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Study on the Performance of Electronic Yarn Clearer

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Abstract: *Electronic yarn clearer (EYC in the winding unit is the spinner's last chance for "inspection and correction" a yarn quality and it works basis on closed loop principle. 100% cotton ring yarn were processed with predefined yarn fault clearing setting at auto winding machine to analyze the electronic yarn clearer's efficiency. The classimat fault values were recorded before and after the pre-defined "Active Setting" for yarn clearer. The study shows that the yarn clearer does not perform for yarn clearing at 100% efficiency for all classimat fault concern. For the yarn count 30/1 Ne and 40/1Ne EYC efficiency for yarn fault clearing has been observed lower and for coarser yarn, e.g. 16/1 Ne combed, EYC efficiency for yarn fault clearing was observed higher. It was also observed that capacitive sensor performs better than optical sensor.*

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I. INTRODUCTION

In the textile community, yarn consumers are more sensitive to quality and the spinning mills face more demanding quality challenges [1-3] regarding foreign fiber contamination, remaining disturbing defects, barré and uneven fabric appearance claims and in critical condition they have pay for fabric damage. An overall quality management concept is essential to deal with the quality challenges in modern spinning mills. This has to include effective bale management [4-8], fiber process technology [5-13] fiber process control parameter [14-15] and the elimination of off-quality bobbin using sophisticated yarn clearers [16-17] at the high speedy winding unit for final quality inspection.

Sensing principle of the modern EYC include by optical, capacitive and tribo-electric system [16],[18-21]. A modern yarn clearer on the winding machine is now a multi-purpose sensor [22] which determines the disturbing thick places, thin places and foreign fibers as well as the evenness (CVm%), the imperfections (IPI), off-count, detection of periodic defects, the hairiness, etc. except the strength and elongation values.

II. METERIAL AND METHOD

We selected three samples of 16/1Ne, 30/1Ne and 40/1 Ne of ring combed yarn for our experiment for evaluation of Uster(R) classimat faults [23]. Ring cop yarn was processed at Uster(R) Quantum 2 of Muratec 21C Process Coner to form cone for evaluation of classimat faults with "Zero Setting" (all sensitivity channel set to "0") to evaluates and assesses the classimat faults that present into the ring cop yarn. The produced cones were processed with the pre-defined class-clearing limit known as "Active Setting" to clear-out the pre-defined classimat faults as shown into the Figure-1 & 2. The cone yarn packages produced with the "Active Setting" were processed again at auto winding machine with the "Zero Setting" to assess the remaining classimat faults that present into the yarn; actually intended to clear-out with "Active Setting".

When the yarn will pass through the parallel plates, the equation for capacitance [24] will take the following form.

$$C=\frac{A\varepsilon_0}{\left(\frac{d_1}{\varepsilon_{r1}}+\frac{d_2}{\varepsilon_{r2}}\right)} \qquad (1)$$

Where, C is the capacitance in farad (F); ε_{r1} is the *dielectric constant* of the material yarn between the plates; ε_{r2} is the *dielectric constant* of the material air between the plates; ε_0 is the permittivity of free space, vacuum which is equal to 8:854 X 10^{12} F/m; A is the area of each plate, in square meters and d1 is the thickness of material yarn between the two plates; d_2 is the thickness of material air (free space) between the two plates. Physically, dielectric effects are due to polarization in the medium [25-26].

Yarn faults can be classified under the term “frequent faults” or "imperfections" that exceed –30% or +35% and “non-frequent faults” or “seldom–occuring faults” that exceed the limit of +100% and -45% [23] of the mean yarn size. Before pinpointing the root causes [27-28] of these disturbing faults in the spinning process, it is critical to ensure consistent quality. But the first step is to measure and quantify them.

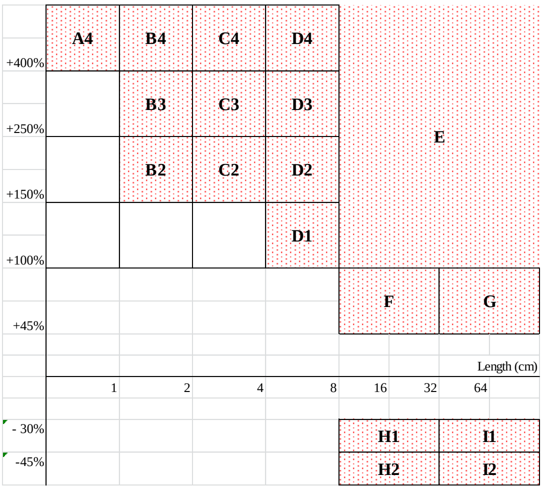

Fig-1: Classimat view of the “Active Setting” for “NSLT” channel.

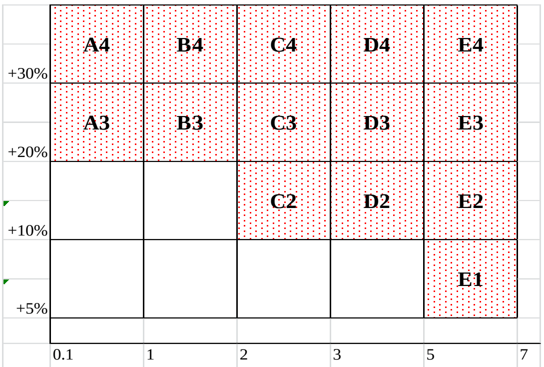

Fig-2: Classimat view of the “Active Setting” for “FD” channel.

To assess the yarn clearer performance, we determined the yarn fault clearing efficiency of EYC from equation -2.

$$CE_{EYC}\%=\frac{[CF_B - CF_A]}{CF_B}\times 100 \quad (2)$$

CE_{EYC}= Clearing efficiency of EYC
CF_B=Classimat Faults before Active Setting and
CF_A=Classimat Faults after "Active Setting"

III. RESULTS AND DISCUSSION

The classimat faults can be described as the faults that are non-frequent or rare. The classimate faults of the ring cop yarn that were obtained at first with “Zero Setting” are denoted by “Before” in the test status and the classmate faults of the cone yarn that were obtained with “Zero Setting” after clearing the pre-defined yarn faults with “Active Setting” are denoted by “After” in the test status. Three yarn counts, each count with four samples for four yarn faults category were observed for remaining classimat faults.

Table 1 shows that eventually not any kind of pre-defined classimat yarn faults were removed completely with “Active Setting”. This was observed also that in case of objectionable short thick faults and objectionable foreign matter faults, degree of remaining classimat yarn faults were to higher level for all count.

Table 1: Classimat faults of the samples-MV.

Test's Condition		Fault Parameters			
Count	Test Status	OSTKF	OLTKF	OLTNF	OFMF
16/1 Ne	Before	45.7	37.2	1.4	22.3
	After	4.8	1.4	0.0	6.8
30/1 Ne	Before	41.9	17.3	2.5	28.8
	After	6.2	2.1	0.6	5.8
40/1 Ne	Before	79.0	14.0	4.7	46.7
	After	10.6	0.9	1.3	9.6

Figure 3 shows that yarn fault clearing efficiency of the EYC have been performed at various levels. The lowest individual CE_{EYC} % (53.33%) was observed for 40/1 Ne in case of OLTNF for observation no 1.

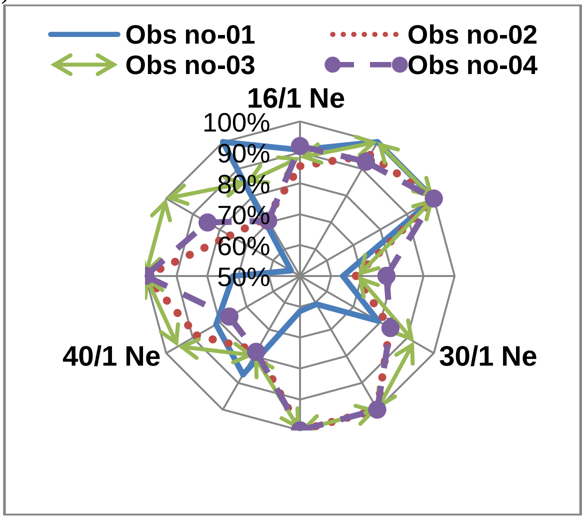

Fig. 3: CE_{EYC} % for all individual samples.

EYC efficiency, CE_{EYC}%%- mean values (MV) are summarized in Table 2. Table 2 & Figure 4 shows that classimat yarn fault clearing efficiency, CE_{EYC}% is higher for 16/1 Ne (avg 88.86%) and lower for 30/1 Ne (avg 82.82%). The lowest individual CE_{EYC} % (69.62%) was observed for 16/1 Ne in case of OFMF.

Table 2: EYC efficiency, CE_{EYC}%%- MV

Count	Fault Clearing Efficiency				AVG Efficiency (Overall)	AVG Efficiency (Optical)	AVG Efficiency (Capacitive)
	OSTKF	OLTKF	OLTNF	OFMF			
16/1 Ne	89.45%	96.37%	100.00%	69.62%	88.86%	69.62%	95.27%
30/1 Ne	85.21%	88.15%	78.00%	79.91%	82.82%	79.91%	83.79%
40/1 Ne	86.55%	93.92%	72.58%	79.55%	83.15%	79.55%	84.35%
Overall Results					84.94%	76.36%	87.80%

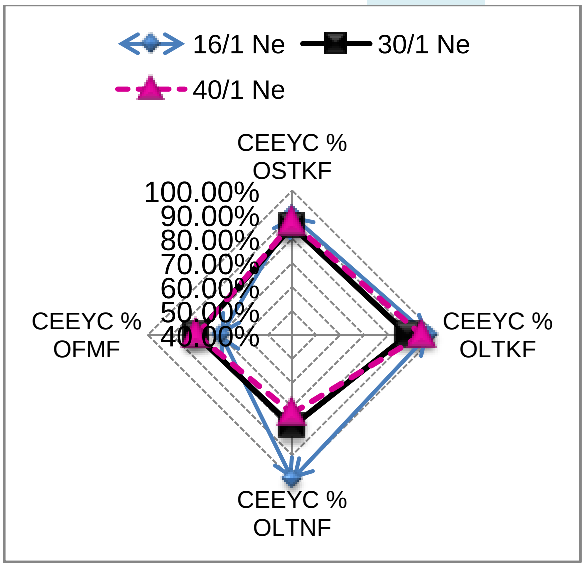

Fig. 4: CE_{EYC} % for all samples-summary.

Table 2 indicates an important point and it is the CE_{EYC}% of the two different type electronic yarn clearer, capacitive sensor and optical sensor. Table 2 indicates that EYC performs poorer (76.36%) for optical sensor than capacitive sensor (87.80%) and CE_{EYC}% for optical sensor is lowest for all count. As count become finer CE_{EYC}% for capacitive sensor become lower and CE_{EYC}% for optical sensor become higher (Fig. 5). Due to lowering the mass for finer yarn CE_{EYC}% for capacitive sensor become lower and for reducing the diameter for finer yarn CE_{EYC}% for optical sensor increases.

IV. STATISTICAL ANALYSIS

For hypotheses testing, One-Way ANOVA (Table 3) was employed where each independent variable (different yarn count) was taken against the dependent variables (CE_{EYC} %) to examine the variability significance. It was found that mean CE_{EYC} % is statistically equal for selected yarn count.

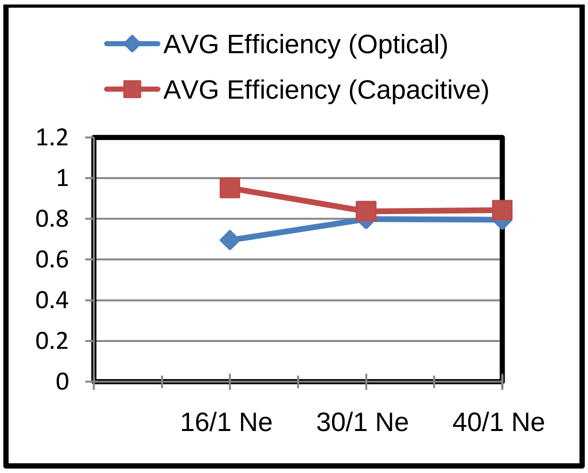

Fig. 5: CE_{EYC} % for all count

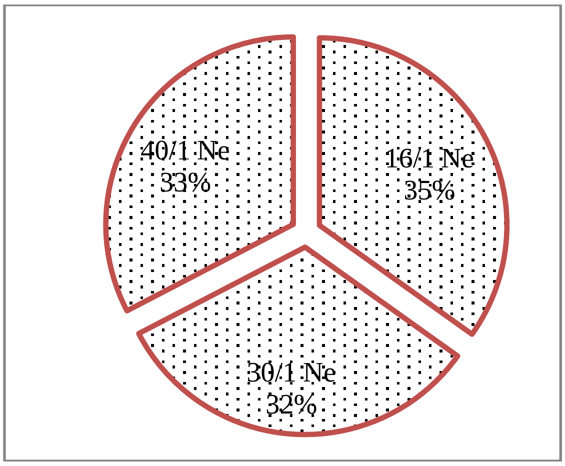

Fig. 6: CE_{EYC} % for all count

Table 3: ANOVA of CE_{EYC} % (One-way).

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.015	2	0.007	0.410	0.666	3.204
Within Groups	0.807	45	0.018			
Total	0.822	47				

For hypotheses testing, Two-Way ANOVA (Table 4) was employed to examine the variability significance considering CE_{EYC}% of two type EYC, C15 (Capacitive Sensor) and F23 (Optical Sensor) as dependent variables. It is observd that mean CE_{EYC} % of the two different type sensor, namely capacitive sensor and optical sensor is statistically equal for selected yarn count.

Table 4: ANOVA of CE_{EYC} % (Two-way).

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	4.1E-05	2	2E-05	0.003	0.997	19.00
Columns	0.01964	1	0.01964	2.589	0.249	18.51
Error	0.01517	2	0.00759			
Total	0.03485	5				

From the descriptive statistical analysis of "Yarn Clearer Efficiency" of Classimat Fault it were found that Mean CE_{EYC} % is 86.70%, Min CE_{EYC}% is 53.33%, Kurtosis-0.535369381, Skewness-0.667717382 and Confidence Level (95.0%) 0.0384057.

Kurtosis is a parameter that describes the shape of a distribution. As Kurtosis value is -0.535369381, i.e. Kurtosis < 3, it is platykurtic and it tells us that central peak is lower and broader, and it's tail are shorter and thinner. Skewness is a parameter that describes the symmetry of a distribution. Skewness value -0.667717382 mean the frequency distribution of EYC efficiency% negatively i.e. left side skewed (Fig.7).

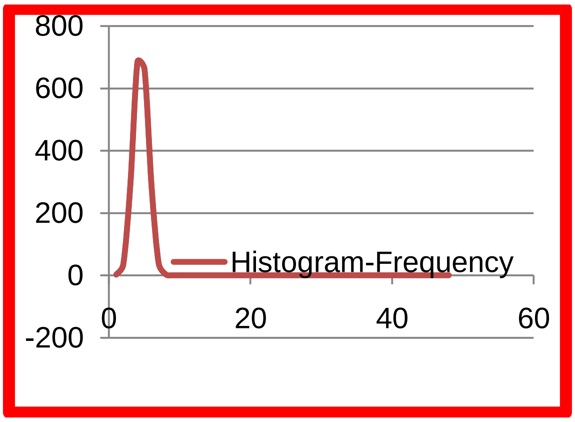

Fig. 7: CE_{EYC} % for all count

V. CONCLUSION

The objectionable yarn faults that deteriorate the physical and chemical performance of the product, delivered to the consumer will results in not only financial claims from the yarn consumer but also downgrade the competitiveness in the market. A few grams of objectionable yarn faults are sufficient enough to culminate the delivered whole lot, quantifying the thousand kgs of yarn. "Inspection & Correction" of the quality of the 100% ring yarn production is very necessary to avoid the back fall in claims and competitiveness.

In this experiment EYC performance efficiency was assessed with the "Active Setting". It is found that EYC yarn fault clearing efficiency (CE_{EYC} %) is better for 16/1 Ne combed yarn (average efficiency 88.86%) and poorer for 30/1 Ne combed yarn (average efficiency 82.82%). Yarn fault clearing efficiency, CE_{EYC} % was observed higher for capacitive type sensor than optical type sensor

From the analysis of variation (ANOVA), it can be concluded that variation in the results are not significant and we cannot reject the null hypothesis. By rechecking the yarn clearer performance and if it is found inferior, we can improve the performance by electronic maintenance work. By doing this work of assessing the electronic yarn clearer performance, we can avoid passing the objectionable yarn faults to the delivered yarn packages and thereby quality complaint from customer end. This will increase profitability as well as compatibility of the spinning industry.

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