INFLUENCE OF WINDING MACHINE SETTINGS ON QUALITY AND COST OF WOVEN FABRICS

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ABSTRACT

High speed weaving machines run with higher weft insertion rate. This can cause high tension on both warp and weft yarns during weaving operation. Therefore, these weaving machines require certain yarn quality for both warp and weft, which can subject this higher tension. In this work yarns with different quality for both warp and weft are prepared under the same conditions. Warp yarns are divided into five zones and a fabric of 65" 104x76/30 x 30 is produced on air jet weaving machine Picanol PAT. Yarn breaks during each process are recorded and production costs in winding and weaving are calculated. Fabric appearance as a major property for different yarn quality was examined. It was found that yarn with higher quality for both warp and weft is expensive for very good fabric appearance, while a good quality fabric, which has less than two minor faults per 10 m^2 and is acceptable for export and Egyptian garment industry can be produced with 18.5% decrease in costs than fabric which is relatively without appeared defects. Fabric with visible defects cleared that the total cost is the highest due to excessive yarn breaks in the weaving operation which is considered as the important process in fabric production.

Keywords: Yarn quality, Fabric appeatance, Minor faults, Yarn clearer setting, Visible defects, Yarns breakage cost factor, Weaving cost.

INTRODUCTION

The development of weaving machine construction was aimed at the increase in the weaving machine weft insertion rate through new weft insertion systems. The use of weft insertion principles has in itself, already contributed a great deal due to a reduction in stoppage rate. Reducing the stoppage rate by using a better quality yarn can bring an improvement, also warp preparation should be done with higher attention, weft preparation should be appreciated for high yarn insertion speed encountered. A shuttle loom is much more "forgiving" of poor yarn quality, the shuttle can push apart warp threads tending to cling, but air jet can not "open up" any clinging warp threads. Advancements in weaving technologies over the past decade have resulted in weaving machines which are more sensitive to the imperfections and hairiness of both warp and weft yarns. Many workers have investigated some of these problems. Some of the workers studied the effect of removing yarn defects on running conditions at subsequent processes. Jenes and Mc Camey [1] stated that the optimum condition of yarn clearing is achieved when the number of faults in the produced fabric acceptable with a lowest frequency of end breaks in weaving. Douglas K. [2] studied the count variation on the appearance of woven fabrics and found that 80% of warp stops due to knots and 20% of weaving downtime was the results of dust, thin places and other reasons. Bollen, M. [3] found that the efficiency and fabric appearance in the weaving room are determined to a high degree by the quality of the warp preparation. Nehrenberg [4], Azarschab and Murrweiß [5], Richard and Adams [6], Ramaszeder [7], Hari et al [8] concluded that excellent yarn quality must be established during preparatory processes and prior to weaving to insure maximum weaving shed efficiency. Schlichter [9] studied the effect of yarn breakage during spinning on the different processes in weaving mill and had concluded that yarn quality for weaving depends on the quality of yarn from the spinning process. Other workers [10], [11] and [12] studied the end product cost and percentage cost of thread breakage. It was concluded that the percentage cost of yarn breakage in weaving is higher than any other process before weaving. This is as a result of longer time spent in repairing defects.

The aim of this work is to find the better yarn quality, which has minimum yarn imperfection for Egyptian cotton Giza 75. This yarn may be suitable for the new high speed weaving machines. Fabric may be produced with minimum weaving costs and good appearance for export and Egyptian garment industry.

EXPERIMENTAL WORK

In this work an Egyptian cotton Giza 75 for warp and weft was chosed. A carded yarn has a count $30/1^s$ with a twist factor 3.7 and was spun by Misr Spinning and weaving Co. KED. A Murata Mach Coner 7II winding machine is used for yarn winding. An electronic Peyer 550 is the yarn clearer type, which is used for five clearing limits. Three of them have the clearing limit, C_1, C_2 and C_3, while the other two, U_1 and U_2, are the modified clearing limits, which are stored and named as U_1 and U_2. C_1 represents the highest yarn quality while U_2 is the lowest one in this work. During winding process, the P 510 system component is connected which enables to regist a complete recorded data about the yarn and machine state for the different five settings. To produce a fabric with the following specification: 65" - $\frac{104 x 76}{30 x 30 N_e}$, 12 warp beams are produced on a direct warping machine. The threads are separated by coloured yarns into five zones for different five yarn quality. On the sizing machine a weaver's beam is produced with 6696 ends. The warp yarns are drawn in four heald shafts 2 end/dent in the reed.

After each process, the yarns are tested, and during each process the number of yarn breakage are recorded.

A Picanol PAT-Air jet weaving machine with a speed run 660-760 p.p.m is used in this work. The running speed during experiment was 720 p.p.m. The running conditions of the weaving machine is precise controlled to avoid any fabric faults due to the weaving machine.

The weft yarn has also five sorts of yarn quality with the same levels as in the warp threads.

The fabric produced is inspected to judge the fabric appearance with help of a cloth inspection machine. A several number of experts and weavers, who have different experience, ages and levels gave their opinions on the woven fabric appearance. All of these judges are ordered and analysed by "Ranking method".

RESULTS AND DISCUSSION

The results of the tested yarn after each process during yarn preparation are tabulated in Table (1). Yarn imperfection which is removed from the yarns through the adjustment of different winding machine settings, increases as the setting of electronic clearer is closed. i.e setting C_1 has a lower yarn imperfection of winding than settings C_2, U_1, C_3 and U_2 . Therefore, from the above results it can be deduced that the higher yarn quality which is prepared from the winding operation and has minimum yarn imperfection is obtained from setting C_1 and follow it the other yarn quality from settings C_2, U_1, C_3 and to U_2 respectively.

It is also clear that the number of yarn breakage per 100 km, during winding, is higher from setting C_1. This higher value of yarn breakage is due to the removal of higher number of thick places and neps which are extracted from the yarn. This higher value is reflected on the winding machine efficiency and the time consumed to produce 10^5 meters of the yarn. It is found that the winding machine efficiency decreases and the time consumed to produce 100,000 meters increases as the setting of the electronic yarn clearer is closed. Consequently, the winding cost of the electronic setting C_1 is higher than the winding cost of the other settings C_2, U_1, C_3 and U_2. As shown in Table (1) the winding cost by setting C_1 is double the winding cost of the next setting C_2 while the other settings show a reasonable difference against setting C_2. Therefore, if the winding cost of C_2 is taken as a recommended setting of a higher quality yarn instead of C_1, then the percentage increase or decrease in winding cost of other winding settings can be plotted as shown in Figure (1).

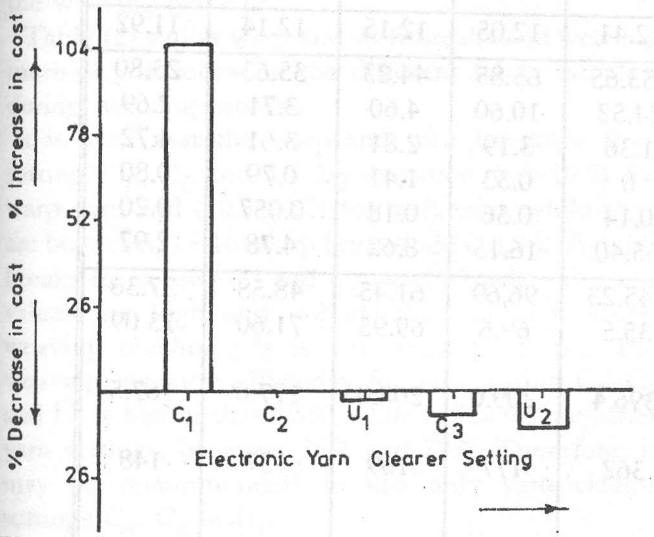

Figure 1. Percentage increase and decrease in cost for different yarn clearer setting.

The yarn produced through adjusting setting C_1 is very expensive and shows an increase in winding cost by 104% than setting C_2 while settings U_1, C_3 and U_2 show a maximum decrease of 14%. Therefore, from the economical point of view, the setting C_1 is not a practical setting to be adjust in winding department.

To discuss the effect of the different winding setting on the number of yarn breakage during warping of the different five yarns, the yarn breakage are recorded per 1000,000 meters and the results are given in Table (1). It is clear that the yarn breakage for setting C_1, C_2 and U_1 are less than 1, which agrees with the recommended values for high speed weaving machines from the workers [3,4]. The rate of yarn breakage from electronic setting C_3 and U_2 is higher than 1 and was 1.3 and 1.56 respectively. Then, these two yarns are not suitable for air jet weaving machine, which requires yarns with low percentage of yarn imperfection. The behaviour of the different five yarn quality on the sizing operation can be judged through the number of yarn breakage which are less than 0.75 for the first four settings while it is slightly high by setting U_2.

These results sure that the electronic setting U_2 is not suitable. Also, from the economic point of view the production of wound yarn through electronic setting U_2 during yarn preparation is expensive.

To analyses the process cost of the different yarn quality, the yarn breakage cost factor is calculated and plotted in Figure (2). The yarn breakage cost in this work is the ratio of the yarn breakage cost of any yarn clearer setting to the yarn breakage cost of the yarn clearer setting C_1. It is found that as the yarn breakage cost factor decrease, due to yarn winding operation, increases the yarn breakage cost factors by the other following operation i.e warping and sizing. The lower yarn breakage cost factor due to the yarn winding becomes the higher yarn breakage cost factor after warping the yarn. This affects on the cost of yarn preparation and on the yarn quality. Therefore, care must be given to the winding process to minimize the preparatory cost of the warp and weft yarn and also to reduce the percentage of yarn imperfection.

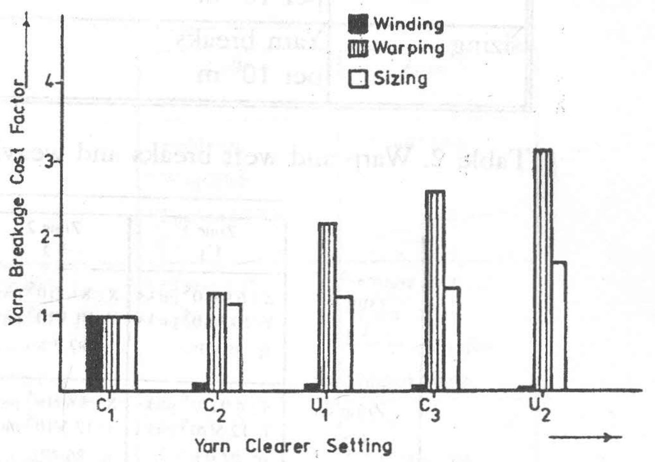

Figure 2. Yarn breakage cost factor of different weaving preparation for different yarn quality.

To explain the effect of yarn imperfection on the performance of the weaving machine a certain fabric is woven on an air jet weaving machine. This fabric includes five yarn quality in warp direction with one weft yarn quality. The purpose of producing five fabric samples beside each other is for the judgment of fabric appearance keeping other factors being constant.

Table 1. Yarn clear setting and yarn properties.

Winding setting		C1	C2	U1	C3	U2
	Yarn count Ne	30.54	30.09	30.57	30.14	30.89
	CV% count	2.8	1.71	1.69	2.71	3.39
	U%	12.41	12.05	12.15	12.14	11.92
extracted imperfection per 100 kg	Short thick	653.65	65.85	44.23	35.63	25.80
	Long thick	24.52	10.60	4.60	3.71	2.69
	coarse yarns	1.36	3.19	2.81	3.61	4.72
	Long yarns	0	0.33	1.41	0.79	0.80
	Thin places	0.14	0.56	0.18	0.057	0.20
	Neps	65.40	16.15	8.62	4.78	2.97
winding operation	Yarn breaks per 100 km	745.23	96.69	61.45	48.58	37.36
	Winding machine ζ [%]	35.5	69.6	69.95	71.60	73.09
	Time consumed per 10^5 m [min]	396.4	209.0	208.0	177.0	167.5
	Winding cost per 10^5 m [piasters]	362	177	169	157	148
warping	Yarn breaks per 10^6 m	0.50	0.63	1.09	1.30	1.56
sizing	Yarn breaks per 10^6 m	0,55	0.62	0.71	0.74	0.92

Table 2. Warp and weft breaks and weaving machine efficiency for different fabric sample

Weft threads \ warp threads	Zone 1 C_1	Zone 2 C_2	Zone 3 U_1	Zone 4 C_3	Zone 5 U_2
Zone 1 C_1	X : 6.9 /10^5 picks Y: 10.3/10^5 picks η : 89.09%	X : 8.6 /10^5 picks Y: 10.3/10^5 picks η : 87.7%	X : 10.5 /10^5 picks Y: 10.3/10^5 picks η : 86.3%	X : 13 /10^5 picks Y: 10.3/10^5 picks η : 84.3%	X : 16 /10^5 picks Y: 10.3/10^5 picks η : 81.9%
Zone 2 C_2	X : 6.9 /10^5 picks Y: 12.5/10^5 picks η : 87.9%	X : 8.6 /10^5 picks Y: 12.5/10^5 picks η : 86.7%	X : 10.5 /10^5 picks Y: 12.5/10^5 picks η : 85.08%	X : 13 /10^5 picks Y: 12.5/10^5 picks η : 83.1%	X : 16 /10^5 picks Y: 12.5/10^5 picks η : 80.7%
Zone 3 U_1	X : 6.9 /10^5 picks Y: 14.2/10^5 picks η : 87.04%	X : 8.6 /10^5 picks Y: 14.2/10^5 picks η : 85.7%	X : 10.5 /10^5 picks Y: 14.2/10^5 picks η : 81.2%	X : 13 /10^5 picks Y: 14.2/10^5 picks η : 82.2%	X : 16 /10^5 picks Y: 14.2/10^5 picks η : 79.8%
Zone 4 C_3	X : 6.9 /10^5 picks Y: 18.9/10^5 picks η : 84.5%	X : 8.6 /10^5 picks Y: 18.9/10^5 picks η : 83.2%	X : 10.5 /10^5 picks Y: 18.9/10^5 picks η : 81.7%	X : 13 /10^5 picks Y: 18.9/10^5 picks η : 79.7%	X : 16 /10^5 picks Y: 18.9/10^5 picks η : 77.3%
Zone 5 U_2	X : 6.9 /10^5 picks Y: 23.3/10^5 picks η : 82.2%	X : 8.6 /10^5 picks Y: 23.3/10^5 picks η : 80.9%	X : 10.5 /10^5 picks Y: 23.3/10^5 picks η : 79.4%	X : 13 /10^5 picks Y: 23.3/10^5 picks η : 77.44%	X : 16 /10^5 picks Y: 23.3/10^5 picks η : 75.02%

A 25 samples of fabric with different yarn imperfection are produced with the same specifications and on the same weaving machine. A higher careful is given during fabric manufacture to avoid any major defects occur due to the weaver or the weaving machine.

Table (2) shows warp and weft breaks and weaving machine efficiency, of the different fabric samples, during weaving process.

It is clear that the warp and weft breakage from setting C_1, C_2 and U_1 lay between (6.9-10.5) for warp yarn and (10.3-14.2) for weft yarn, while they are between (13-16) warp breaks and (18.9-23.3) weft breaks for setting C_3 and U_2 per 10^5 picks. The last values are high and not suitable for high speed weaving machine. It is also remarkable that the weaving machine efficiency for yarn setting C_1, C_2 and U_1 is higher than 85%, while it lies for the other yarn settings, between 75% and 79%. Therefore, it may be recommended to use only yarn clearer settings C_1, C_2 or U_1.

In order to recommend what yarn clearer setting that is suitable and economic for air jet weaving machine, fabrics are inspected and the defects are recorded. Table (3) shows the recorded fabric defects for different fabric samples.

According to the wide inspection of experts and others from weaving department, the ranking method is used and the coefficient of concordance is found to be 0.6 which proves that the judgement is close agreement. Therefore, a better fabric appearance, which has less than two minor faults per 10 m^2, is that produced from yarn with less imperfection such as yarn setting C_1, C_2 and U_1.

In order to choice the minimum yarn cost during yarn processing into fabric, the winding cost and weaving cost are calculated for each fabric samples as shown in Figure (3). It is clear that the weaving cost in all cases three times the winding cost, therefore it may be recommended to give more interest in the processes before weaving to decrease the weaving cost as possible.

Table 3. Recorded fabric deffect for different fabric sample.

Weft threads \ warp threads	Zone 1 C_1	Zone2 C_2	Zone 3 U_1	Zone 4 C_3	Zone 5 U_2
Zone 1 C_1				• Soild end. • Warp Slub. • Foreign weft yarn.	•• Warp slubs
Zone 2 C_2		• Coarse pick.	• Coarse pick •• warp slub. • Fuzz balls. • Mixed filling.	• Coarse pick. • Mixed filling	• Coarse pick • Fuzz •••••• warp slub • Mixed filling
Zone 3 U_1		• knot • Coarse plick	• Fuzz balls. • Coarse pick.	• Fuzz balls. • Coarse pick. • Neppiness. •••• warp slub.	• knot ••• coarse pick •••••• warp slub.
Zone 4 C_3		• Coarse pick	• Coarse pick	• Coarse pick	• Coarse pick
Zone 5 U_2	••• Warp slub. •••• Coarse pick	•• Warp slub. •••• Coarse pick • Neppiness. • Knot • Foreign weft yarn.	•••• Warp slub. •••• Coarse pick • Fuzz. • Slubs.	•• Knot. •••• Coarse pick • Warp slub. •• Coarse ends. • Coarse pick.	• Knot. •••• Coarse pick ••• Warp slub. • Foreign weft yarn. ••• Coarse pick. • Coarse end.

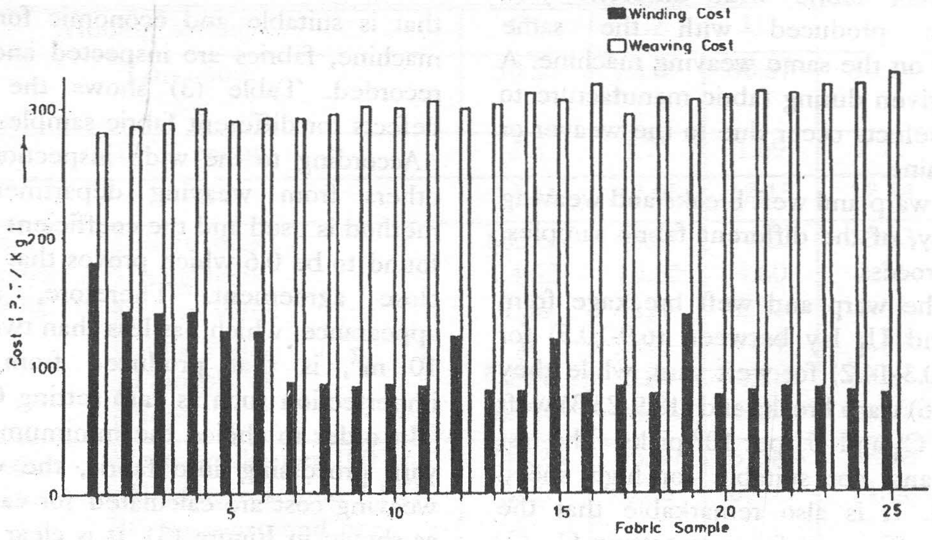

Figure 3. Winding and weaving cost for different fabric sample of different yarn quality.

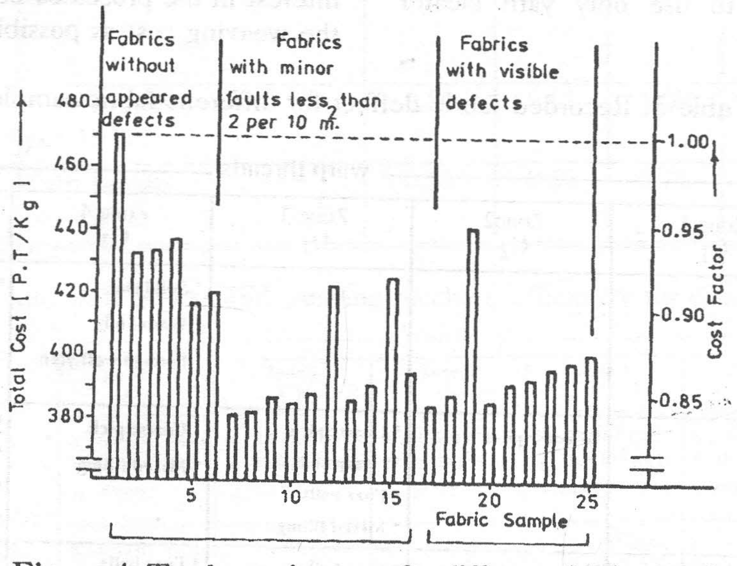

Figure 4. Total weaving cost for different fabric sample.

Figure (4) and Table (4) show the total cost i.e the preparation and weaving cost per kg for each sample of fabric produced. Fabrics are classified into three zones, the first one is for fabric which relatively without appeared defects. It includes samples 1 to 6, Figure (4). This zone has higher total cost. Most of these fabric samples using setting C_1 for both warp and weft or at least in one direction, Table (4). These types of fabrics can be produced for some end-uses and only when the total costs is out of question.

Fabrics with minor faults and have good appearance, which are acceptable for both export and Egyptian garment industry, lay in the second zone and have minimum total cost. This zone includes fabric samples from 9 to 16, Figure (4), and are produced from setting C_2, U_1 or C_3. Table (4). In this zone, there are two fabric samples with higher weaving cost due to insertion the weft yarn from yarn setting C_1. The last zone has fabric with visible defects due to relative number of yarn imperfection in both warp and weft direction. These fabric samples have slightly high total cost and mainly are produced from setting C_3 and U_2. Table (4). Therefore it may be recommended that settings C_2, U_2 can be used for both warp and weft and setting C_3 can also be used only in warp or in weft direction. These yarns give a good fabric appearance with minor faults less than two per 10 m^2. and are economically in processing.

Table 4. Winding weaving and total cost for each fabric produced.

Warp and weft quality	Weaving Machine efficiency (%)	Winding Cost (P.T/kg)	weaving Cost (P.T/kg)	Total Cost (P.T/kg)
C1C1	89.09	182.00	286.48	468.48
C1C2	87.90	142.84	289.60	432.44
C1U1	87.04	141.80	291.78	433.58
C1C3	84.50	139.69	298.34	438.03
C2C1	87.70	127.92	290.07	417.99
U1C1	86.30	126.47	293.69	420.16
C2C2	86.70	88.75	292.65	381.40
C2U1	85.70	87.70	295.20	382.90
C2C3	83.20	85.60	301.70	387.30
U1U1	84.20	86.25	299.11	385.36
U1C3	81.70	84.15	305.57	389.72
C3C1	84.30	123.57	298.81	422.38
C3C2	83.10	84.40	301.95	386.35
C3C3	79.70	81.25	310.74	391.99
U2C1	81.70	120.67	305.05	425.72
U2C3	77.30	78.35	316.93	395.28
U1C1	85.08	78.30	296.84	384.14
C3U1	82.20	83.35	304.28	387.63
C1U2	82.20	137.59	304.28	441.87
U2C2	80.70	76.25	308.15	384.40
U2U1	79.80	80.45	310.48	390.93
C2U2	80.90	83.50	307.64	391.14
U1U2	79.40	82.05	311.51	393.56
C3C2	77.40	79.15	316.68	395.83
U2U2	75.02	76.25	322.82	399.82

CONCLUSION

From the results and discussion it can be concluded that:

1- The production of defective fabrics can be eliminated and kept to a minimum level if proper quality control steps are carried out on the yarn during its manufacture and principally in winding operation. This operation has a direct influence on the other followed operations and consequently on the production cost.

2- For Egyptian cotton Gize 75, it is preferable to neglect the peyer winding setting C_1 due to higher winding and weaving cost.

3- Fabric appearance which is considered as a good image for fabric quality is affected to a great extent through electronic yarn clearer setting during yarn winding. Open setting causes yarn with higher imperfection "setting C_3 and U_2.

4- Weaving cost is three times the winding cost, therefore an effort may be given during winding which can save the total cost i.e warping, sizing and weaving cost.

5- Fabric with good quality level with two minor faults per 10 m^2 can be produced with minimum total cost when the yarns are prepared without opening yarn clearer, setting U_2 or too close setting C_1, i.e only through yarn clearer setting C_2, U_1. Yarns in one direction warp or weft can be used from yarn clearer C_3. The fabric produced through these three settings was acceptable for export and Egyptian garment industry and showed a decrease in total weaving cost by 18,5% than fabric which are relatively without appeared defects.

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