# CHAPTER (5)

# RESULTES AND DISSECTION

## 1. Introduction

The experimental work was carried out in the factory working conditions without affecting the mill's production or quality. The significant factors for the regression equations by applying the step wise regression.

From the obtained regression we can determine the effect of the factors under study; from which it will be possible to attain the best operating condition.

The different results of the experimental work have been tabulated, graphed and analyzed.

## 2. Properties of Obtained Yarns

The results of open end yarns obtained by different experimental conditions were show in table (5.1).

Table (5.1) represents the properties of open end yarns obtained due to the application of proposed experimental design.

## 3. Regression Analysis

The coefficient of the significant regression equation shown in table (5.2) from table(5.2) it can be concluded that these significant regression represent to high extent the results obtained except that of neps, cvb, attain values of $R^2$ equal to 0.802,0.855, respectively , with a very high f-significant of E -05.

This means that a higher number of experiments can increase the value of R2 due to a greater variability in the results.

Also three properties thick places, Elongation at break, and CVb have only factors at straight line relation.

From table (5.2) the most effective factors in the yarn properties consist of the hard waste are the C.VN $_m$, Evenness, CV Evenness and RKM.

Table (5-3) represented the significant regressions coefficients attained for every property.

## 4. Open End Frame

The significant regression equations for the factors under study were analyzed for different_yarn properties; the following consist of there results.

**Table (5.1) Represents the properties of open end yarns obtained due to the application of proposed experimental design.**

| | Results | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Evenness | | | | | | | | Uster tensorapide3 | | | | | |
| No. | CVb% | Neps | CVb% | Thick | CVb% | Thin | C.Vb% | CVn% | C.V% | ELO. | C.V% | RKM | C.V% | NM |
| 1 | 30.1 | 811 | 39.3 | 313 | 211 | 1 | 7.63 | 15.2 | 8.55 | 10.8 | 7.12 | 14.2 | 2.95 | 9.57 |
| 2 | 24.5 | 1005 | 30 | 348 | 0 | 1 | 4.89 | 15.7 | 6.68 | 10.1 | 9.04 | 13 | 2.27 | 9.8 |
| 3 | 89 | 766 | 80.9 | 140 | 1724 | 3.9 | 10.6 | 17.8 | 16.3 | 8.54 | 10.4 | 8.8 | 8.3 | 9.81 |
| 4 | 37.8 | 284 | 41.4 | 56 | 0 | 1 | 14.8 | 14.8 | 16.3 | 9.2 | 25.6 | 7.8 | 12.9 | 9.86 |
| 5 | 35.1 | 326 | 48.7 | 72 | 0 | 0 | 10.5 | 14.2 | 14.7 | 10.2 | 7.01 | 9.35 | 3.78 | 8.6 |
| 6 | 25.9 | 2679 | 44.2 | 714 | 114 | 10.2 | 9.07 | 17.7 | 9.53 | 9.34 | 11.8 | 13 | 3.68 | 16.4 |
| 7 | 38.8 | 2418 | 21.1 | 570 | 149 | 11.7 | 8.17 | 17.8 | 6.43 | 9.15 | 11.9 | 12.3 | 5.14 | 16.8 |
| 8 | 62.3 | 1665 | 25.7 | 203 | 297 | 412 | 28.1 | 18.3 | 13.9 | 7.79 | 18.4 | 6.69 | 4.2 | 17.1 |
| 9 | 59.7 | 1202 | 90.2 | 238 | 295 | 7.4 | 11.6 | 16.2 | 11.3 | 8.33 | 11.2 | 8.37 | 5.34 | 15.6 |
| 10 | 61.7 | 1067 | 68.4 | 190 | 150 | 20 | 19.4 | 16.2 | 13.2 | 9.61 | 10.9 | 9.1 | 4.31 | 16.7 |
| 11 | 33.3 | 1051 | 32 | 483 | 263 | 2.47 | 8.51 | 16 | 5.81 | 10.3 | 11.1 | 12.9 | 2.96 | 19.4 |
| 12 | 49.4 | 1035 | 36.5 | 444 | 397 | 3.39 | 12.6 | 16.7 | 5.29 | 9.55 | 12.9 | 11.6 | 6.4 | 20.4 |
| 13 | 58.8 | 633 | 58 | 176 | 0 | 1 | 10.1 | 15.3 | 11 | 9.16 | 13.1 | 7.49 | 3.07 | 19.9 |
| 14 | 39.9 | 703 | 43.9 | 215 | 282 | 3.39 | 8.3 | 16.3 | 9.72 | 10.2 | 18.9 | 8.72 | 6.47 | 20.2 |
| 15 | 60.9 | 419 | 49 | 139 | 0 | 0 | 8.02 | 14.6 | 7.77 | 10.8 | 13.9 | 9.35 | 6.98 | 17.5 |

**Table (5-2) Represents the Values of significant factors of the regression equations for different open end yarns properties.**

| | | X 1 | X 2 | X 3 | X 4 | X 1X2 | X 1X3 | X 1X4 | X 2X3 | X 2X4 | R square | F- sig |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Cv Nm** | **Coeff** | -1.154 | -2.301 | 0.1445 | - | 0.0415 | - | 0.0072 | 0.0298 | 0.096 | 0.9603 | 0.0001 |
| | **p.value** | 0.002 | 0.0097 | 0.0117 | - | 0.0047 | - | 0.0156 | 0.0147 | 0.0113 | - | - |
| **Nm** | **Coeff** | 1.0147 | - | - | - | -0.002 | - | - | - | - | 0.998 | 2E-17 |
| | **p.value** | 9E-14 | - | - | - | 0.1551 | - | - | - | - | - | - |
| **Ev** | **Coeff** | - | - | - | - | -0.026 | 0.0089 | 0.008 | 0.0085 | 0.0095 | 0.987 | 2E-08 |
| | **p.value** | - | - | - | - | 0.0027 | 4E-05 | 0.0007 | 0.0003 | 0.0003 | - | - |
| **Thick Places** | **Coeff** | 10.51 | - | - | 3.852 | - | - | - | - | - | 0.9478 | 1E-08 |
| | **p.value** | 3E-05 | - | - | 6E-06 | - | - | - | - | - | - | - |
| **Neps** | **Coeff** | - | - | 0.926 | - | - | - | 1.1338 | - | - | 0.8017 | 4E-05 |
| | **p.value** | - | - | 0.0017 | - | - | - | 4E-05 | - | - | - | - |
| **El** | **Coeff** | - | 0.1337 | 0.0826 | - | - | - | - | - | - | 0.9947 | 5E-13 |
| | **p.value** | - | 5E-05 | 1E-08 | - | - | - | - | - | - | - | - |
| **Cv El** | **Coeff** | -0.587 | 0.1171 | 0.2434 | 0.0925 | - | - | 0.0052 | - | - | 0.9901 | 6E-09 |
| | **p.value** | 0.0003 | 0.0167 | 2E-07 | 0.0072 | - | - | 0.0317 | - | - | - | - |
| **Cv b** | **Coeff** | - | - | 0.1687 | 0.1033 | - | - | - | - | - | 0.855 | 6E06 |
| | **p.value** | - | - | 3E-06 | 0.0016 | - | - | - | - | - | - | - |
| **Rkm** | **Coeff** | - | - | 0.1094 | 0.1833 | 0.0076 | -.0.002 | -0.003 | - | - | 0.9972 | 2E-11 |
| | **p.value** | - | - | 2E-06 | 7E-0s | 6E-05 | 0.0125 | 0.0028 | - | - | | |
| **Cv Rkm** | **Coeff** | - | -3.021 | - | - | - | - | - | 0.0487 | 0.0457 | 0.9276 | 9E-07 |
| | **p.value** | - | 0.0006 | - | - | - | - | - | 0.0001 | 0.0002 | - | - |

**Table (5-3) Represents the sign of the significant factors in the different regressions for yarn properties**

| | | X1 | X2 | X3 | X4 | X1X2 | X1X3 | X1X4 | X2X3 | X2X4 |
|---|---|---|---|---|---|---|---|---|---|---|
| **C.V Nm** | **Coefficient** | - | - | + | | + | | + | + | + |
| **Nm** | **Coefficient** | + | | | | - | | | | |
| **Evenness** | **Coefficient** | | | | | - | + | + | + | + |
| **thick places** | **Coefficient** | + | | | + | | | | | |
| **Neps** | **Coefficient** | | | + | | | | + | | |
| **Elongation** | **Coefficient** | | + | + | | | | | | |
| **C.V Elo.** | **Coefficient** | - | + | + | + | | | + | | |
| **C.V b** | **Coefficient** | | | + | + | | | | | |
| **RKM** | **Coefficient** | | | + | + | + | - | - | | |
| **C.V rkm** | **Coefficient** | | - | | | | | | + | + |

The sign of most of the significant factors are positive as stated before.
Due to that we have to choose carefully the optimum working conditions and it depends essentially on the clips percentage applied

Yarn count=1.0147*X1-0.002*X1X2 .................................... (5-1)
P value 9E-14 0.1551

From the above value of $R^2 = (0.998)$ and significance F = (2E-17) it is clear that the equation (5-1) represents the experimental results, the factor affecting the yarn count can be concluded from the above equation, it is obvious that the interaction between the yarn count and the polyester percentage has a negative effect on yarn count i.e. the yarn tends to be finer when the interaction decrease.

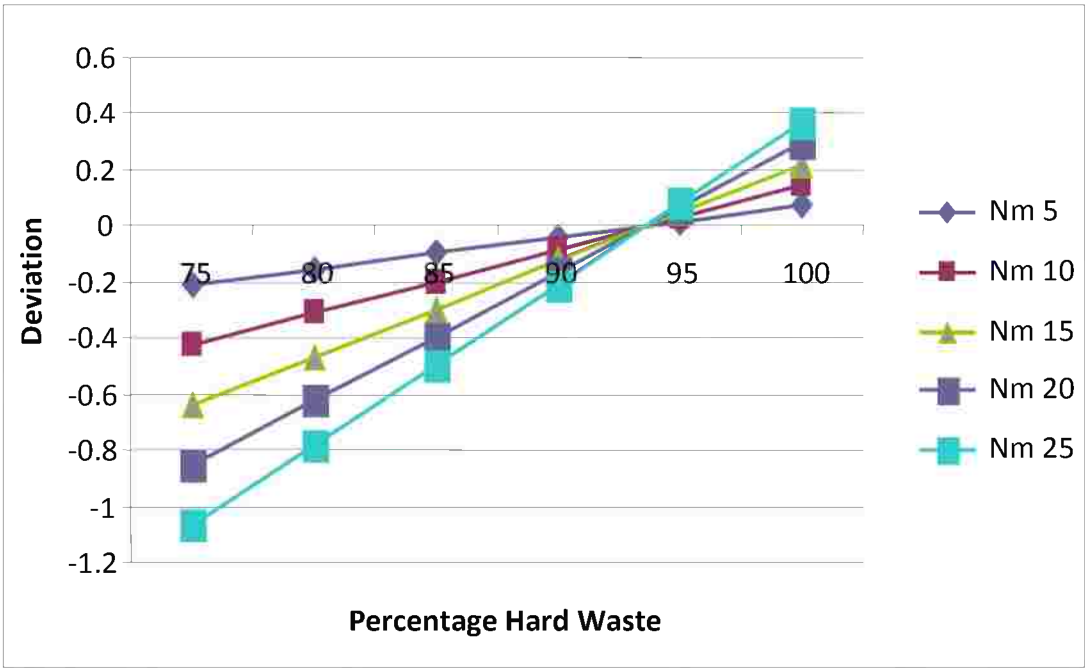


**Figure (5-1) Represents the relation between deviation of Actual yarn Count and Nominal yarn count for different percentage Hard Waste.**

1-Yarn Count

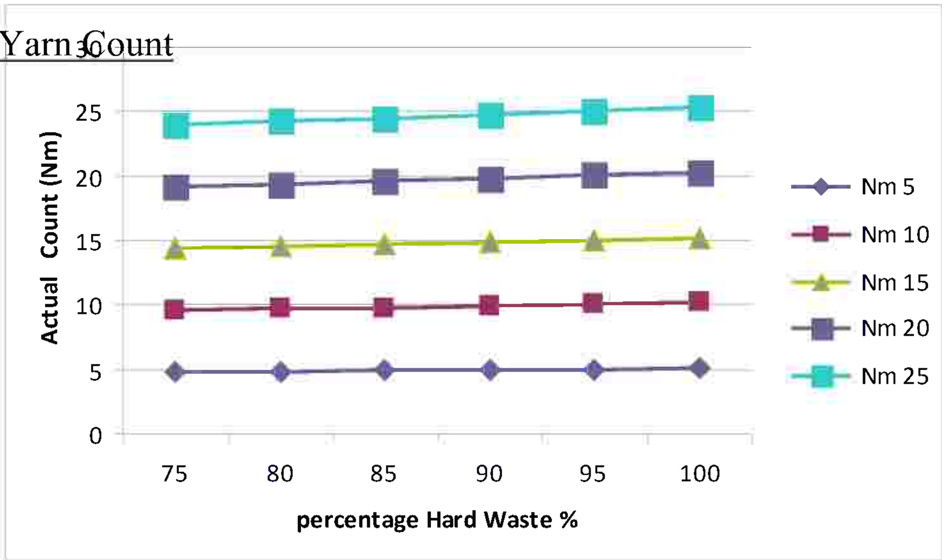


**Figure (5-2) Represents the relation between Actual yarn Count and Nominal yarn count for different percentage Hard Waste.**

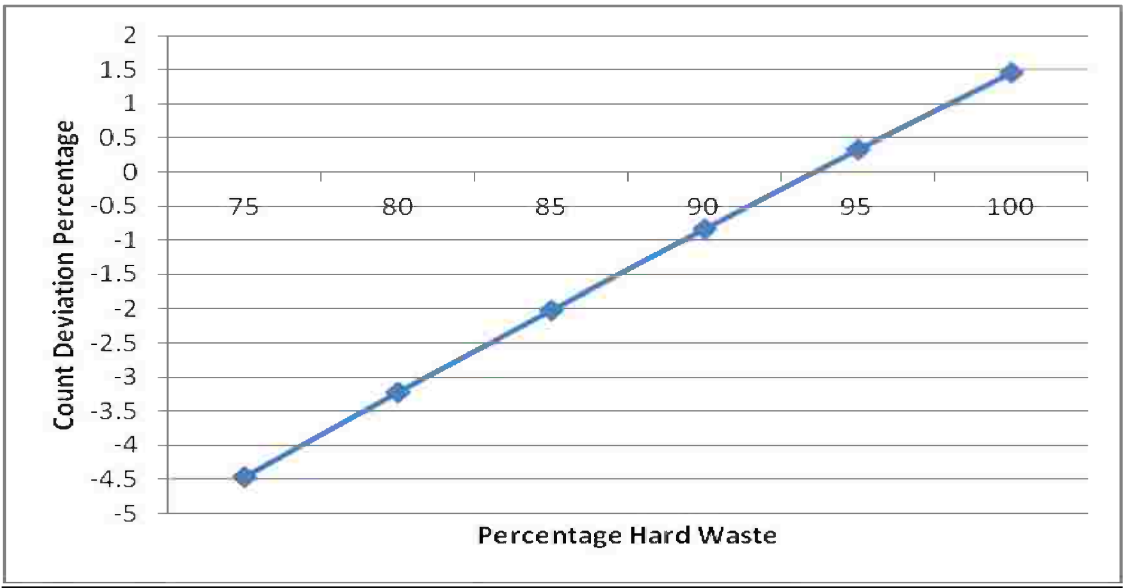


**Figure (5-3) Represents the relation between Percentage deviation of Actual yarn Count and Nominal yarn Count for different percentage Hard Waste**

## 2- C.V% Yarn Count

CV % count =$-1.15x1-2.3\,x_2+0.145\,x_3+0.042x_1x_2+0.0072\,x_1x_4+0.03\,x_2x_4+0.03x_2x_3$ ... (5-2)
P value 0.002 0.0097 0.0117 0.0047 0.0156 0.0113 0.0147

Equation (5-2) represent to a great extent the experimental results since $R^2$ attain a value of (0.96), an efficiency of 96%, and the significance F of the equation is (0.0001), only 1case from 10000 the relation fails to represent it. From the above equation it can be detected that the count and the polyester ratio both have a negative effect on the C.V %count, while the percentage knitted waste has a positive effect, this has to be expected since we are working in a mixture design were the sum of polyester and hard waste is constant. Also four interaction between the studied factors are presented in the relation, the yarn count is interacted with both the polyester fiber and the yarn waste indicate that the coefficient of count variation can increase or decrease depending on the percentage of their ratios. This is not the case for the yarn hard waste since any interaction between the yarn count and the fiber components has an effect in the significant relation. In the main time the significant interactions between the fiber components will introduce some difficulties in the real relation between these factors. Figure (5-4) to figure (5-7) tends to demonstrate the different effect of these factors under different conditions. From figure (5-4) it is seen that the curves consist of two categories depending on yarn count, the first category is for

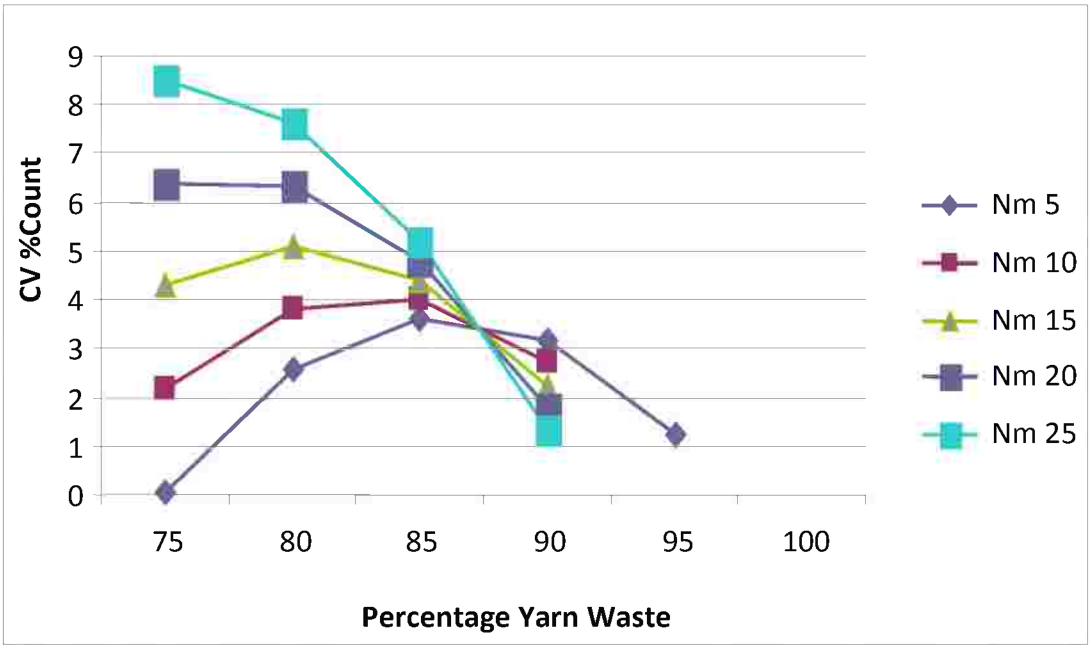


**Figure (5-4) Represents the relation between yarns Count CV% with both percentage Yarn Waste and yarn count**

Nm 5 and 10 while the second one consist of Nm 15, 20 and 25.In the thicker yarn the relation follow a quadratic form , increase of yarn waste increase the yarn coefficient of variation till 87.5 percent of yarn waste after that the coefficient of variation decrease. While in case of finer yarn the coefficient of variation decrease when increasing the percentage yarn waste. For all yarns except Nm5 the maximum percentage yarn waste is 90% for yarn formation while 95% percentage can be used for Nm5.The relation between yarn coefficient of variation for knitted waste and yarn count is demonstrated in figure (5-5), from which we can detect that it has the same tendency as the yarn waste only with different rate. Three yarn counts 5, 10 and 15 Nm demonstrate an increase in yarn coefficient of variation with the increase of percentage knitted waste after that they decrease .The point of return differs from count to count, it is 93% for Nm5, 87% for yarn count 10 and 81% for 15 Nm which is about to be constant between every yarn count increment, constant rate. The two other counts 20, 25 their yarn coefficient of variation decrease with the increase of knitted waste. In case of knitted waste the coefficient of variation for coarse count is greater than that of the finer one, this differs than that obtained in case of yarn waste but agrees with the literatures. Due to that more research had to be carried out to attains the causes of such deviation, some of the possible factors can be the components specification of every waste since the yarn waste is obtained from Egyptian cotton while the knitted waste is in most case imported and is produced from shorter fibers, in some cases a percentage of polyester can also be found. It was difficult to have an analogue specification for the two wastes since the work was carried out on the factory and no pilot plan is available to carry out such research. Another possibility of such variation between the two types of hard waste consists of that their percentages exceed the 70% while the literatures are based on only 30% percentage hard waste. Also the coefficient of count variation is very high in case of knitted waste compared with yarn waste, it attain a maximum of 13.7 and a minimum of 1.8 while in case of yarn waste these values are 8.8 and 0.5 respectively. In the main time the maximum percentage of knitted waste is lesser in knitted waste than that of yarn waste for finer count but it can attain 100% for counts 5 and 10 Nm instead of 95% only for count 5 in case of yarn waste.

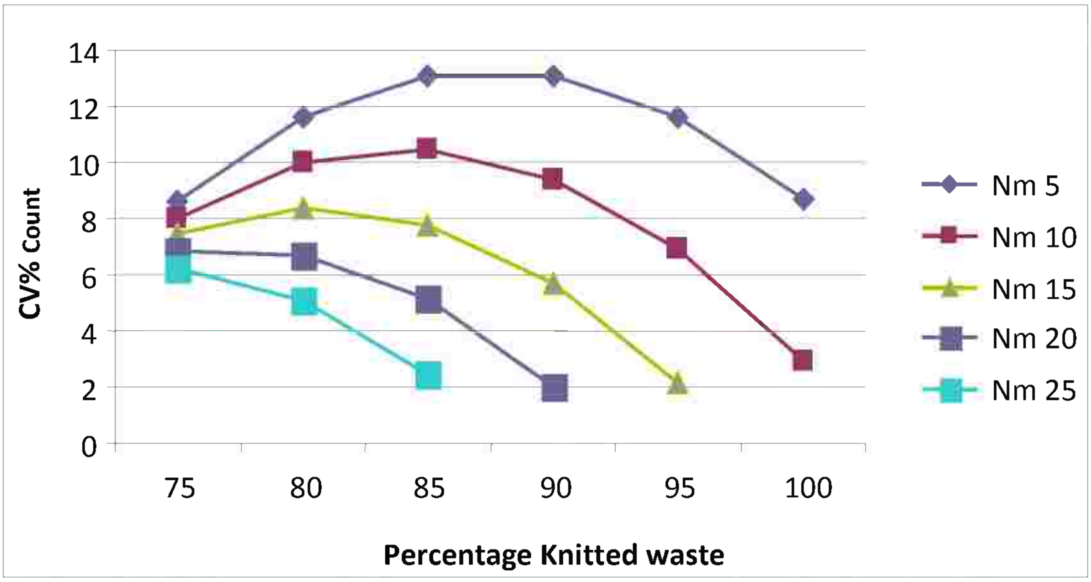


**Figure (5-5) Represents the relation between yarns Count C.V% with both percentage Knitted Waste and yarn count.**

Figure (5-6) is applied for determining the effect of yarn waste on the direction and value rate of coefficient of count variation. From figure it can be detected that the count coefficient of variation increase with the increase of yarn count in case of 75%,80% and 85% yarn waste while it decrease with the 90% yarn waste. The higher increase rate is obtained at 75% yarn waste and it decrease with the increase of the percentage of waste.

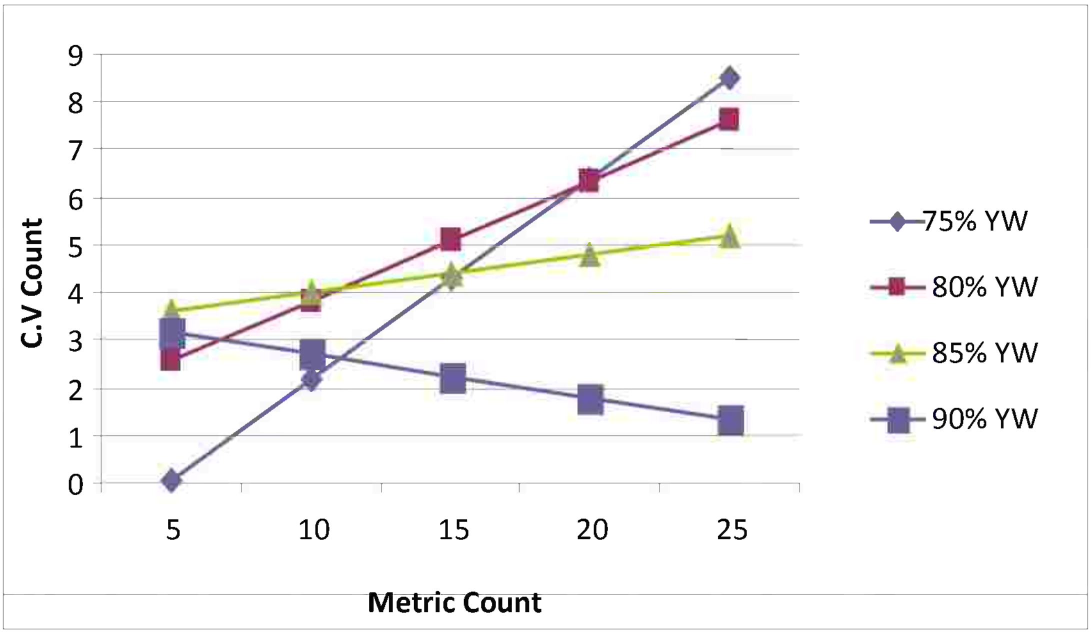


**Figure (5-6) Represents the relation between yarns Count C.V% with both yarn count percentage Yarn Waste (YW).**

From figure (5-7) it is possible to compare between the rates of yarn coefficient of variation due to the increase of yarn count.

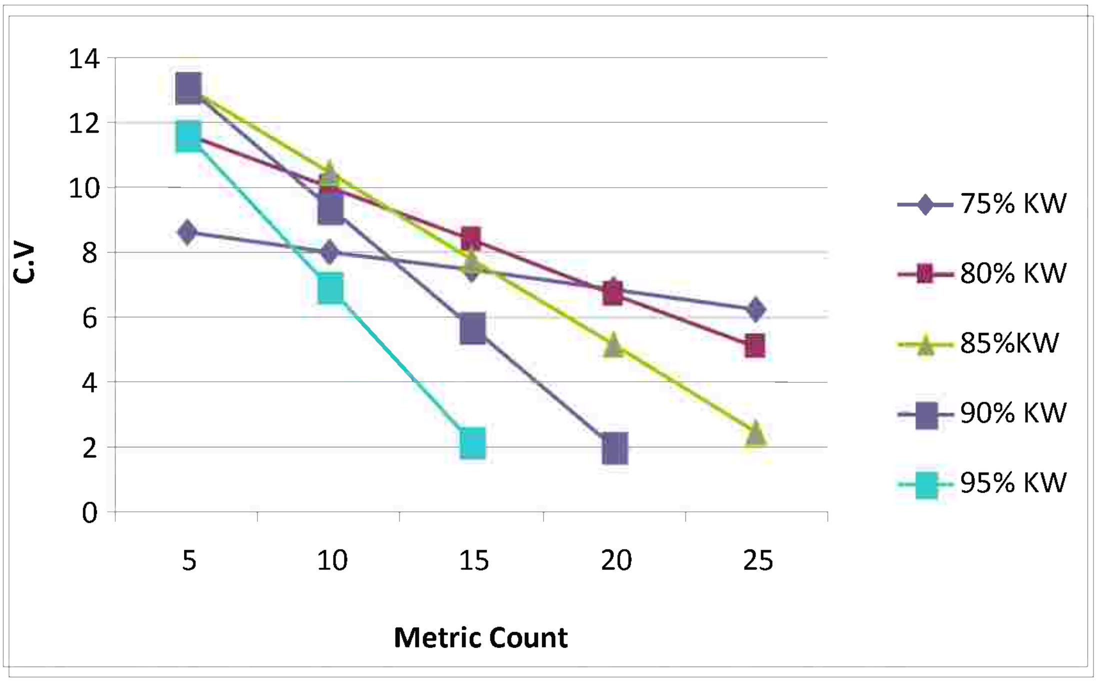


**Figure (5-7) Represents the relation between yarns Count C.V% with both yarn count percentage Knitted Waste (KW).**

From this figure it is easily attained that the coefficient of yarn variation decreases with the increase of yarn count. The rate of decrease is higher with the higher percentage of knitted waste.

## 3-Evennes

Evenness=-0.026*x1x2+0.0089*x1x3+0.008*x1x4+0.0085*x2x3+0.0095*x2x4. (5-3)
P value 0.0027 0.0003 0.0007 0.0003 0.0003

From equation (5-3) we can deduce that only all the interactions between factors give significant values in the regression relation. The yarn count interact with other three factors, this differ from that obtained in case of yarn count coefficient of variations were the interaction between yarn count and the knitted waste do not exist in the regression equation . Also all the values are positive except the interaction between count and percentage polyester. Also it is clearly that the values of interaction between yarn count and both type of hard waste don't vary significantly ,this is also can be accepted for the interaction between the polyester waste and the types of hard waste. Due to that the performance of the two type of hard waste with the two other factors yarn count and percentage polyester fiber will not differ significantly. This will demonstrated through the figures which will describe the relation between the factors under study. Figure (5-8) and figure (5-9) represents the relation between yarn counts; both type of hard waste on yarn evenness. From figures it is clear that the two figures coincide to a great extent. The yarn evenness of the coarser count is lower than the finer yarn and the value is highly related to count. Also the 95% hard waste has lower evenness values for coarse counts, but this is reversed after Nm 15 for both type of hard waste. In the same time of increase in yarn evenness is directly proportion with the percentage of hard waste in both cases. This contradicts with the result of yarn coefficient of variation for the knitted waste.

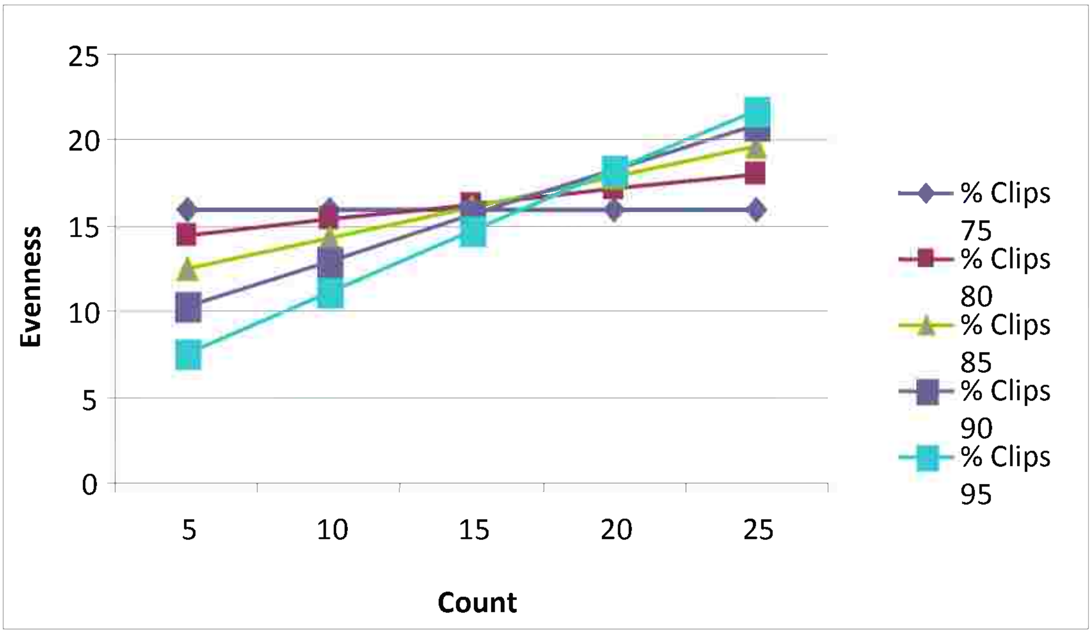


**Figure (5- 8) Represents the relation between yarn Evenness CV% with both yarn count and percentage clips.**

In the main time the range of variation in yarn evenness between knitted yarn wastes is higher for coarse yarns in comparison to finer yarn till Nm 15 were it attain its minimum variations, after that it increase another time till yarn count Nm 25. In case of yarn waste the tendency is the same with some changes in the values only. The point of minimum variation is at Nm 20 instead of Nm 25 in case of knitted waste. Also the range of variation is higher for count Nm5 and lesser for Nm25 than that of Knitted waste.

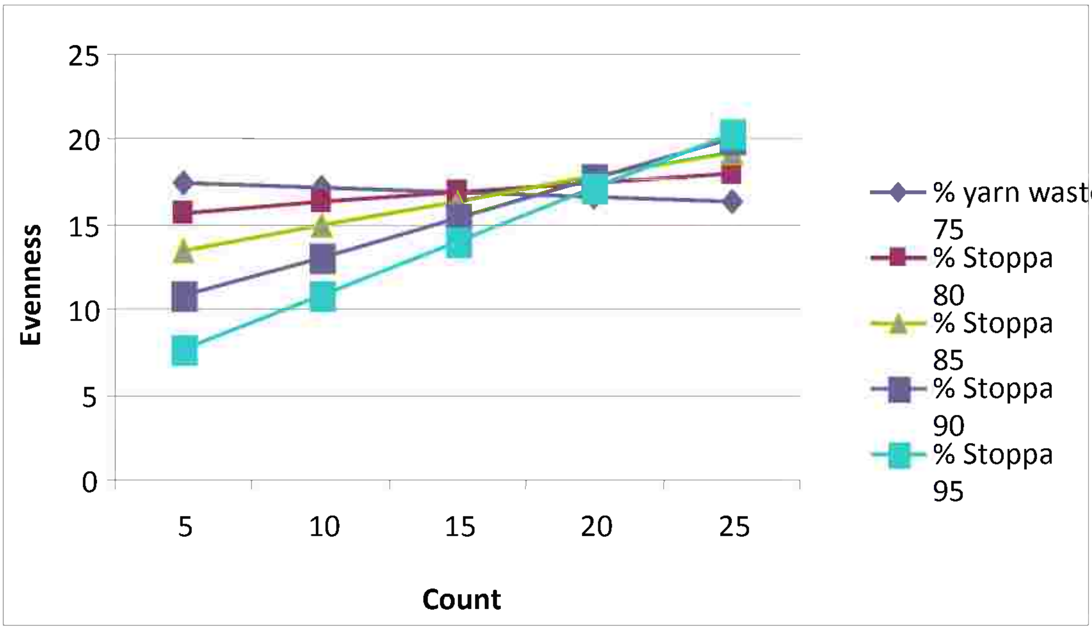


**Figure (5- 9) Represents the relation between yarn Evenness CV% with both yarn count and percentage yarn waste.**

Figure (5-10) and figure (5-11) demonstrate the relation between hard waste, yarn count and yarn evenness. For both type of hard wastes the 75% waste give the evener yarn, with a approximately the same value for all counts. The yarn unevenness increase with the

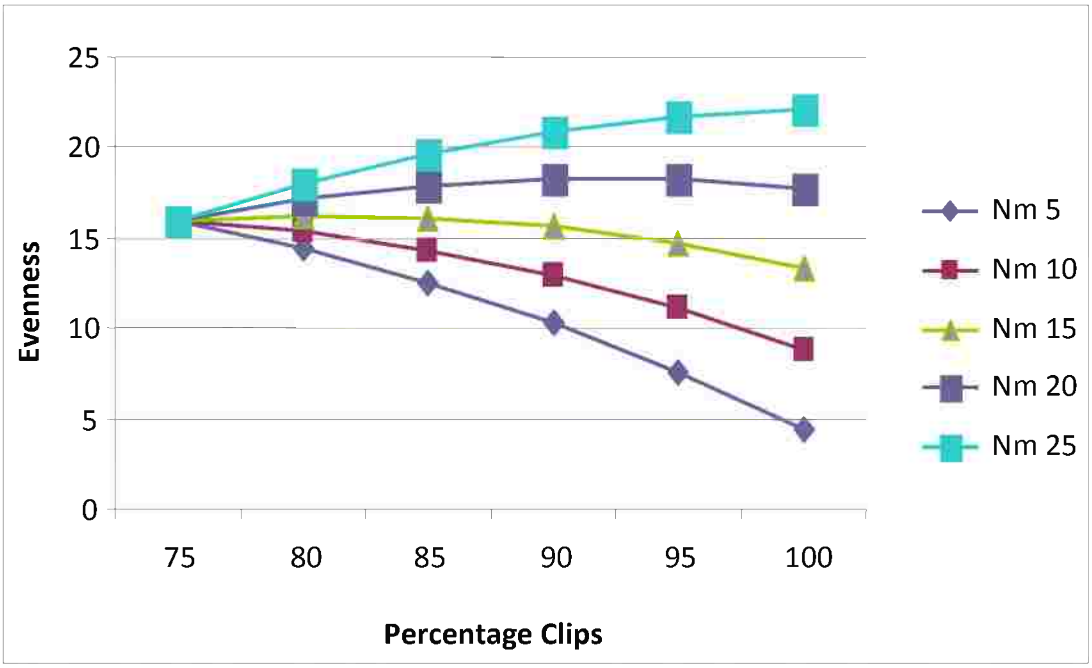


**Figure (5-10) Represents the relation between yarn Evenness CV% with both percentage clips and yarn count.**

Increase of percentage knitted waste for counts 15, 20 and 25 Nm with the higher rate of increase for the finer yarn. While the yarn evenness increase with the increase of percentage knitted waste for the two other yarns Nm5 and 10. This is the same as obtained in yarn coefficient of variation. Compared with knitted waste only two counts Nm 20 and 25 their unevenness increase with the increase of yarn waste, while in case of other yarns the yarn evenness increase with the increase of percentage waste. Also the range of variation between counts is slightly lesser for yarn waste then knitted waste.

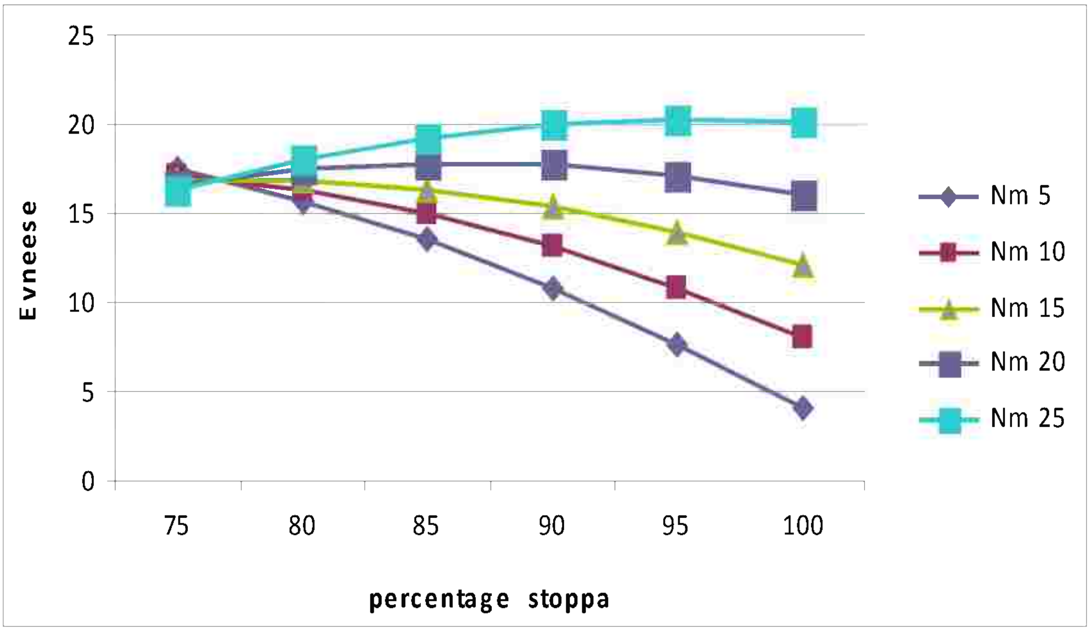


**Figure (5-11) Represents the relation between yarn Evenness CV% with both percentage yarn waste and yarn count.**

## 4- C.V Elongation

The significant regression describing the relation the relation between coefficients of variation for the elongation at break (CVEl) is shown in equation (5-4).

$CV_{el}$ = -0.587 * x1 + 0.117 * x2 + 0.244 * x3 + 0.092 * x4 + 0.0052 * x1x4...... (5-4)

| P value | 0.0003 | 0.0167 | 2E-07 | 0.0072 | 0.0317 |
|---|---|---|---|---|---|

The Square of the Coefficient of Correlation $R^2$ for the significant regression is equal to $R^2$ = (0.99), while the significant F is equal to (6E-09). Depending on the value of both $R^2$ and F it can be concluded that the regression equation represent the data concerning the coefficients of variation for the elongation at break significantly. All the factors under study had a straight line effect on the elongation coefficient of variation only the percentage yarn waste has an interactive relation with the yarn count. From the obtained relation the increase of metric count will decrease the coefficient of variation of elongation CV% at break. Since no interaction is obtained in case of knitted waste, the rate of decrease will be constant of all the waste percentage as shown in figure (5- 12), with the higher value of coefficient of variation for the yarn with greater percentage of hard waste, this is due to the fact that the coefficient of percentage knitted waste is more than two time that of the polyester waste. In case of yarn waste there are an interaction between yarn count and percentage yarn waste, this will decrease the value of yarn break elongation coefficient of variation, this is demonstrated in the figure (5-13), from which the maximum coefficient of variation for elongation at break is 9% compared with 20% in case of knitted waste. Due to the interaction between yarn waste and yarn count the range in coefficient of variation between different waste percentages will increase when the metric count will increase. The range of coefficient of variation for the yarn waste is from 5% to 9% which is about the same of that of knitted waste from 6% to10%.

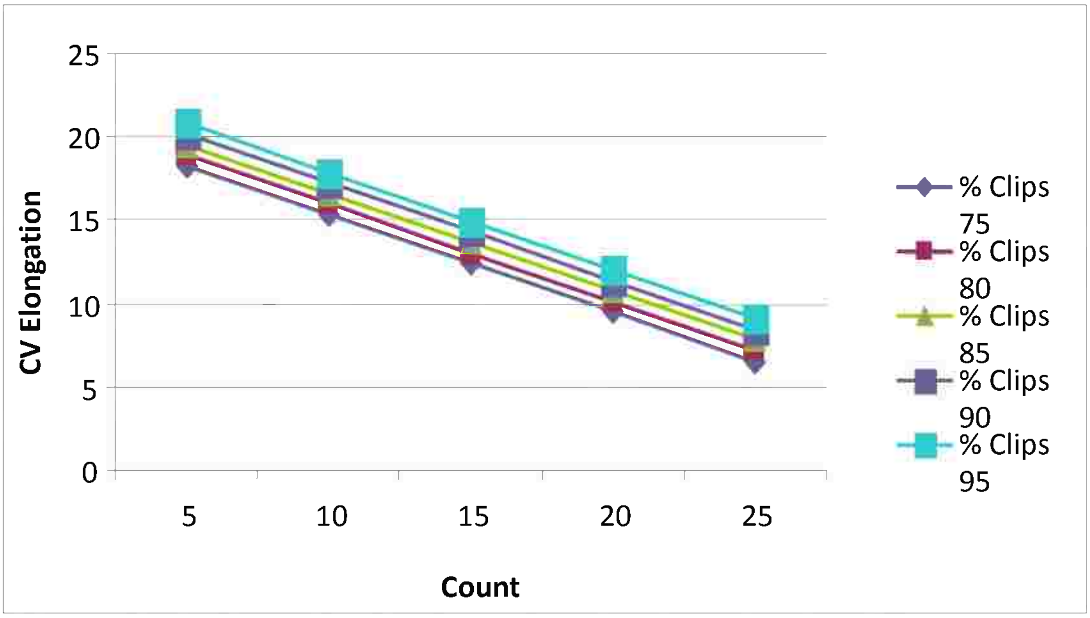


**Figure (5-12) Represents the relation between yarn Elongation CV% with both yarn count and percentage clips.**

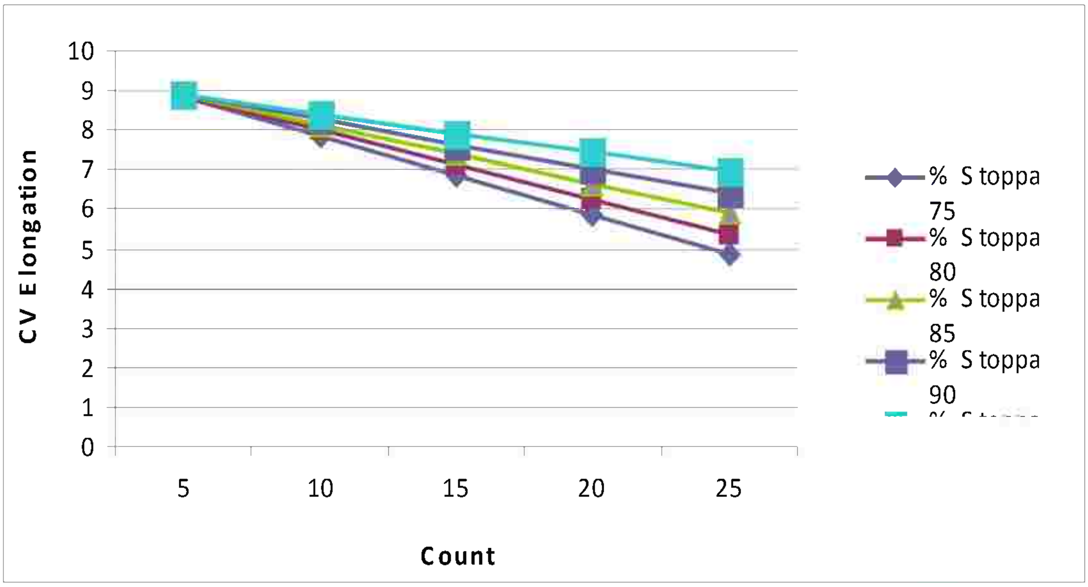


**Figure (5-13) Represents the relation between yarn Elongation CV% with both yarn count and percentage yarn waste.**

Figure (5-14) and figure (5-15) presented the relation between hard wastes, yarn metric count and the coefficient of variation of yarn elongation at break. From these figures it is obvious that the finer count has lower coefficient of variation for both type of waste. This result is obtained in case of count variability. In the main time the coefficient of variation is not significantly affected by the knitted percentage waste but it increase with the increase of yarn waste, the rate of increase in the coefficient of variation is higher for the finer count.

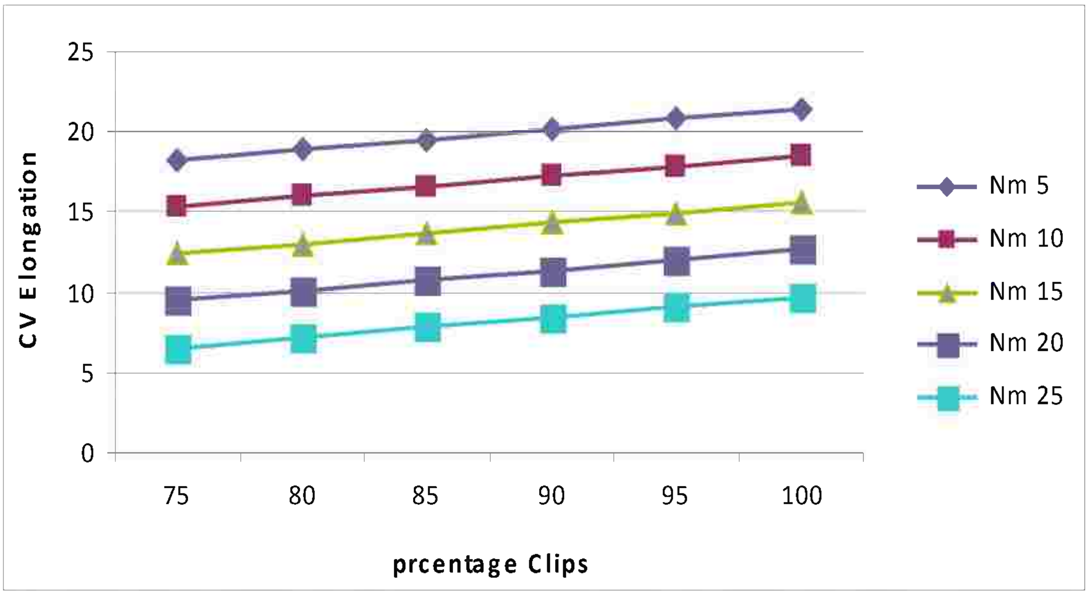


**Figure (5-14) Represents the relation between yarn Elongation CV% with both percentage clips and yarn count.**

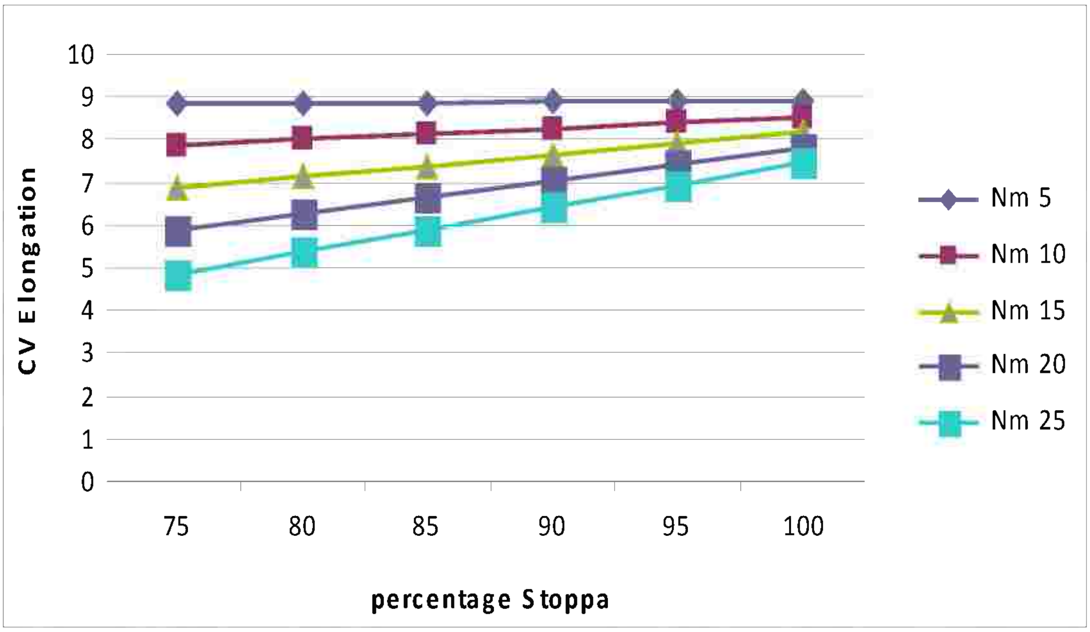


**Figure (5-15) Represents the relation between yarn Elongation CV% with both percentage yarn waste and yarn count.**

The maximum range of coefficient of variation between counts is higher in case of knitted waste compared with the yarn waste.

## 5-Yarn RKM

RKM = 0.11* x3 +0.183 * x4 +0.0076* x1x2 -0.002 x1x3 -0.003* x1x4 …… (5-5)
P value 2E-06 7E-08 6E-05 0.0125 0.002

Since the insignificant regression indicates that the values of $R^2$ = (0.997) and significance F= (2E-11), it can be stated that this equation (5-5) represents the experimental results to a very high degree.

It is clear that the clips percentage and yarn waste percentage both have a high positive effect on the yarn RKM , also from the equation , it is shown that the interaction between the yarn count and polyester percentage has a positive low effect on yarn tenacity, also we can detected that from the equation (5-5) the enter action between the yarn count and the clips ratio , the yarn waste ratio both have a negative effect on yarn RKM.

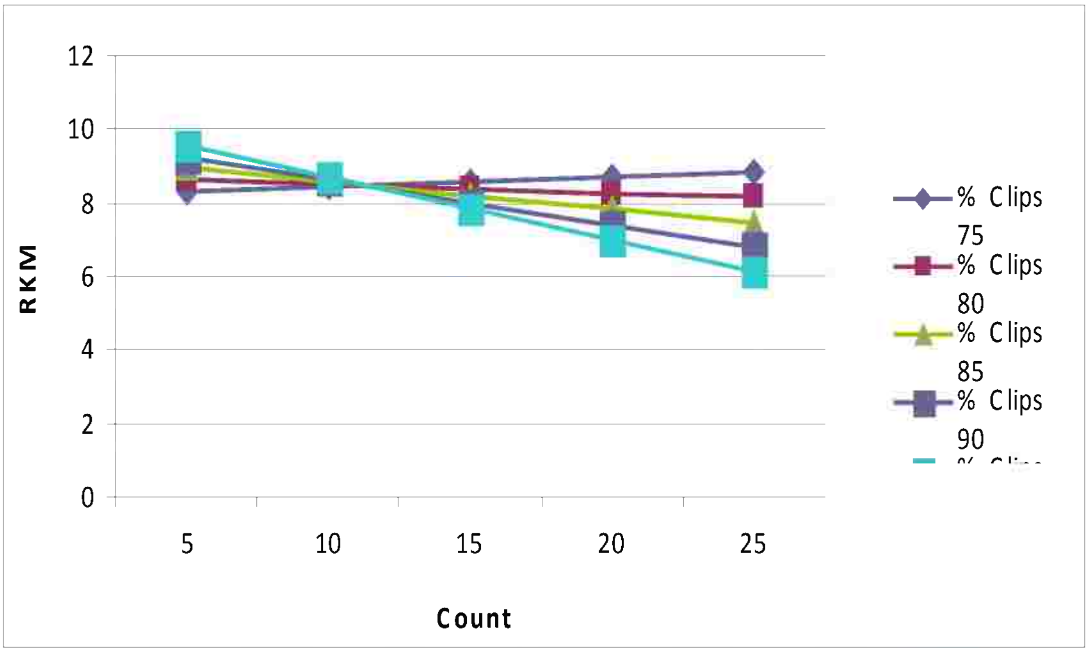


**Figure (5-16) Represents the relation between yarn RKM with both yarn count and percentage clips.**

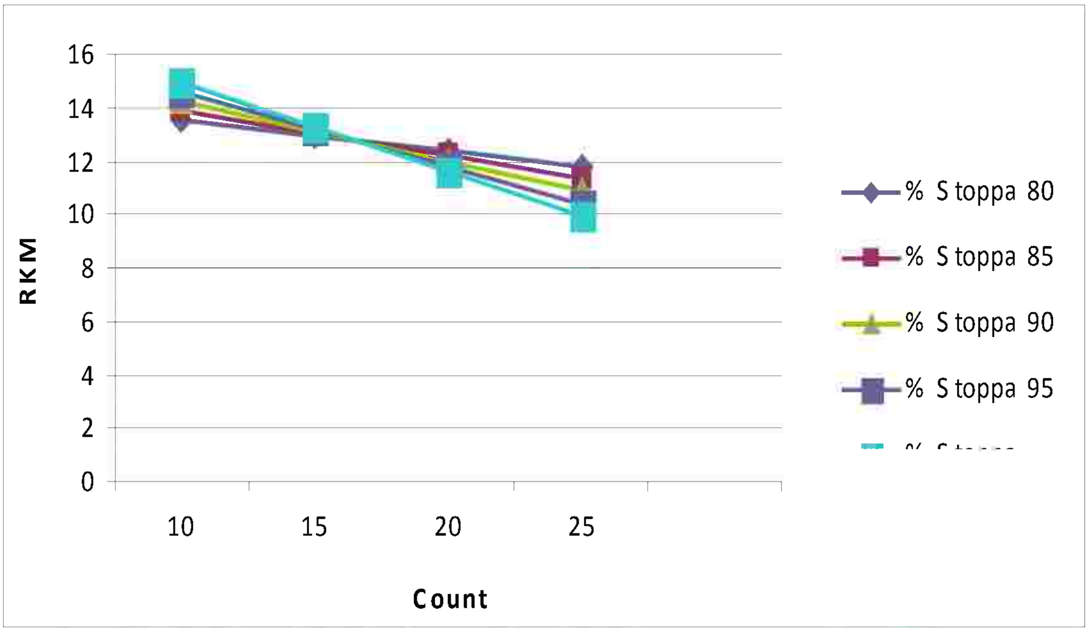


**Figure (5-17) Represents the relation between yarn RKM with both yarn count and percentage yarn waste.**

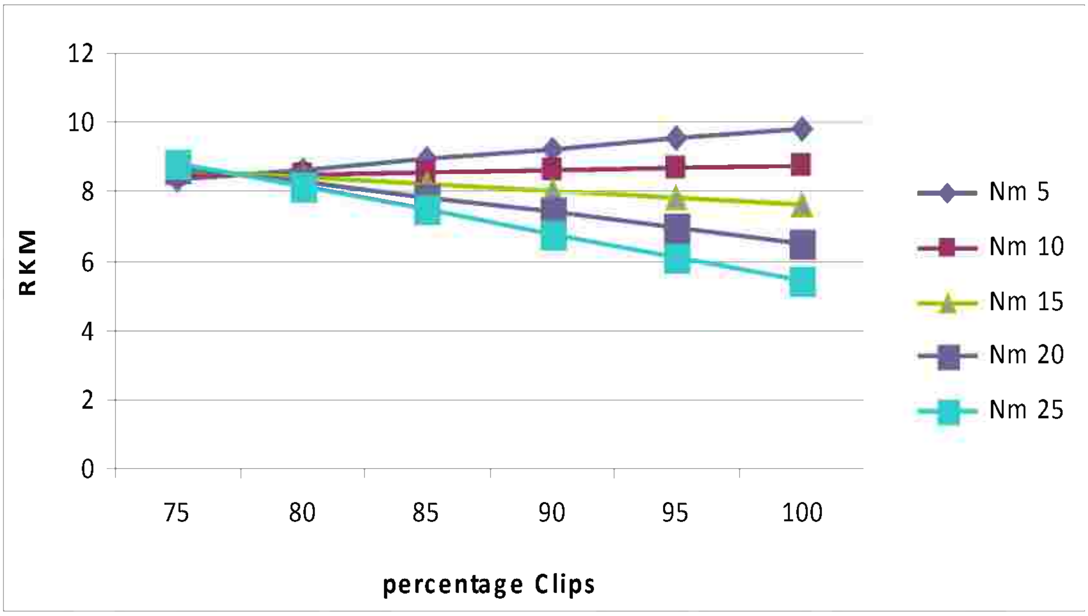


**Figure (5-18) Represents the relation between yarn RKM with both percentage clips and yarn count.**

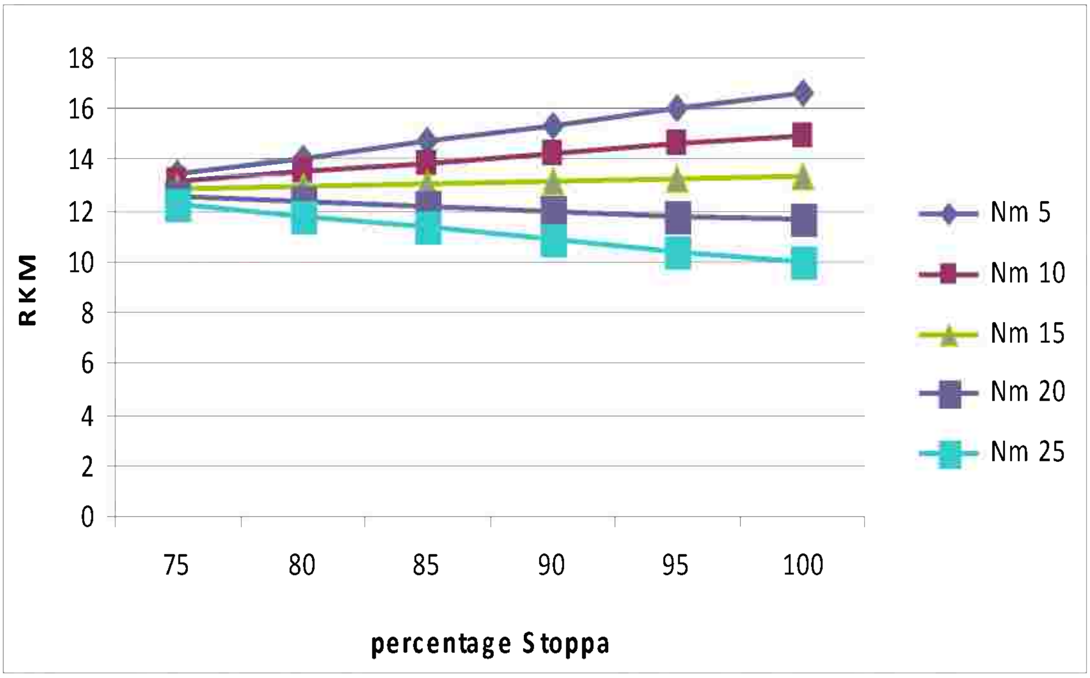


**Figure (5-19) Represents the relation between yarn RKM with both percentage yarn waste and yarn count.**

## 6-Yarn RKM CV%

C.V. RKM = -3.021 * x2 + 0.0487 * x2x3 +0.0457 * x2x4 ………….. (5-6)
P value 0.0006 0.0001 0.0002
$R^2 = 0.927$ F-significance =9E-07

The regression equation (5-6) represents the effect of the studied factor on C.V% RKM only the X2 is the factor which exists also in equation (5-6) consisting of the yarn RKM.

The two factors which affected the C.V % RKM in the nearly way are the interaction between the polyester ratio and each of clips ratio and the yarn waste ratio and this may be due to the high same fiber content on the yarn .

From Figure (5- 20), it can be deduced that the C.V % RKM increase with increase of the clips ratio from 75% to 80% where equal 17.8 % the maximum value, then decrease gradually to 95% where the C.V % RKM equal 8 % the minimum value.

From Figure (5- 21), it can be deduced that the nearly same curve but the increase of the C.V % RKM from 10.2 %to12.9 % where is the maximum value at 75% to 85% yarn waste ratio then decrease gradually to 95% where the C.V % RKM equal 6.5 % the minimum value.

From previous discussion it is clear that clips ratio leads to high C.V % RKM than yarn waste ratio.

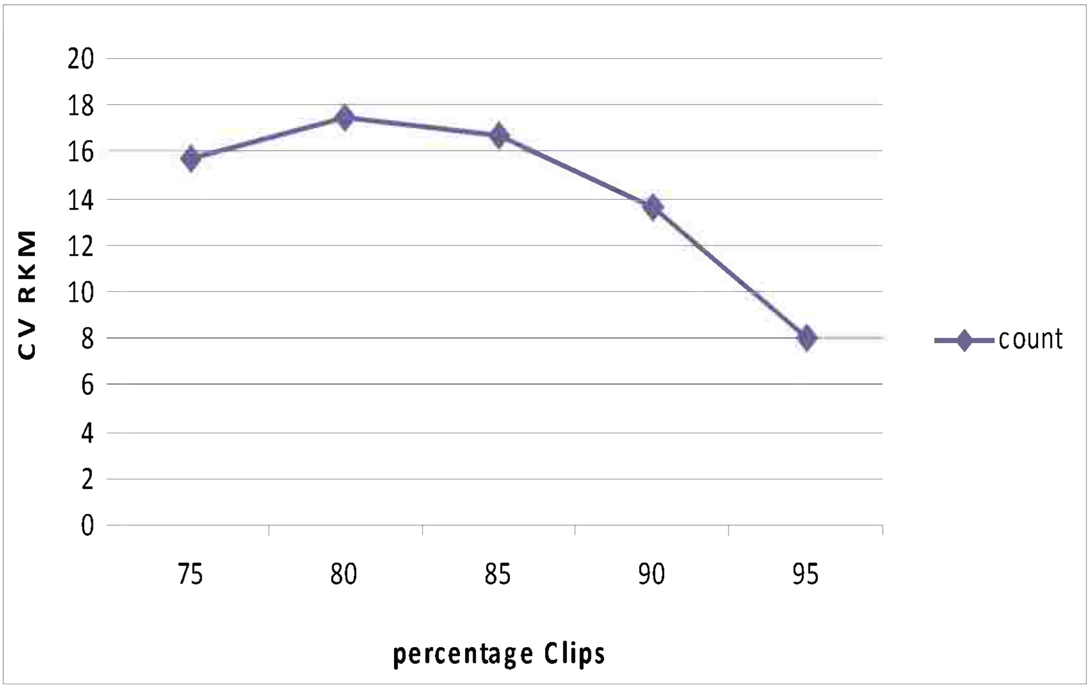


**Figure (5-20) Represents the relation between yarn RKM CV% with percentage clips.**

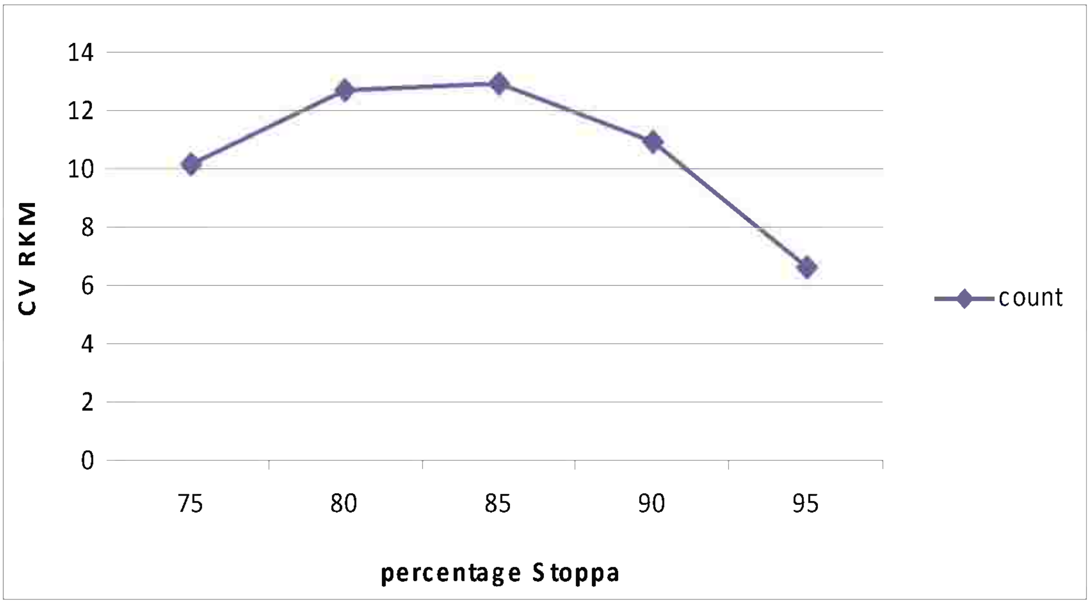


**Figure (5-21) Represents the relation between yarn RKM CV% with percentage yarn waste.**

## 7-Neps

Neps=0.9262 * x3 + 1.1338 * x1x4 ....................................... (5-7)
P value 0.0017 4E-05

From the table we can deduce that the neps have 2 equation; the first one is related with the clips percentage (X3) neps=9.9262 x3,

$R^2$ =0.8017 and significant F= 4E-05, it's clear that the equation represents the experimental results and the equation. Show that when the percentage of clips is raising the neps value is raising too.

The second equation is neps =1.1338x1x4

$R^2$=0.8017 and significant F= 4E-05, it is clear the equation. is represent the experimental results , and show that the relation between the interaction between the count and the yarn waste percentage and the neps , when the value of the interaction is raising the value of neps is raising too, but not like the percentage of the raising of the clips , and this is clear too on the charts.

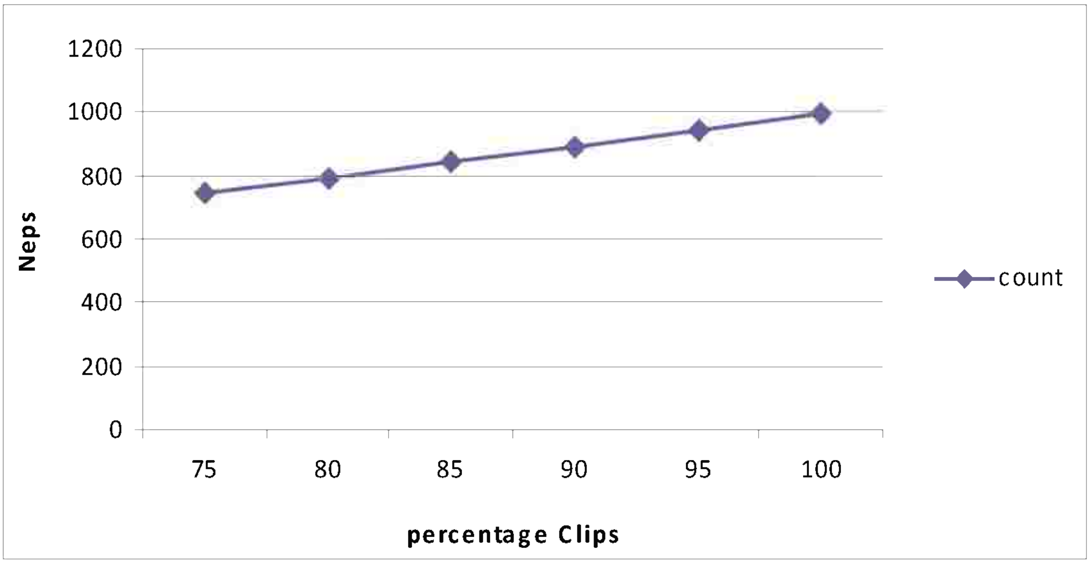


**Figure (5-22) Represents the relation between Number of neps for 1000 meter and percentage clips.**

From figure (5-22), it is shown that the numbers of neps increase with the increase of the clips percentage from 7500 to 1000, so it is clear that all the yarn counts have the same affect on the neps.

Also from figure (5-23), it is shown that the number of neps increase with the increase of the yarn waste percentage but not like the clips percentage, the range of neps between 400 to 2800 and the finer counts have a higher number of neps than the coarse counts with the increase of the yarn waste percentage .

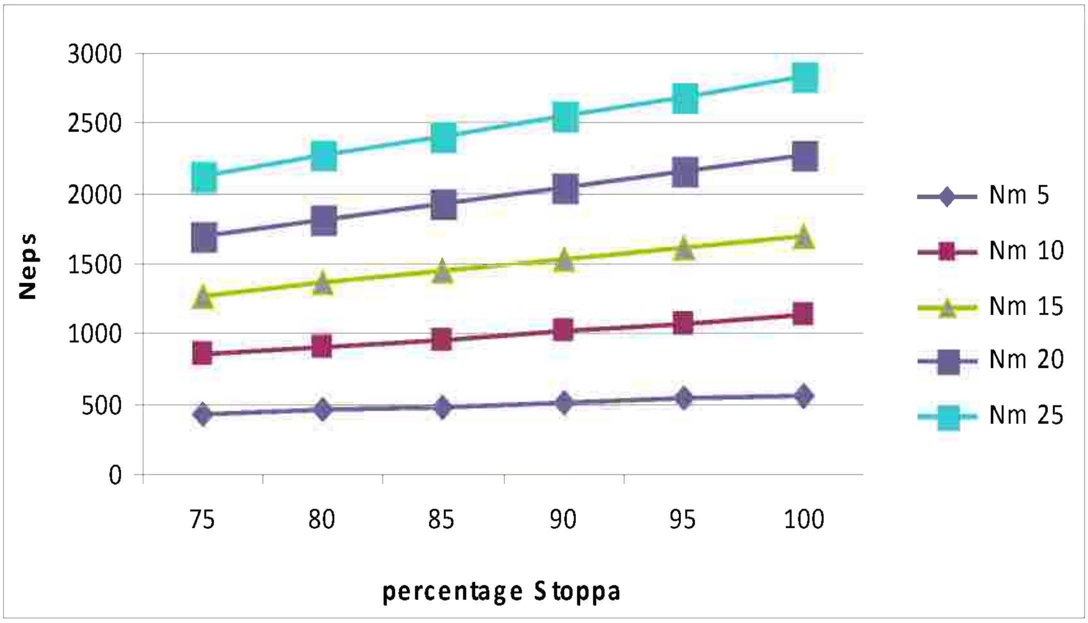


**Figure (5-23) Represents the relation between Number of neps for 1000 meter for different percentage yarn waste at different count.**

## 8- Thick places

Thick places = 10.51*x1 +3.852 * X2 ……………………...... (5-8)
P-value 3E-05 6E-06

From the above values of $R^2$= (.9478) and significance F= (1E-08) it can be clear that the equation (5-8) represents the experimental results, Also from the equation (5-8), it can detected that only the yarn count and the yarn waste percentage have the main effect on the yarn thick places and both have a positive effect on it is value, this may be due to exist of unopened fibers and very short fibers content.

## 9- Elongation

Elongation = 0.1337 * X2 +0 .0826 * X3 …………………….. (5-9)
P-value 5E-05 1E-08
$R^2$ = (0.99), F-significance = (5E-13).

Equation (5-9) consists of the significance regression describing the relation between the factors under study and the value of elongation, from this equation it can be deduced that both of polyester percentage and clips percentage only have the effect on the elongation , and have a positive affect , but the polyester percentage has the higher effect , this may be due to the nature of the man-made fibers which have a high elasticity and the clips consist, which have open structure , low twist and no plied yarns .

## 10- C.Vb

C.Vb = 0.1687 * X3 + 0.1033 * X4………………………… (5-10)
P-value 3E-06 0.0016
$R^2$ = (0.855), F- significance = (6E-06).

From the values of $R^2$ and F- significance, it is clear that the Equation (5-10) represents the experimental results, from the equation (5-10), it is clear that only the clips percentage and the yarn waste percentage have the affect on the c.vb and positive effect, and this may be due to very short fibers, unopened fibers and the high different in fiber length.

# Economical Approach

One important factor concerned when getting to apply the reclamation process is the cost factor. It was understood through reviewing some papers concerned in textile waste reclamation that the wastes in U.S.A. and Europe are buried in the landfills, and that the rising cost of the land is starting to be an annoying issue to the investors. In Egypt, the soft wastes are sold at cheap prices to be used in the open-end production or as padding material for mattresses. As for the hard wastes, their prices are so cheap because their reclamation is still limited and not so popular

To study the cost of reclaiming cotton clips and applying the resulted material to the open-end industry, these steps are followed:

- Raw material cost is compared in both cases; processing of raw cotton and that of cotton clips. Cotton factor calculation defines the amount of raw material needed to produce one kilogram of yarn. This factor is expected to be higher in the case of reclaiming clips, due to the high percent of short fibres. It is calculated in both cases.
- There is an added weight of returnable waste. Its percentage is studied to calculate the total value of material.
- The industrial cost is compared, considering that the waste processing needs extra opening process that contributes to the total processing cost with the larger portion. Moreover, it is assumed that there is about 10% increase in the industrial cost of processing reclaimed waste because of the reduction in productivity. On the other hand, the processing of reclaimed waste will reduce the cost-effective dyeing process.
- Selling prices are compared also, expecting the raw material to be prevailing in the quality and price.

Here, the study of the industrial application on reclaiming hard wastes is limited to the open-end industry, the only application that already exists in the Egyptian mills. Other applications are suggested by this research, and are still subject to question with no availability of practical trials.

## 1- Raw material

Raw material cost is known to be contributing to the total industrial cost by the greatest portion. It is studied as for applying each of the opened cotton clips and the raw cotton to the open-end industry. Its cost depends on two items:

1- Cotton factor of each of the 2 materials, which is the amount of raw material in kg. Necessary to produce one kg.of yarn. It is expected to be much higher in the case of the reclaimed cotton waste due to the high percentage of invisible waste and the high content of unopened material that has to be extracted during the opening process. Moreover the invalidity of returning some types of soft waste to the processing line, as it is common in case of raw cotton processing.

a) In case of raw material, the cotton factor is calculated through the following data;

| Process | Weight fed | Waste % | Weight out | Weight returned | Weight sold | Total value |
|---|---|---|---|---|---|---|
| **Blow room** | 100.0 | 7.0% | 93.0 | 0.0 | 7.0 | 93.0 |
| **Carding** | 93.0 | 5.0% | 88.4 | 2.8 | 1.9 | 91.2 |
| **Drawing** | 91.2 | 1.5% | 89.8 | 0.0 | 1.4 | 89.8 |
| **O.E. Spinning** | 89.8 | 3.6% | 87.1 | 1.8 | 0.9 | 88.9 |

Card waste is classified to 3 types:
Sliver waste about 1%
Flat waste about 2%
Under casing about 2%

Sliver and flat wastes are returned wastes, while under casing waste is sold. This means that about 3/5 of the card waste of the raw cotton material is reused, in addition to a high portion of the waste of the spinning.

Cotton factor of raw cotton in the open-end = 100/88.9 = 1.12

(b) In case of opened cotton clips, the cotton factor is calculated through the following Data
It is obvious that opening cotton clips results in wastes of low value since they are mainly yarns and bits of fabric, so there is no intention of reusing these wastes as returned material.

| Process | Weight fed | Waste % | Weight out | Weight returned | Weight sold | Total value |
|---|---|---|---|---|---|---|
| **Blow room** | 100.0 | 14.0% | 86.0 | 0.0 | 10.0 | 86.0 |
| **Carding** | 86.0 | 9.0% | 78.3 1 | 0.0 | 6.0 | 78.3 |
| **Drawing** | 78.3 | 2.5% | 76.3 | 6.6 | 2.0 | 76.3 |
| **O.E. Spinning** | 77 .1 | 3.0% | 74.8 | ..0.0 | 2.0 | 74.8 |

Cotton factor of opened clips = 100/74.8 =1.34

## 2. The price of each of the two materials,

Prices of the raw material are:

We may consider that G.80 is the most suitable type for the open-end processing, price/ton being = 16 L.E. /ton.

Price of the cotton clips (garment wastes) are:

* White clips: 6000 L.E. /ton.

* Coloured clips: 3500 L.E/ton.

So, to produce 1 K.G. of open-end yarn out of raw cotton, the raw material will cost = 1.12*16 = 17.9 L.E. /k.g.

And to produce 1 K.G. of open-end yarn out of reclaimed cotton, the raw material will cost = 1.34*6 = 8 L.E. /k.g.

## 3. Industrial cost

Industrial cost of processing both raw cotton and reclaimed cotton clips is compared. Either material is passed over along the fame processing route, except for some differences concerning the different structure of both. These differences are:

Clips need extra opening process. The integrated tearing, opening and blending line should be studied as an independent issue when planning a mill lay out for both materials. The cost of this line is subject to market effects, and is determined according to its model, age and processing behavior.

In case of processing reclaimed material, some reduction in productivity is observed. Production studies prove this reduction to cost a 10% increase in the industrial cost.

The coloured reclaimed material reduces the dyeing process, and results in a fancy-like yarn structure.

The added costs are dependant- on the choice of processing lines, but anyhow, some industrial studies concerned in textile waste reclamation declare that the industrial cost of reclamation processes -s nearly equivalent to the raw material cost. Moreover, the points above may be summarized in that the reclamation of cotton clips will cost an extra opening line plus a 10% increase in industrial cost, but will reduce the entire dyeing process when compared to processing: of raw cotton.

## 4. Selling price

The selling price of the open-end yarn depends on its quality. The processing of raw cotton or cotton soft wastes will result in a higher quality product if compared to reclaimed hard wastes.

The open-end yarn Ne 6/1 made up from reclaimed cotton clips containing a portion of man-made fibres like polyester or acrylic is sold at a price of 14000 L.E. /ton.