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Studying the Influence of some Parameters of Opening and Cleaning Machines on Cleaning Efficiency

دراسة تأثير بعض متغيرات ماكينات التفتيح والتنظيف على كفاءة التنظيف

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ملخص البحث

الهدف من هذا البحث هو دراسة تأثير بعض متغيرات ماكينات التفتيح والتنظيف على كفاءة التنظيف. حيث تم دراسة تأثير ضبطات المسافة بين جراند الباظات في ماكينات" تفتيح البالات، المضرب المتدرج، مضرب بوركبين و ماكينة RV " على كفاءة التنظيف، نسبة العوادم ونسبة الشعيرات في العوادم. وعن طريق تصميم التجارب تم اختيار ثلاث متغيرات عند مستويات مختلفة (٢x٣x٥) لدراسة مدى معنوية تأثيرها على كفاءة التنظيف لماكينة تفتيح البالات، حيث تم اختيار نوعين من القطن بنسب شوائب مختلفة، ٣ مستويات لضبطيات المسافة بين جراند الباظات و ٥ مستويات ضبطات المسافة بين الحصيرة المسننة والدرفيل المنظم. وأيضا لمضرب بوركبين تم اختيار ٣ مستويات لضبطيات المسافة بين جراند الباظات و ٤ مستويات لسرعة التغذية (٣x٤) لدراسة مدى معنوية تأثير هذه المتغيرات على كفاءة التنظيف. وقد أوضحت النتائج أن نسبة الشوائب في القطن وضبطات جراند الباظات بالإضافة إلى باقي المتغيرات الأخرى لها تأثير معنوى على كفاءة التنظيف. كما وجد انه بزيادة المسافة بين الباظات لماكينات خط التفتيح والتنظيف من المستوى الأول للثالث زادت كفاءة التنظيف من ٤٣% إلى ٥٦% بينما زادت نسبة الشعيرات في العوادم بمقدار ٣١٠%.

Abstract

The aim of this work is studying the influence of some parameters of blowroom opening and cleaning machines on cleaning efficiency. Effect of grid gap width on waste and good fibre elimination as well as cleaning efficiency is studied for opening and cleaning machines and for blowroom line. Factorial analysis were carried out to determine if the variation in cleaning efficiency is significant or by accident. For bale opener the variables were cotton type (trash content), grid gap width and spiked lattice and evener roller setting with interaction 2 x 3 x 5. Also for cleaner RN factorial analysis were carried out for grid gap width and feed roller speed with interaction 4 x 3. Results showed that trash content and grid gap width as well as the other variables have a significantly effect on cleaning efficiency. Every elimination of foreign matter is accompanied by a simultaneous elimination of good fibres. For opening and cleaning machines, as grid gap width increased trash and good fibres eliminated increased, but the rate of good fibres elimination is higher than the rate of trash elimination. For blowroom line increasing grid gap width of opening and cleaning machines from narrow to open level raised the cleaning efficiency from 43% to 56% and good fibres eliminated increased by 310%.

1. Introduction

For opening and cleaning machines as the production increases, trash removal efficiency decreases, and complaints of dirty cotton are made by the card room. The mill's answer to this was to put additional cleaning machines in the line to remove more trash, which was a generally accepted procedure. The result of this in cases where mills employed too many machines was over beating, which caused degradation of the cotton staple, increase in neps, and curling of the cotton all throwing additional work on the cards, as well as increasing waste%. The waste produced in a cotton textile mill is an important factor in determining the cost of operation, and therefore in influencing the profits of the mill. Since cotton goes to market principally in the form of products manufactured by the mills, better control of waste production and increased value of the waste produced are also important to those segments of the cotton industry which supply the raw fiber.

Krifa et al [1] stated that cleaning operations conducted during opening/ cleaning are relatively ineffective against SCF. Since fibers are attached to the SCF, they behave in a manner similar to cotton

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tufts during beating and in pneumatic flows. Furthermore, intensification of this processing, with the intention of eliminating as many SCF as possible and improving the cotton grade, decreases the length of the cotton fibers and increases the proportion of short fibers. This results in decreased yarn evenness and resistance and in increased breaks during spinning [2]. This difficulty of eliminating SCF during cleaning and fiber preparation operations is explained earlier [3,4,5,6]. Since postginning cleaning operations conducted with a lint cleaner cause additional fragmentation of the SCF and thus increase their numbers in the fibers. Their total mass and average size are nonetheless fairly small.

According to Frey and Schneider [7], increasing the total trash discarded during opening/cleaning does not result in significant elimination of SCF, but does increase the proportion of good fibers discarded with the trash. In addition, multiplying the cleaning points, with the intention of extracting more SCF, excessively weakens the fibers and decreases the quality of the resulting yarn.

Klein [8] stated that the blowroom contributes by about 5–10% to production costs in ring spinning mill, the insulation itself is not a relevant cost factor ; however the loss of raw material that arises here is a factor. The fibre loss needs closer attention, since it is an important factor in determining the cost of operating, and therefore in influencing the profits of the mill

2.Experimental work

Two Egyptian cottons with two different levels of non-lint content (5.6% and 11.2%) were processed through blowroom line with the following machine sequences: Bale opener (GBR) – Step cleaner (SRS6) –cleaner RN - Multimixer –cleaner RV.

Experimental variables of opening and cleaning machines are shown in Tables (1) to (4) Grid bar gaps width "1" is closed and "4" is open.

2.1.Measurements and Evaluation

All the cotton samples before and after opening and cleaning machines were tested for lint and non lint content using Shirley analyzer (four replications). Machine cleaning efficiency (CE_i) was calculated according to the formula:

$$CE_i = \frac{T(cnt)_{input} - T(cnt)_{output}}{T(cnt)_{input}} \times 100\% \quad ....(1)$$

where

CE_i = cleaning efficiency of ith machine

$T(cnt)_{input}$ = non lint content (%) of feed material to ith machine

$T(cnt)_{output}$ = non lint content (%) of the delivered material from ith machine

For the different levels of grid gap width and for different machines, to calculate waste%, fibre loss%, and cleaning efficiency, the eliminated waste during processing a specific quantity of cotton was analyzed to trash and fibres. Weight and percent of both was calculated. Waste%, fibre loss% and cleaning efficiency for opening and cleaning machines are calculated according to formulas (2), (3) and (4).

<u>***Waste % eliminated by ith machine (W_i)***</u>

$$W_i = \frac{W_t}{M_{input}} \times 100\ \% \quad ..... (2)$$

where

M_{input} = input material to ith machine in kg

Wt = total eliminated waste (kg) by ith machine during processing M_{input} material.

Table (1) Bale opener (GBR) variables

Cotton type (trash content%)	2 levels							Spiked lattice speed (m/min) for cotton 2
	Cotton 1 (non lint content (5.6%)				Cotton 2 (non lint content(11.2%)			
Grid gap width (mm)	4 Levels				3 Levels			
	1(close)	2(narrow)	3(medium)	4 (open)	2(narrow)	3(medium)	4 (open)	
Spiked lattice evener roller setting (mm)	5 levels	5 levels	5 levels	5 levels	5 levels	5 levels	5 levels	36
	5	5	5	5	5	5	5	65
	10	10	10	10	10	10	10	90
	15	15	15	15	15	15	15	-
	20	20	20	20	20	20	20	-
	25	25	25	25	25	25	25	-

Table (2) Step cleaner (SRS6) variables

Grid gap width (mm)			
Grid setting	Beater 1, 2	Beater 3 , 4	Beater 5, 6
1st	4	3	2
2nd	3	3	3
3rd	4	4	4
4th	4	4 , 3	3

Table (3) Cleaner RN variables

Feed roller speed r/min	4 levels			
	30	40	50	66
Grid gap width (mm)	3 levels	3 levels	3 levels	3 levels
	2	5	5	5
	3	10	10	10
	4	15	15	15

Table (4) Cleaner RV variables

Grid gap width	
position	Setting (mm)
1st	2
2nd	3
3rd	4

Table (5) Summary of analysis of variance for cleaning efficiency (bale opener)

Source of variation	SS	df	MS	F
a (cotton type)	2177.1	1	2177.100	73.82795*
b (grid gap width)	224.837	2	112.4185	3.81224**
c (spiked lattice and evener roller setting)	9680.867	4	2420.217	82.07231*
a x b	3995.557	2	1997.779	67.74695*
a x c	2766.881	4	691.7202	23.45702*
b x c	1995.965	8	249.4957	8.460683*
abc	6863.933	8	857.9917	29.09548*
within	1769.330	60	29.48883	

* significant at 99% ** significant at 95%

Table (6) Summary of analysis of variance of cleaning efficiency (cleaner RN)

Source of variation	SS	df	MS	F
a (feed roller speed)	4548.04	3	1516.01	25.44981*
b (grid gap width)	20024.07	2	10012	168.0755*
a x b	5674.19	6	945.7	18.87576*
Within	1429.65	24	59.57	

* significant at 99%

Fibre loss by ith machine (A%)

$$A_i = \frac{(f_{loss})_i}{(F_{input})_i} \times 100\% \quad \ldots\ldots..(3)$$

where

$(F_{input})_i$ =Lint content (kg) of the processed material M_{input} by the ith machine.

$(f_{loss})_i$ = good fibres obtained from waste material (fibre loss) eliminated by the ith machine (kg) during processing M_{input} material.

Cleaning efficiency of ith machine(CE_i)

$$CE_i = \frac{(T_{elimi})_i}{(T_{input})_i} \times 100 \quad \% \ldots\ldots\ldots (4)$$

where

$(T_{input})_i$ = trash content (kg) of the processed material M_{input} by the ith machine .

$(T_{elimi})_i$ = eliminated trash obtained from waste material by the ith machine (kg) during processing M_{input} material.

Blowroom cleaning efficiency and good fibre loss are calculated according to formula (5) and (6) :

Blowroom cleaning efficiency

Total cleaning efficiency (CEt%) of the blowroom with "n" opening and cleaning machines is calculated as the following :

$$CE_t = \sum_{i=1}^{n} CE_i \prod_{j=1}^{j=i} \left(1 - \frac{CE_{j-1}}{100}\right)\% \ldots\ldots(5)$$

i.e. for the blowroom containing four opening and cleaning machines (n=4) total cleaning efficiency is:

$$CE_t = CE_1 + CE_2\left(1 - \frac{CE_1}{100}\right) + CE_3 \times \left(1 - \frac{CE_1}{100}\right)\left(1 - \frac{CE_2}{100}\right) + CE_4\left(1 - \frac{CE_1}{100}\right) \times \left(1 - \frac{CE_2}{100}\right)\left(1 - \frac{CE_3}{100}\right)\%$$

Total fibre loss by blowroom (A_t %)

Total fibre loss% of the blowroom with "n" opening and cleaning machines is calculated as the following :

$$A_t = \sum_{i=1}^{n} A_i \prod_{j=1}^{j=i} \left(1 - \frac{A_{j-1}}{100}\right)\% \ldots\ldots..(6)$$

i.e. for n = 4

$$A_t = A_1 + A_2\left(1 - \frac{A_1}{100}\right) + A_3\left(1 - \frac{A_1}{100}\right)\left(1 - \frac{A_2}{100}\right) + A_4\left(1 - \frac{A_1}{100}\right)\left(1 - \frac{A_2}{100}\right)\left(1 - \frac{A_3}{100}\right)\%$$

Factorial analysis were carried out for bale opener with an interaction between cotton trash content (2 levels), grid gap width (3 levels) and setting between spiked lattice and evener roller (5 levels) i.e. an interaction between these 3 variables, of (2 x 3 x 5) is carried out to determine if the variation in cleaning efficiency is significant or by accident.

The same was carried out for cleaner RN with the interaction (4x3) between feed roller speed (4 levels) and grid gap width (3 levels).

3.Results and discussion

3.1.Effect of grid gap width

Table (5) shows summary of analysis of variance of cleaning efficiency. It has been found that grid gap width has a significant effect on machine cleaning efficiency (at 95% confidence level)

Fig. (1) to (4) demonstrate the influence of grid gap width on waste%, good fibre elimination and cleaning efficiency of blowroom opening and cleaning machines. Where gap width "1" : the gap is closed, "2" : the gap is narrow, "3" : the gap is medium and " 4 " : the gap is open.

Table (7) Effect of grid gap width on fibre loss% and trash% (Bale opener)

Grid gap width (mm)	Fibre loss%	Trash%
1	0.004	0.196
2	0.02	0.613
3	0.1133	1.22
4	0.3133	1.287

For bale opener (GBR) as shown in Fig. (1) and Table (7), it is clear that as the gap width increases eliminated waste%, cleaning efficiency, and good fibre loss increase. Increasing the gap width from 2mm to 3mm raised CE% from 8.66 to

16.66%. Waste eliminated increased by 111%. Where foreign matter eliminated increased by 99% and good fibres eliminated increased by 467%. Increasing the gap width from 3mm to 4mm raised CE% from 16.66 to 18%, waste eliminated increased by 20%. Where foreign matter eliminated increased by 5.5% and good fibre loss increased by 176%.

Table (8) Effect of grid gap setting on fibre loss% and trash% (Step cleaner)		
grid gap setting	Fibre loss%	Trash%
1st	0.121	1.249
2nd	0.23	1.256
3rd	0.27	1 35
4th	0.12	1.457

Effect of grid gap width of step cleaner on waste%, trash and good fibre elimination and cleaning efficiency is shown in Fig (2) and Table (8). It can be noticed that changing gap width from 1st setting (beater 1,2 the gap is 4mm, beater 3,4 the gap is 3mm and beater 5 and 6 the gap is 2mm) to 3rd setting (4mm for the 6 beaters), CE% is raised from 28% to 31%, total waste increased by about 18% and foreign matter eliminated increased by 8% while and fibre eliminated increased by 123%.

Table (9) Effect of grid gap setting on fibre loss% and trash% (Cleaner RN)		
Grid gap width (mm)	Fibre loss%	Trash%
2	0.0057	0.237
3	0.02	0.46
4	0.035	0.537

Fig (3) and Table (9) show the influence of grid gap width on total waste%, good fibre loss, trash% and cleaning efficiency of cleaner RN. By increasing the gap width from 2 to 3mm CE% is raised from 6% to 11%. Eliminated waste% increased by 98% and trash eliminated increased by 94% while good fibres eliminated increased by about 251%. By increasing the gap from 3mm to 4mm CE% is raised from 11% to 13% and total waste increased by 19%. As eliminated trash increased by 17% fibres eliminated increased by about 75%.

Table (10) Effect of grid gap setting on fibre loss% and trash% (Cleaner RV)		
Grid gap width (mm)	Fibre loss%	Trash%
2	0.04	0.236
3	0.092	0.321
4	0.164	0 346

The same was found for the cleaner RV as shown in Fig (4) and Table (10). Where increasing the gap width from 2mm to 3mm raised CE% from 8% to 10%, total waste increased by 50%. Foreign matter and good fibres eliminated increased by 36% and 130% respectively. While increasing the gap from 3 to 4mm raised CE% from 10 to 12%. Waste increased by 23% and eliminated trash increased by 8% and good fibres eliminated increased by 78%.

Fig (5) shows the effect of grid gap width on total waste% represented by its two categories: trash% and good fibre loss%, for bale opener and cleaner RV. It can be noticed that by increasing grid gap width the total eliminated waste, eliminated trash and good fibres loss increase Elimination of foreign matter is accompanied by a simultaneous elimination of good fibres, but with a higher rate.

Fig (6) shows the effect of grid gap width on total fibre loss and cleaning efficiency of blowroom. Theoretically assuming that the opening and cleaning machines with the same grid gap setting i.e. all in narrow or in medium or open setting. It can be noticed that as grid gap width of blowroom machines increases blowroom cleaning efficiency and good fibre loss increase. The rate of increment good fibre loss is higher that this of cleaning efficiency. Where as grid gap increases from narrow to medium, cleaning efficiency increases from 43% to 53% and good fibre loss increases by about 142% Increasing grid gap from narrow to open cleaning efficiency increases from 43% to 56%, while good fibre elimination increases by about 310%.

3.2. Effect of feed speed and trash content

Fig (7-1) shows the effect of spiked lattice speed on bale opener cleaning efficiency. It is clear that as spiked lattice speed increases cleaning efficiency decreases. This is due to increasing lattice speed while evener roll speed is kept constant. This permits large flocks to pass without opening. The lower the degree of opening the lower the degree of cleaning. So spiked lattice speed will be useful in increasing degree of opening and accordingly degree of cleaning as well as higher productivity if evener roller speed is increased with the same proportional.

For cleaner RN, as shown in Table (6) feed roller speed has a significant(at 99% confidence level) effect on the cleaner RN cleaning efficiency. As shown in Fig (7-2) as the feed roller speed increases cleaning efficiency decreases. Since the mass of separated tuft by the beater is proportional to feed roller speed. So as feed roller speed increases mass of separated tuft increases, degree of opening decreases and consequently degree of cleaning decreases.

As shown in Table (5) cotton trash content has a significant effect on cleaning efficiency. Fig (8) shows cleaning efficiency (for bale opener) for two cotton with different trash content at different setting between spiked lattice and evener roller. Cleaning efficiency of the trashy cotton is higher than this of the less trash content cotton at different values of spiked lattice evener roller setting .

Fig (8) shows the effect interaction of trash content and setting between spiked lattice and evener roller on cleaning efficiency. For the trashy cotton drop in CE% due to increasing spiked lattice evener roller setting is clear and higher than this for the low trash content cotton. Where changing spiked lattice evener roller setting from lower to higher level GBR cleaning efficiency dropped from 16.5 to 13.5% for the lower trash content cotton and from 31.6% to 17.7% for the higher trash content cotton. The difference in CE% of the two cottons is higher for the lower setting value and decreases as the setting gets wider.

3.3. Effect of feed speed and grid gap width

Fig (9). shows the effect interaction of grid gap width and setting between spiked lattice and evener roller on cleaning efficiency of bale opener. As shown CE% increases as gap width increases. Cleaning efficiency decreases as spiked lattice evener roller setting increases. The difference in cleaning efficiency at different values of gap width is lower for the lower level of setting between spiked lattice and evener roller.

4. Conclusions

From the experimental work and discussion the following conclusions can be drawn:

i. cotton trash content has a significant effect on cleaning efficiency. As cotton trash content increases cleaning efficiency increases.

ii. Regarding to opening and cleaning machines:

- o Grid gap width has a significant effect on machine cleaning efficiency. As the gap width increases cleaning efficiency, quantity of waste eliminated, quantity of foreign matter and good fibres loss increase.
- o Every elimination of foreign matter is accompanied by a simultaneous elimination of good fibres. The rate of elimination of good fibres is higher than rate elimination of waste and foreign matter. Where for opening and cleaning machines as gap width increases from 2mm to 3mm:
    - For GBR the quantity of waste eliminated is raised from 0.63 to 1.33% , while the quantity of foreign matter eliminated increased

by 99% and the quantity of fibres eliminated increased by 467%.

- For cleaner RN the quantity of waste eliminated is raised from 0.243 to 0.48%, quantity of trash eliminated increased by 94 % and fibre loss increased by 251%.
- For cleaner RV the quantity of waste eliminated is raised from 0.276 to 0.413% while the quantity of trash eliminated increased by 36% and quantity of fibres eliminated increased by 130%

- For blowroom line increasing the grid gap width of opening and cleaning machines from narrow to medium level blowroom cleaning efficiency is raised from 43% to 53% and the quantity of fibres eliminated raised from 0.19 to 0.46% i.e. increased by about 142%. While increasing the gap width from narrow to open level raised the cleaning efficiency from 43% to 56% and good fibres eliminated is raised to 0.78% i.e. increased by 310%.
- For bale opener setting between spiked lattice evener roller has a significant effect on machine cleaning efficiency. As this setting increases cleaning efficiency decreases.
- As the feed speed increases (lattice speed of bale opener or feed roller speed of the beater) machine cleaning efficiency decreases
- Improvement in cleaning efficiency due to increasing grid gap width is minimum at the higher level of spiked lattice and evener roller setting.
- For bale opener drop in cleaning efficiency due to increasing setting between spiked lattice and evener roller is higher for trashy cotton.

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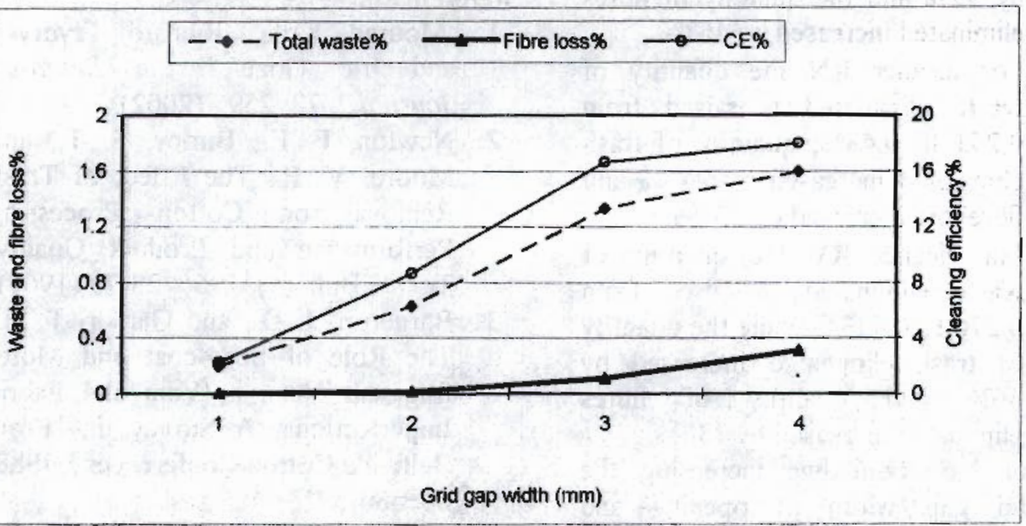

Fig. (1) Effect of grid gap width on fibre loss, waste% and cleaning efficincy by bale opener (GBR)

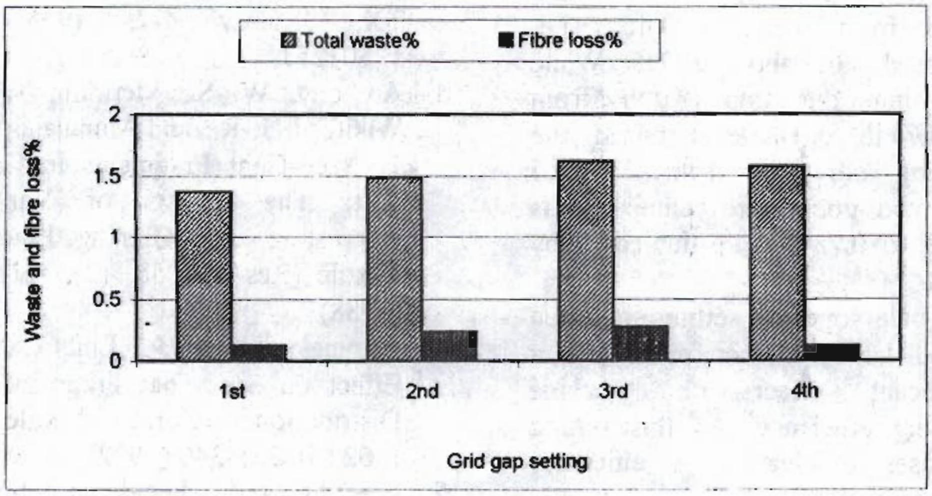

Fig. (2-1)

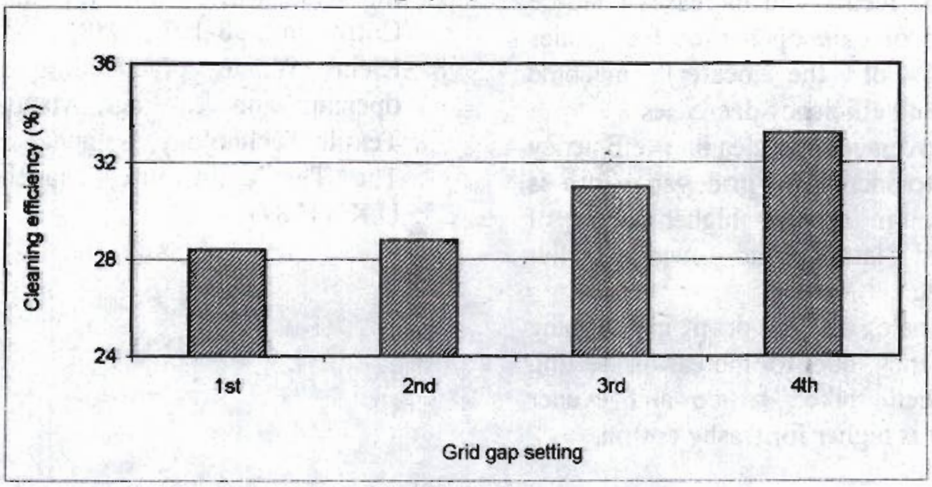

Fig. (2-2)

Fig. (2) Effect oEffect of grid gap width on fibre loss, waste% and cleaning efficincy by step cleaner

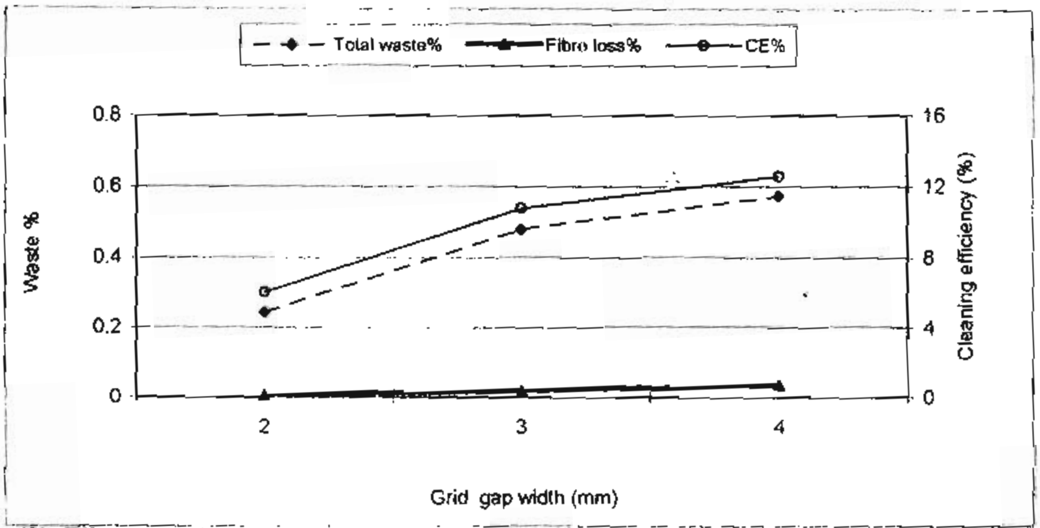

Fig. (3) Effect of grid gap width on fibre loss, waste% and cleaning efficincy by cleaner RN

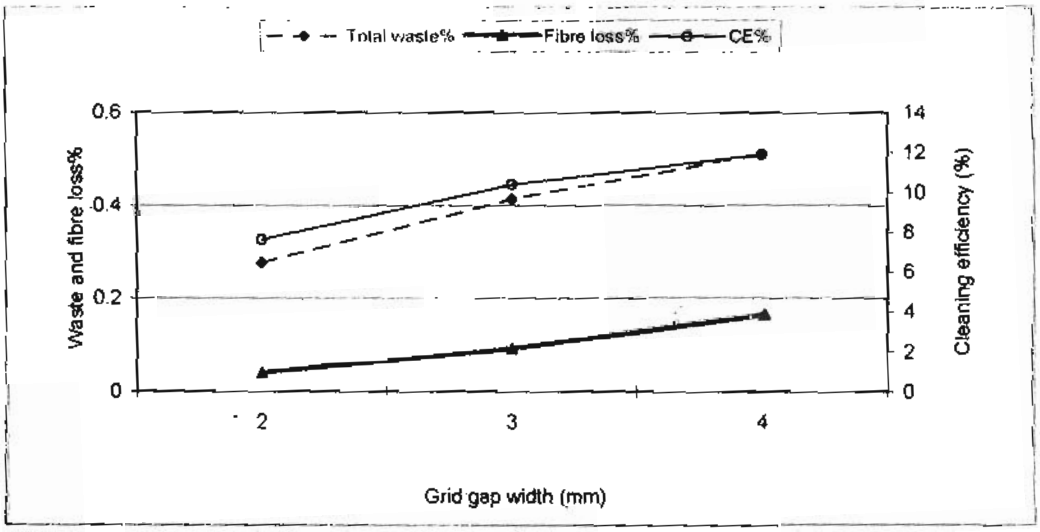

Fig. (4) Effect of grid gap width on fibre loss, waste% and cleaning efficincy by cleaner RV

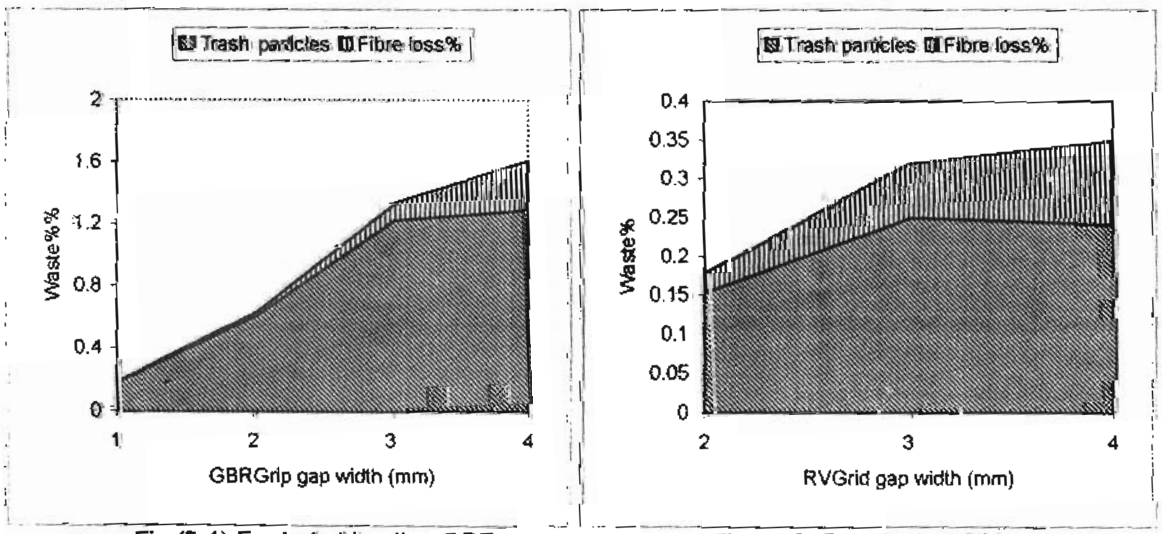

Fig.(5-1) For bale blending GBR

Fig. (5-2) For cleaner RV

Fig.(5) Dependence of trash particles and good fibres loss on grid gap width

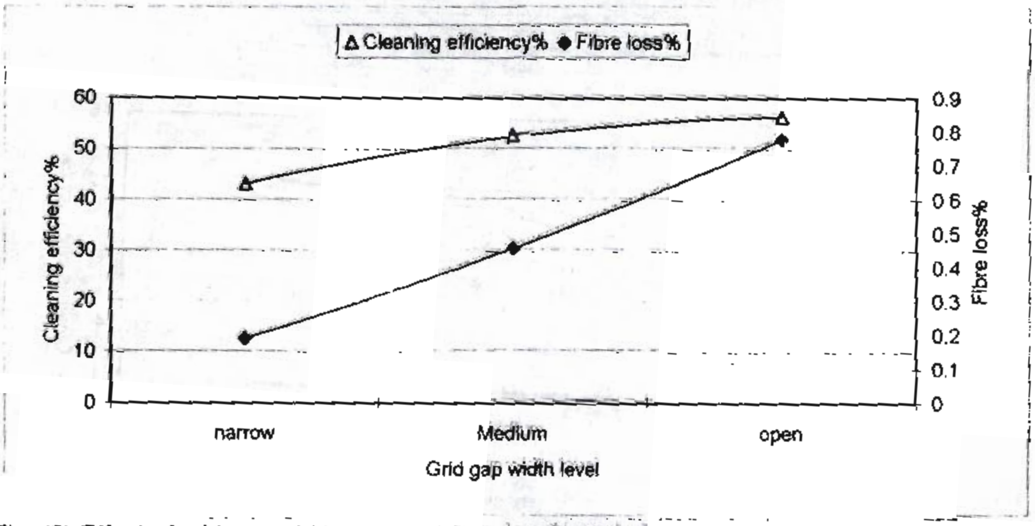

Fig (6) Effect of grid gap width on total fibre loss% and cleaning efficiency of blowroom

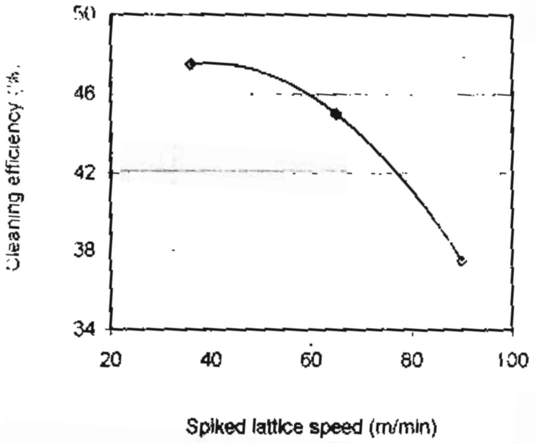

Fig. (7-1) For bale opener

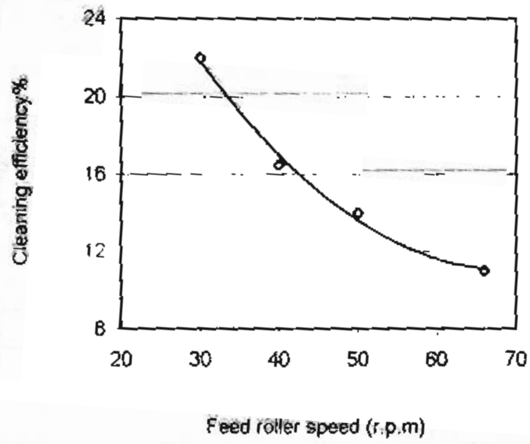

Fig. (7-2) For RN cleaner

Fig. (7) Dependence of cleaning efficiency on feeding speed

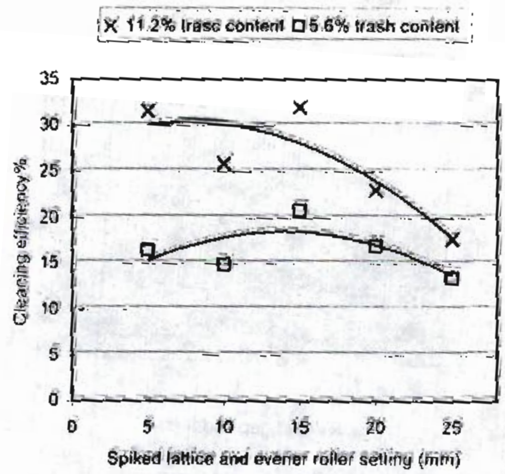

Fig. (8) Interaction between trash content and setting between spiked lattice and evener roller (GBR)

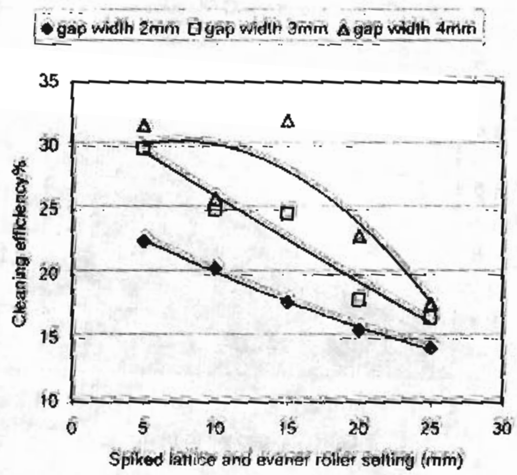

Fig. (9) Interaction between grid gap width and setting between spiked lattice and evener roller (GBR)