).

The cot diameter under the influence of top arm loading is the crucial factors that determining the final yarn quality in ring spinning. Diameter of the small rubber rollers, essentially still be put to good use, and this should be supported by adjustments to the amount of loading on the rubber roller (Moeliono et al.)

According to (Moeliono et al.), the rubber roller cot should never be ground to the total thickness of less than 3.5mm. However, in industry practice the total thickness of top roller cot removed by grinding over the total grinding cycle is 2mm. From this fact there is about 1.5mm loss of useful top roller cot diameter. (Ghane et al., 2008) stated that lower grinding limits of roller diameter will be made to good use by generating new weighting arm. However, the amount of top roller pressure for the new roller diameter as well as for roller diameter after grinding cycles is still the same and no effort is taken to vary and optimize the top arm pressure.

II. MATERIALS AND METHODS

A. Material

- *Raw Materials*

Two types of cotton fibre at different mix ratio and with properties shown in Table 1 were used to spin the 20s Ne counts yarn samples from 0.9s Ne count of roving.

Table 1. The type of cotton fiber, mix ratio and their specific properties

Fibre type	Cotton fibre Properties						
	Mix ratio (%)	Short fiber (%)	Staple length (mm)	UI%	Micronaire value (μg/tex)	Strength (g/tex)	Maturity Coeff.
Awash	10.7	9.7	28.21	3.07	3.86	25.7	0.85
Wolqaitttt	89.29	12.8	27.31	3.07	4.06	29.2	0.86

- *Machineries and Equipment's*

Ring frames manufactured by Rieter with machine parameters shown in Table 2 was used to spin 20s Ne ring spun yarn sample for the study.

Table 2. Specifications of Ring frame.

Machine	Specification	
Ring frame machine manufactured by Rieter.	M/c model:	Rieter G-35
	Draft type:	High draft
	Total draft	23.00
	Loading type:	Pneumatic
	Spindle speed:	12,000 rpm
	TPM	740
Grinding machine	Semi-automatic BerkolDAYtex (India)	
UV treatment machine	Berkol UV treatment m/c	
Cot mounting machine	Semi-automatic, pneumatic vertical cot mounting machine	

B. Methods

Table 3 indicates the existing cot grinding frequency practiced at the industry (BDTSC) and the method employed by this study.

Table 3. The existing trend of BDTSC and the new method employed on rubber cot grinding

Activity	Existing method of BDTSC	Method employed by this study
New cot diameter	32.0mm	32.0mm
Cot diameter reduced per each grinding cycle	0.4mm	0.3mm
Total diameter reduced over total grinding cycle	2.0mm	3.0mm
Total grinding frequency over complete cot usage	2.0mm ÷ 0.4mm = 5	3.0mm ÷ 0.3mm = 10
Minimum cot diameter	30.0mm	29.0mm

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As it can be seen from Table 3 in the actual cot grinding trend of the company, cots are utilized by grinding till the diameter reached 30.0mm after this diameter, the cots disposed as waste this reveals a total of 5 grinding frequencies per complete cot usage. Unlike this, the new method proposed by this study worked to extend the grinding frequency to ten; this could be up to 29.0mm by reducing 0.3mm per each grinding.

- *Experimental Design*

The general flow of the experimental procedure used in this theses work is shown in Figure 1.

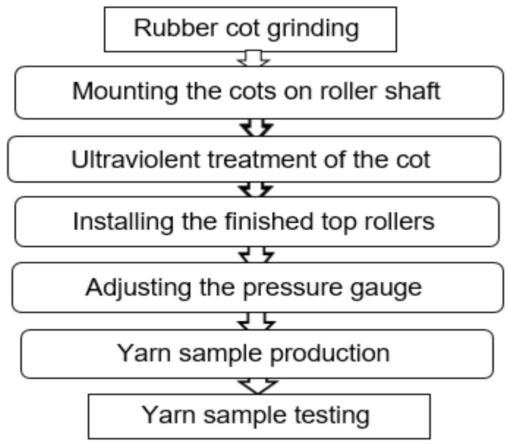

Fig 1:- General procedure followed by experimental of research work

✓ *Top roller cot grinding*

The diameter of top roller rubber cot reduced after each grinding cycle was by 0.3mm. The semiautomatic grinding machine was used for grinding the cots. As a result, the following diameter variations were obtained: 32.0mm, 31.7mm, 31.4mm and 31.1mm, 30.8mm, 30.5mm,30.2mm, 29.9mm, 29.6mm, 29.3mm and 29.0mm this gives total of 10 grinding cycle which enables the rubber roller to serve twice of the actual serviceability. From these ten variation of diameters was obtained, five of the diameters are selected systematically for sample production, these are 32.0 mm, 29.9mm, 29.6mm, 29.3mm and 29.0mm from these diameter 32.0mm diameter cot at the initial top roller pressure was used as a control sample diameter.

✓ *Ultra-Violent treatment of the roller cot*

After preparing the grinded rubber cot, the finished top rubber rollers were subjected to Ultra-Violent treatment on Ultra-Violent treatment machine in order to provide an optimum surface smoothness to the fresh grinded roller cots.

✓ *Cot Mounting*

After effectively grinding the cots and cooling it, this cot was mounted in to the bare roller or cot shaft. The semi-automatic vertical pneumatic cot mounting machine was used to mount the cots on to the bar roller. This makes the top rubber covered rollers ready for installation on the drafting arrangement of ring frame.

✓ *Yarn sample production*

After treating the top roller cots, these cots conditioned for minimum of 24hrs under standard temperature and relative humidity. The ring frame front top roller with finished outer diameters of 32mm, 29.9mm, 29.6mm, 29.3mm and 29.0mm were installed in to the drafting arrangement of ring frame for sample production. In order to provide randomness, the spindles of ring frames were selected randomly. The front top roller pressure was adjusted at 2.1bar, 2.2bar and 2.3bar with the progressive reduction of cot diameter.

Table 4. Roller pressure and cot diameter combinations used for sample production, sample cods

Top roller pressure* cot diameter, sample cod.		
2.1bar*32.0mm, (Control)	2.2bar*32.0mm, (S1)	2.3bar*32.0mm, (S2)
2.1bar*29.9mm, (S3)	2.2bar*29.9mm, (S4)	2.3bar*29.9mm, (S5)
2.1bar*29.6mm, (S6)	2.2bar*29.6mm, (S7)	2.3bar*29.6mm, (S8)
2.1bar*29.3mm, (S9)	2.2bar*29.3mm, (S10)	2.3bar*29.3mm, (S11)
2.1bar*29.0mm, (S12)	2.2bar*29.0mm, (S13)	2.3bar*29.0mm, (S14)
	Total number of yarn samples	15

The yarn samples coded as can be seen from Table 4 was produced from 100% cotton fiber with raw material specification shown in Table 1 were processed in the modern Rieter ring spinning line for carded yarns. The machine particulars used for sample spinning presented in Table 2.

✓ *Sample Testing*

Before conducting sample test, all the samples were conditioned for minimum of 24hours and all the tests were carried out under standard atmospheric conditions. All similar tests for each yarn samples were carried out on the same testing instrument keeping all testing machine conditions and parameters same. For all samples produced at different combination of top roller pressure and cot diameter, after the ten readings were taken, the average result of each test parameters were calculated by the testing instruments.

Table 5. Test parameters and testing standard

S No	Test parameters	Testing standards
1	Unevenness	ISO-16549
2	Tensile strength	ASTM D-2256

III. RESULT AND DISCUSSION

A. *The effect of cot diameter on unevenness.*

The effect of spinning front line top roller cot of varying in diameter (32.0mm, 29.9mm, 29.6mm, 29.0mm) and top roller pressure (2.1bar, 2.2bar, and 2.3bar) on 100% cotton 20sNe ring spun yarn was investigated. The change in cotton yarn properties on mass unevenness, total imperfection levels, and tensile strength with progressive reduction in cot diameter by grinding at specified top roller pressure adjusting situation were investigated.

- *The effect of cot diameter on the yarn imperfection.*

The average of the yarn imperfection test result obtained from the mentioned evenness testing tool at normal sensitivity levels is shown in Table 6 for samples produced at top roller pressure of 2.1bar, 2.2bar and 2.3bar.

Table 6. Imperfection result.

Roller Pressure.	2.1bar					2.2bar					2.3bar				
Cot diameter.	32	29.9	29.6	29.3	29	32	29.9	29.6	29.3	29	32	29.9	29.6	29.3	29
Thin -50	8	14	20	36	28	11	8	5	12	14	22	11	12	6	14
Thick +50	76	109	87	137	134	88	90	48	69	109	157	110	98	70	109
Neps +200	144	176	166	190	146	152	136	126	130	178	158	148	184	148	176
Total	228	299	273	362	308	151	234	179	212	302	337	269	294	224	299

The total imperfection result of each sample was obtained by summing up the mean results of the yarn imperfection. The relationship between yarn imperfection results of samples produced at a specified cot diameter by adjusting top roller pressure at 2.1bar, 2.2bar, and 2.3bar as the cot diameter reduced is shown in Figure 2.

As it can be seen in Figure 2 below, by considering the top roller pressure of 2.1bar the imperfection result with progressive reduction in cot diameter shows varying effect. The minimum yarn imperfection is shown on the bigger cot diameter (32mm), and as the cot diameter vanishing small, the yarn tends relatively increased effect.

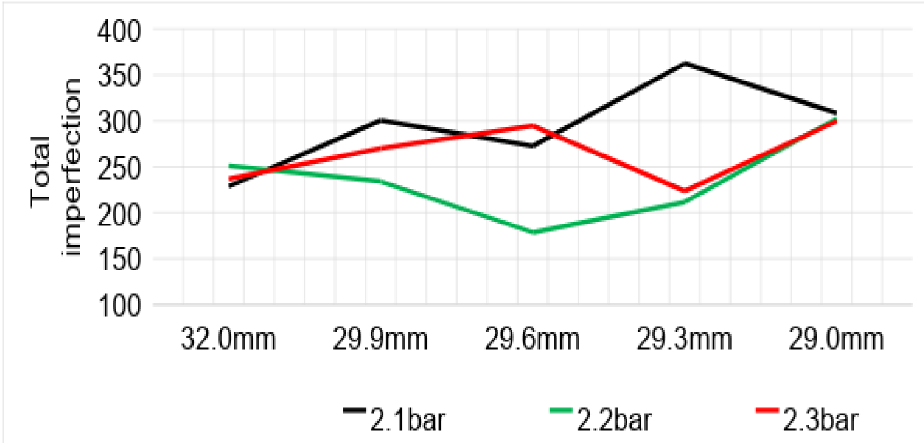

Fig 2:- The effect of cot diameter and roller pressure on yarn imperfection.

Increasing the top roller pressure from 2.1bar to 2.2bar, for similar reduction of cot diameter shows varying effect from the result obtained at top roller pressure of 2.1bar.

At the big cot diameter, the increased in top roller pressure to 2.2bar shows an increasing effect on total imperfection, as the cot diameter decrease the yarn show a reduction in the total imperfection until the minimum point of imperfection is reached this is shown at cot diameter of about 29.6mm. For this cot diameter, top roller pressure of 2.2bar is taken as the optimum pressure which shows minimum result of imperfection.

The increased adjustment of top roller pressure from 2.2bar to 2.3bar, the decrease on cot diameter shows increasing effect until it reaches relatively high imperfection level, after this maximum point (29.6mm), the yarn tends opposite trend and the result shows declining effect to reach at the minimum imperfection level and this optimum point is shown at cot diameter of 29.3mm, and 2.3bar pressure is taken as optimum pressure for this cot diameter.

As the cot diameter reduced keeping the top roller pressure unchanged still the result shows varying effect. Therefore, the relative adjustment of both factors is essential to handle the variability in yarn imperfection result which can able to maintain consistency on yarn evenness by means of imperfection throughout the service life of the rubber cot.

- *Pair wise comparison of imperfection result*

Table 7 below shows t-test output for pair wise comparison of the mean value of imperfection level of each sample with the mean value of the control sample.

The significantly affected results were determined by comparing the values of the t-tabulated and t value of the t-calculated. Samples which show t value with the absolute value of t or │t-calculated │≥ │t-tabulate│ reveals that the results are not significant to the mean of the control sample, this indicates the sample yarn is not in accordance to the plan and samples which shows │t-calculate │< │t-tabulated│, indicates the pressure and cot diameter combination at which the sample yarn was produced resulted a significant effect on the mean value of yarn imperfection and the sample is in accordance to the plane, the cot diameter and roller pressure shows the optimum adjustment which can result optimum imperfection result.

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Table 7. Pair wise comparison of imperfection test result with the control sample.

Sample code	Test value with the control sample					
	t-cal.	Deg. of freedom	Sig. (t-tab.)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
S1	0.546	9	0.640	22.30000	-153.3354	197.9354
S2	1.130	9	0.376	51.03333	-143.3071	245.3738
S3	0.828	9	0.495	38.90000	-163.2862	241.0862
S4	0.445	9	0.700	16.76667	-145.4681	179.0015
S5	0.704	9	0.554	28.76667	-146.9294	204.4627
S6	0.701	9	0.556	29.63333	-152.1542	211.4208
S7	-0.048	9	0.966	-1.70000	-153.6293	150.2293
S8	0.744	9	0.535	36.96667	-176.9188	250.8521
S9	1.315	9	0.319	59.56667	-135.3242	254.4576
S10	0.272	9	0.811	9.30000	-138.0251	156.6251
S11	0.321	9	0.778	13.10000	-162.3111	188.5111
S12	1.103	9	0.385	41.36667	-119.9557	202.6891
S13	0.831	9	0.493	39.36667	-164.4552	243.1885
S14	0.820	9	0.498	38.70000	-164.2703	241.6703

It is evident that, samples which show t value with │t-cal. │ ≥ │t-tab. │ indicates the results are not significantly affected by the combination of the factors and the yarn produced is not in accordance to the plan. In the other extreme, those samples which shows │ t-cal.│<│ t-tab. │, indicates the pressure and cot diameter combination at which the sample yarn was produced show a significant effect on the mean value of yarn imperfection and the samples are in accordance to the plan.

Samples S1(0.546 < 0.64). S4 (0.445 < 0.7), S7 (0.048 < 0.966), S10 (0.272 < 0.8110), and S11 (0.321 < 0.778) shows significant result of yarn imperfection and this indicates these samples are in accordance to the plan and the top roller pressure and cot diameter shows optimal combination of cot diameter and roller pressure.

From these, the most significant effect was investigated for sample S7. The remaining yarn samples S2, S3, S5, S6, S8, S9, S12, S13 and S14 shows results which are not significantly affected by the combination of the factors.

- *The effect of cot diameter on yarn irregularity*

As it can be seen in Figure 3, at top roller pressure of 2.1bar the yarn mass irregularity result shows a relatively increasing effect as the cot diameter reduced progressively from 32.0mm to 29.0mm diameter.

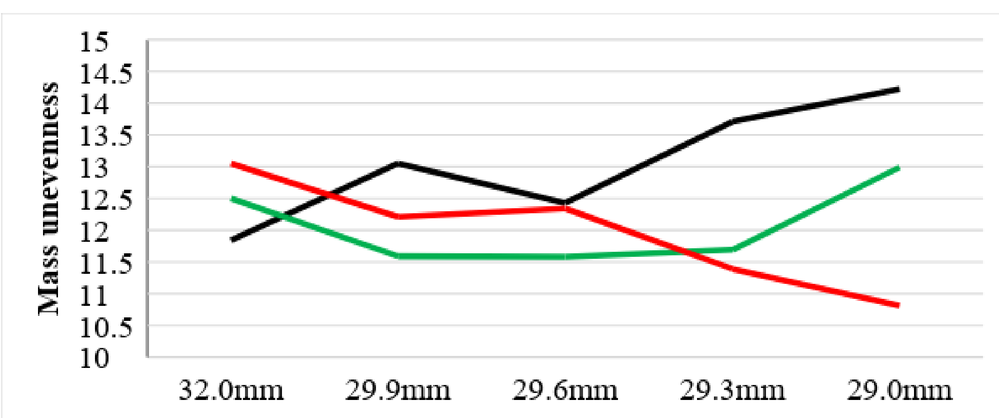

Fig 3:- The effect of cot diameter and roller pressure on mass unevenness.

The increased value of mass irregularity shows more unevenness on the yarn. Since minimum yarn irregularity is preferred in good yarn, the minimum irregularity result was achieved at 32.0mm cot diameter as considering smaller top roller pressure adjusted situation of 2.1bar pressure.

However, as the top roller pressure increase beyond, still it shows varying effect at different cot diameters as discussed in the following paragraphs:

The increase in top roller pressure from 2.1bar to 2.2bar with the decrease in cot diameter, mass irregularity of the yarn shows decreasing effect until the minimum point is reached and this point is shown at the cot diameter of about 29.9mm and 29.6mm, beyond this point the yarn tends increasing effect in mass unevenness.

As further increasing the roller pressure from 2.2bar to 2.3bar, mass irregularity at bigger cot diameter shows higher yarn irregularity percentage value. However, as the cot diameter becoming smaller, it shows a gradual improvement in the result. The minimum irregularity at this pressure is shown at the cot diameter of about 29.3mm and 29.0mm.

- *Pair wise comparison of mass unevenness*

Table 8. Pair wise comparison of imperfection test result with the control sample.

Samples Code	Test value with the control sample mean					
	(t-cal.)	Degree of freedom	Sig. (t-tab)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
S1	-0.093	9	0.930	-0.05400	-1.6661	1.5581
S2	1.749	9	0.155	0.61400	-0.3609	1.5889
S3	4.533	9	0.011	1.21200	0.4696	1.9544
S4	0.282	9	0.792	0.16300	-1.4439	1.7699
S5	-0.453	9	0.674	-0.26400	-1.8807	1.3527
S6	8.091	9	0.001	1.85600	1.2191	2.4929
S7	0.076	9	0.943	0.05000	-1.7869	1.8869
S8	2.093	9	0.104	2.36000	-0.7701	5.4901
S9	0.079	9	0.941	0.05200	-1.7850	1.8890
S10	-0.530	9	0.624	-0.21600	-1.3465	0.9145
S11	-0.200	9	0.416	-1.04600	-2.4984	0.4064
S12	2.562	9	0.063	8.58000	-0.7198	17.879
S13	0.095	9	0.929	0.06200	-1.7450	1.8690
S14	0.948	9	0.397	7.85400	-34.4365	0.1445

Samples S1(0.093< 0.930), S4(0.282 < 0.292), S5(0.453 <0.674), S7(0.76 < 0.943), S9(0.079 ≥ 0.941), S10(0.536 ≥ 0.624), S11(2.20 ≥ 0.416), and S13(0.095 < 0.929) shows significant result of mass unevenness to the control sample and the yarn samples are not in accordance to the plan. In the other extreme, yarn samples; S2(1.74 ≥ 0.15), S3(4.53 ≥ 0.11), S6(8.091 ≥ 0.01), S8(2.09 ≥ 0.104), and S14(0.948 ≥ 0.394) shows opposite effect. This reveals that, the top roller pressure and cot diameter combination on which these samples were produced was not affected the yarn unevenness significantly. Therefore, these yarn samples are not in accordance to the plan and the cot diameter and roller pressure combination is not suitably adjusted as can able to handle the variability in the yarn unevenness.

B. The effect of cot diameter on tensile strength

Tensile strength is an important characteristic of the yarn, which influence the processing performance of the yarn in the subsequent processes. The yarn should have an optimum level of tensile strength.

The influence of the progressive reduction in cot diameter at three different top roller pressure adjusted situation over the tensile strength of yarn is presented in Figure 4.

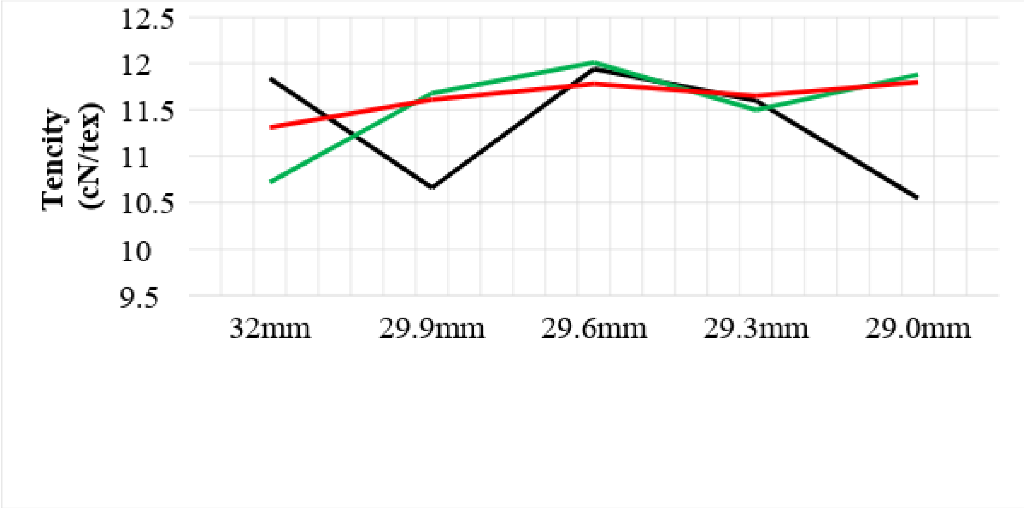

Fig 4:- The effect of cot diameter and top roller pressure on yarn tenacity

As it can be seen from Figure 4, the tensile strength test result shows varying pattern as with the reduction in the cot diameters for different top roller pressure adjusted situations.

At the smaller roller pressure of 2.1bar, the decrease in cot diameter, from 32.0mm to 29.9mm shows decreasing effect on the yarn tenacity value, then as the diameter reduced beyond, the yarn tends to increase in its tensile strength, this is seen up to cot diameter of 29.9mm, and then as diameter decreased beyond the yarn tends indeterminate effect.

- *Pair wise comparison output of tensile strength*

Table 9. Pair wise comparison output of tensile strength result with control sample.

Sample code	Test Value with the control sample mean					
	t-cal.	Degree of freedom	Sig. (t-tab.)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
S1	-4.271	9	0.013	-1.04200	-1.7193	-0.3647
S2	-1.955	9	0.122	-0.44800	-1.0842	0.1882
S3	-4.586	9	0.010	-1.09400	-1.7563	-0.4317
S4	-0.495	9	0.646	-0.08000	-0.5286	0.3686
S5	-0.424	9	0.693	-0.15400	-1.1620	0.8540
S6	-0.067	9	0.950	-0.01800	-0.7691	0.7331
S7	0.081	9	0.940	0.02200	-0.7360	0.7800
S8	1.503	9	0.207	0.18600	-0.1576	0.5296
S9	-0.394	9	0.714	-0.16200	-1.3046	0.9806
S10	-0.772	9	0.483	-0.21400	-0.9832	0.5552
S11	-0.232	9	0.828	-0.11200	-1.4515	1.2275
S12	-5.853	9	0.004	-1.24800	-1.8400	-0.6560
S13	-4.962	9	0.008	-0.83600	-1.3038	-0.3682
S14	-0.036	9	0.973	-0.00600	-0.4715	0.4595

As it can be seen from Table 9, some samples result shows a significant effect to the mean value of the control sample, since, they show │ t-calculated│ < │t-tabulated│.

These results are shown for samples including; S4 (0.495 < 0.646), S5 (0.424 < 0.693), S6 (0.067< 0.950), S7 (0.081< 0.940), S9 (0.394 < 0.714), S11 (0.232 < 0.828), and S14 (0.036 < 0.973).

In the other extreme, the remaining samples are not significantly affected by the variability of the factors or they show│ t-calculated│≥ │t-tabulated value │these includes S1, S2, S3, S8, S10, and S12. Still the mean differences for samples these show no significant difference or not converge to the mean of the control sample are comparatively not wide.

Even though significant effect is seen for some samples, still they could not present a determinant relationship between cot diameter, and roller pressure on the yarn tensile strength result.

C. Analysis by USTER®STATISTICS percentiles level

In order to make critical comparison between the results by considering all the test parameters, to determine the world quality level of each samples, and to classify each samples result according to the current worldwide quality standard, it is essential to calculate and compare the USTER®STATISTICS percentiles level. For this purpose, USTER®STATISTICS 2013 v1.1 was used.

Table 10. Worldwide quality standard level of yarn samples test result.

Sample Code	Mass Unevenness	Thin -50%	Thick +50%	Neps +200%	Total imp. Mean	Tenacity (cN/tex)
	USTER® *STATISTICS* percentiles levels of the results					
Control	≤5	50	16	32	32.7	≥95
S1	≤5	60	22	35	39	≥95
S2	7	82	50	37	56	≥95
S3	≤5	70	32	42	48	≥95
S4	≤5	48	23	30	33.5	≥95
S5	≤5	62	33	34	43	≥95
S6	≤5	79	22	39	46.5	≥95
S7	≤5	37	≤5	26	22	≥95
S8	≤5	64	27	44	45.6	≥95
S9	19.7	≥95	44	45	58	≥95
S10	≤5	63	13	28	34.5	≥95
S11	≤5	42	13	33	29	≥95
S12	26	89	42	33	54.5	≥95
S13	≤5	70	≥95	42	69	≥95
S14	≤5	69	32	42	47.5	≥95

As it can be seen from Table 10, the USP13 level of the test result of each sample shows varying standard percentile levels.

Accordingly, the variability in cot diameter and top roller pressure shows critical influence on the yarn unevenness.

However, specifically for the yarn imperfection result; neps +200% shows, the decrease in cot diameter cannot affect the neps level. Since, from empirical studies, neps are generated at blow room and card only.

All cot diameters and top roller pressure adjusted situations including the control sample shows similar quality standard level on the tensile strength result.

The red color for yarn tenacity means problem-solving interventions in the raw material as well as in the pre spinning process are necessary and require an immediate correction of the process.

This is because; the tensile strength of yarn is sensitive to the fiber property and type of fiber mix. This can be the effect of raw material mixtures, as it can be seen the cotton fibers from both mixtures recipes have problem on their tensile properties and the short fiber contents of the two mix shows poor quality fiber as shown in Table 1. Therefore, the reduction in cot diameter did not have an apparent direct influence on the tensile strength result.

Unlike for the control cot diameter, the optimal result at cot diameter of 29.9mm and 29.6mm was reached at top roller pressure of about 2.2bar.

As the cot diameter decrease beyond, appreciation results were reached at higher top roller pressure. For the cot diameters 29.3mm and 29.0mm cot diameter, this was reached at top roller pressure of about 2.3bar. Therefore, these samples are taken as optimal samples and the diameter and pressure combination that provide the optimal result were taken as optimal diameter and optimal pressure respectively. The worldwide quality standard of samples resulted optimal effect on the tested yarn parameters is shown in Table 11.

Table 11. Worldwide quality standard of samples with optimal result at each cot diameter and at optimal pressures.

Sample cods	Cot dia. * Roller pressure	Mass Unevenness	Thin -50%	Thick +50%	Neps +200%	Total imperfection.	Tenacity (cN/tex)
		USTER® *STATISTICS* percentiles level of samples					
Control Sample	32.0mm*2.1bar	≤5	50	16	32	32.7	≥95
S4	29.9mm*2.2bar	≤5	48	23	30	33.5	≥95
S7	29.6mm*2.2bar	≤5	37	≤5	26	22	≥95
S11	29.3mm*2.3bar	≤5	42	13	33	29	≥95
S14	29.0mm*2.3bar	≤5	69	32	42	47.5	≥95

Considering the samples selected as optimal in Table 11 S4, S7, and S11 shows the most significantly affected samples and shows maintained consistency in the result of yarn unevenness and tensile strength. The consistency in yarn unevenness shows interruption for sample S14, at cot diameter of 29.0mm and its optimum pressure. This indicates critical control of the factors is essential as the cot diameter becoming smaller.

IV. CONCLUSION

It is investigated that the reduction in cot diameter critically influences the yarn imperfection level. In order to spin yarn maintaining the consistency of improved imperfection level by handling the variability resulted due to the reduction in cot diameter by grinding, it is essential to adjust relatively the pressure of top roller.

Bigger diameter rubber cot with relatively small top roller pressure adjusted situation and as the cot diameter vanishing smaller a relatively increased adjustment of top roller pressure is essential to maintain the consistency on yarn unevenness for prolonged service life of cot.

The tensile strength of yarn majorly influenced by the raw material and other technological parameters, the variability in cot diameter and roller pressure presents indeterminate effect. Therefore, problem solving intervention is required in the raw material and spinning preparatory operations.

Similarly, the neps level for all samples shows in determinant effect, this indicates the variability in cot diameter and roller pressure in ring frame cannot affect the neps level.

From the overall analysis of the experimental data, for cot diameter of 29.9mm and 29.6mm, top roller pressure of 2.2bar shows the optimal effect on the results, and for cot diameter of 29.3mm and 29.0, 2.3bar pressure of top roller shows the optimal result which can able to control the variability due to reduction in cot diameter.

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