A STUDY ON CAUSES OF KNITTING MACHINE STOPPAGES AND THEIR IMPACT ON FABRIC PRODUCTION

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Abstract

Knitting machine stoppages cause loss of fabric production. The smooth running of knitting machine depends on yarn quality, knitting machine conditions and knitting production conditions. Knitting machine stops due to different causes. In this work it was found that the causes of stoppages are yarn breakages, set-off, machine cleaning and fabric roll cutting, yarn joining, needle breakages and oil problem. The major cause of knitting machine stoppage was machine cleaning and fabric roll cutting. It occupies almost 40.38% of total stoppage time. This cause lead to the production loss of 43.48 kg of fabric. Similarly, yarn breakages, set-offs, and other causes like yarn joining and needle breakages occupied 20.19%; 7.69% and 31.7% of total stoppage time respectively. The knitting machine was stopped for total 312 minutes among 24 hours or 1440 minutes of running due to all of the causes. The causes, combindly led to production loss of 107.66 kg of fabric in 24 hours. Due to the all of the causes total 21.66% of fabric production loss was realized.

Keywords: Single jersey, knitting machine, causes of stoppages, yarn breakages, set-off, machine cleaning; roll cutting, needle breakage, yarn joining

Introduction

In this paper the causes of knitting machine stoppages were investigated and their magnitude and impact on production analyzed. In knit fabric production process, due to different minor stoppages the amount of fabric production decreases. The more the stoppages the lesser the fabric production. There are many causes of knitting machine stoppages. These

causes not only stop the production but also the output fabric quality is also hampered. This cannot be considered as mere production loss. This also leads to waste of time, labor and raw material. Again the knitting industries produce fabrics mainly for Ready Made Garments sector which has to work with a very short time schedule and where wastage is not acceptable like all other production processes. Though the knitting machine stoppages are mainly due to minor causes of short durations but it impacts a lot of loss collectively. In this paper the common causes of stoppages are identified and their magnitudes are graphically represented and their impact on production is calculated. This study was indented to find out the causes and their impact on production on single jersey fabric production.

Literature review:

Factors for knitting machine stoppages: There are basically three factors which are responsible for optimum fabric production. They are:

a. Yarn Characteristics.
b. Machine Quality Requirements.
c. Knitting production conditions.

a) Yarn characteristics: This includes tenacity and breaking extension, elasticity and friction of yarn. Tenacity is expressed as specific stress at rupture. It is usually expressed in cN/tex (for staple fiber yarn) and in cN/dtex (for filament yarns).

The strength of the yarn must be sufficient to resist the tensile stress those occurs while knitting. Especially during withdrawal from the yarn packages and in the region of needle, sinkers and cam during stitch formation.

In a yarn made from staple fiber, the strength is to a very large extent directly proportional to the amount of twist which is inserted during spinning.

Breaking extension is the extension that the yarn exhibits at the highest strength during a standardized tensile test. It is expressed as percentage. Extension of yarn is necessary, so that it can resist bending strain or neutralize them by getting extended. The extension of yarn (made from staple fiber) is inversely proportional to their twist.

Friction occurs if a body or a surface is in the path of yarn and the yarn rubs against it during its movement. This leads to increase in tension. During knitting it is expected that friction is at the lowest possible level. One of the measures lies in the construction and the shape of the yarn package. Other measures are the surface characteristics of the yarn and the abradant. In order to improve the slide performance yarns made from staple fiber, they are waxed. While producing the cross-wound cone on a winder, paraffin wax in dry state is applied to the yarn surface to reduce friction. [2]

b) Machine Quality Requirements: Long lasting and trouble free quality functioning of the knitting machine could be possible by proper maintenance care and lubrication. Proper horizontal installation of the machine, tension free yarn feeding, flawless yarn guides and needles, exact centering of needle bed towards one another, proper fabric take-off and proper lubrication are the basic quality needs of a knitting machine.

Following maintenance schedule may be carried out:

Checking the lubrication unit for sufficient oil and compressed air for specified pressure are the daily checks before switching on the machine.

Cleaning all the yarn passages and yarn guides elements are the weekly checks to be carried out.

As a monthly maintenance routine, flush needles and cams. If needle beds and cams are heavily fouled, remove the cams and air-blast the cam and needle beds. Half a liter of needle oil heated to 70^0 C is poured into the oiling points of the cams and onto the needle heads. Remove cams once more and wipe oil and dirt.

Once in every three months, remove all the cam segments, needles and sinkers, thoroughly clean them with compressed air or paraffin. Liberally oil all components and replace.

Once in every three years replace the counter memory battery. Machine bed should be cleaned with petroleum. Hand wheel, take up and cylinder gear should receive few drops of light machine oil every day. [3]

c) Knitting production conditions:

i. Suitable yarn count: Selection of suitable yarn count should be based on machine gauge, machine types and knitting structures. The relation between yarn count and machine gauge is as follows:

Yarn Tex = $\left(\frac{100}{G}\right)^2$ where G is the machine gauge.

ii. Machine setting: Optimum setting is based on yarn type and knitted structure. For this balanced yarn tension prior and after to feeder is maintained. Lower fabric take up tension is also observed in machine setting. Finally proper needle timings of dial and cylinder needles in order to obtain loose or tight structure.

iii. Yarn storage: For the yarns to have sufficient moisture for knitting, they should be stored at 20^0 C and 65% RH. Storage under extreme temperatures must be avoided. Higher temperature leads to paraffin migration and lower temperature leads to water condensation.

iv. Air conditioning: Air conditioning of knitting plant prevents yarn dry up, reduces yarn breaks and improves the surface structure of fabric. The recommended conditioning is 55% + 10% RH and 25^0 C + 3^0 C temperature. [3]

Calculation of production of a Single jersey Knitting machine:

Production of a single jersey knitting machine (kg)

$$= \frac{l \times \pi \times d \times G \times \text{No.of Feeders} \times \text{r.p.m of knitting machine} \times \text{Time(min)}}{10 \times 2.54 \times 36 \times 840 \times \text{Yarn count (Ne)} \times 2.2046}$$

Where; l = stitch length in mm, π = 3.1416, d = machine diameter in inches, and G = Needle gauge (Needles per inch.)

Data collection

A knitting machine of 22 inches diameter, 24 gauge, running at 42 r.p.m.; knitting single jersey plain fabric from 24 English count (Ne) of carded yarn was observed for two days for 12 hours each day. The machine was knitting with 3.05 mm stitch length. It had 66 yarn feeders. While the machine was running data was collected in the following example sheet. A group of data was collected till a roll of fabric is cut away from knitting machine. By this way 16 sets of data was obtained in two days after 12 hours for 8 roll of fabric each day. Accumulated data in the sheet was then classified and analyzed with the help of graphs.

Table 1: Example of data collection sheet.

Yarn type Count& Lot	**Stitch Length (mm)**	**R.P.M.**	**Cause of Stoppage**	**Duration of Stoppage in minutes**
24/1	3.05	42	Yarn breakage	1
Carded			Yarn breakage	1
Badsha			Set-off	3
Lot#42A			Machine cleaning and fabric roll cutting	10
			Yarn breakage	1
			Yarn breakage	1
			Yarn breakage	1

Results and discussion

After collecting the data two groups of causes could be identified. Among the frequently occurring causes were: Yarn breakages, set-off, machine cleaning / roll cutting. The seldom occurring causes were yarn joining, needle breakages and oil problem. In this paper the seldom occurring faults are grouped in 'other' causes. The collected data in shown sample sheet (Table 1) was grouped according to the causes and their frequency was counted. The frequency and individual total time was represented in the table 2. The time of stoppages for individual causes was summed up and represented in the table 3 with their percentages. Finally the production loss due to different causes was calculated and was represented in Table 4.

The number of yarn breakages and set-offs in days 1 and day2 varied. The reasons for this were not investigated in this work. But the reasons behind the variation can be anticipated are variation in yarn quality and variation in atmospheric conditions. Again the performance of worker may have varied during joining the yarns and repairing the set-offs. The data was collected in the month of April which is in summer season in the region which is humid and hot. Again as the knitting machine was running comparatively at a high speed, so the needles broke. The causes are also need to be investigated in future works. The machine cleaning and fabric roll cutting was 8 times in each day. But the duration varied in day 1 and day 2. But the reasons behind this variation were not investigated in this paper.

Table 2: Different causes of knitting machine stoppages and their duration.

	Fabric Roll No.	**Weight (kg)**	**No. of Yarn Breakage**	**Time (min)**	**No. of Set-off**	**Time (min)**	**Machine Cleaning & fabric Roll cutting (min)**	**Others**	**Time (min)**
Day 1 (12 hours)	1	24.9	3	3	0	0	7	Yarn joining	10
	2	26.5	1	1	0	0	9	Needle broken	5
	3	25.1	5	5	0	0	11	Yarn joining	4
	4	25.3	5	5	1	3	7	Yarn joining	9
	5	24.5	5	5	1	4	7	Needle broken	9
	6	26.5	3	3	0	0	7		
	7	24.5	6	6	0	0	5		
	8	27.2	4	4	0	0	5		
	Total	**204.5**	**32**	**32**	**2**	**7**	**58**		**37**
Day 2 (12 hours)	1	22.2	8	8	0	0	10	Yarn joining	14
	2	25.1	4	4	1	4	8	Yarn joining	3
	3	25.3	4	4	0	0	10		0
	4	26.4	2	2	0	0	9		0
	5	24.4	2	2	0	0	9	Needle broken	5
	6	25	4	4	1	3	8	Oil Problem	30
	7	20.5	5	5	2	8	9	Yarn joining	8
	8	20.6	2	2	1	2	5	Yarn joining	2
	Total	**189.5**	**31**	**31**	**5**	**17**	**68**	**-------**	**62**
	Grand Total	**394**	**63**	**63**	**7**	**24**	**126**		**99**

Table 3: Summary of different stoppage time and their percentages due to the causes.

Cause	Yarn breakage	Set-off	Machine cleaning and fabric roll cutting	Others	Total
Duration of stoppage (min)	63	24	126	99	312
% of total stoppage time	20.19	7.69	40.38	31.7	100

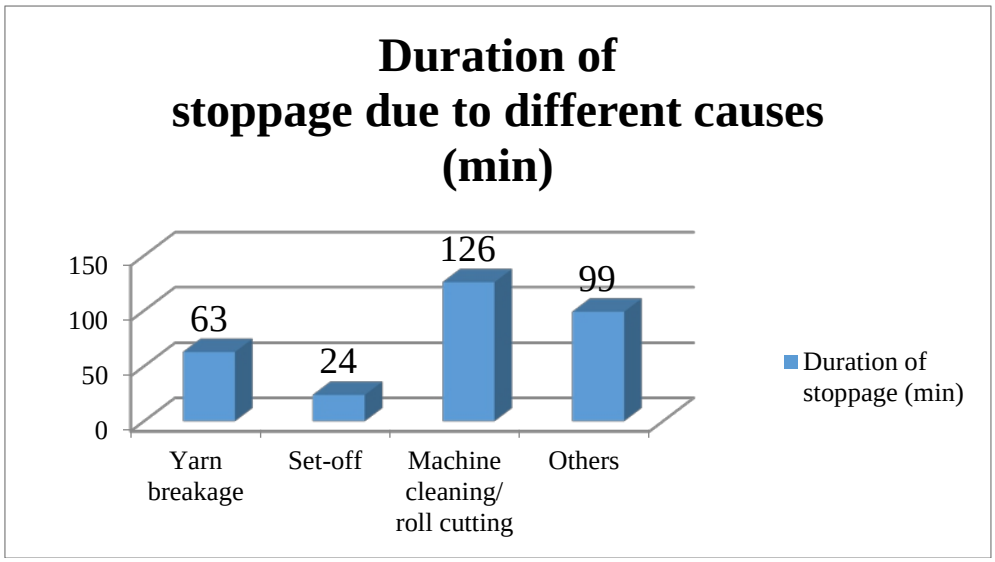

Figure 1: Duration of stoppage due to different causes.

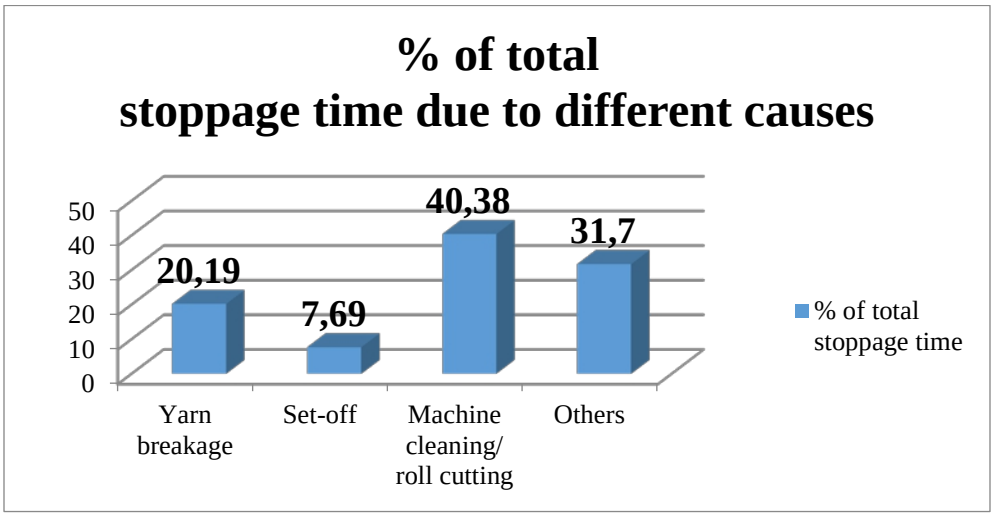

Figure 2: Percentage of total stoppage time due to different causes.

From tables and graphs we can see that due to yarn breakages the knitting machine was stopped for 63 minutes (20.19% of total stoppage

time); for set-off 24 minutes (7.69% of total stoppage time); for machine cleaning / roll cutting 126 minutes (40.38% of total stoppage time); and other causes (yarn joining, needle breakages and oil problem) is 99 minutes (31.7% of total stoppage time).

Table 4: Calculated production loss due to different causes.

Cause of stoppage	**l mm**	**π**	**d inch.**	**G**	**No. of feeders**	**r.p.m**	**Yarn count (Ne)**	**Stoppage Time (min)**	**Production loss (kg)**
Yarn Breakage	3.05	3.1416	22	24	66	42	24	63	21.74
Set-off	3.05	3.1416	22	24	66	42	24	24	8.28
Machine cleaning / roll cutting	3.05	3.1416	22	24	66	42	24	126	43.48
Others	3.05	3.1416	22	24	66	42	24	99	34.16
Total stoppage	3.05	3.1416	22	24	66	42	24	312	107.66
24 hours	3.05	3.1416	22	24	66	42	24	1440	496.91

From Table 4; we can see that the production loss of a single jersey knitting machine for 63, 24, 126, 99 minutes are 21.74kg; 8.28 kg; 43.48 kg and 34.16 kg respectively. Again if we consider the total stoppage time, the total production loss is 107.66 kg. If the knitting machine could run for 24 hour uninterruptedly without the stoppages, it would have produce 496.91 kg of fabric.

Conclusion

It is seen from the data sheet that the causes of the single jersey knitting machine stoppages are: yarn breakages; set-off; machine cleaning and fabric roll cutting; yarn joining, needle breakages and oil problem. Machine cleaning and fabric roll cutting occupied the 40.38% of the total stoppage time. Then the yarn breakages caused the machine to stop for 20.19% of the total stoppage time. Due to set-off the machine was stopped for 7.69% of the total stoppage time. Finally, the other causes (Yarn joining, needle breakages and oil problem) stopped the machine for 31.7% of the total stoppage time.

Again due to yarn breakage 21.74 kg, due to set-off 8.28 kg; due to machine cleaning and fabric roll cutting 43.48 kg and finally due to other causes 34.16 kg of production loss is realized. Finally we find out the total loss of production due to all of the causes is 107.66 kg collectively. This is almost 21.66% of the total production of 496.91 kg of fabric of a knitting

machine producing fabric for 24 hours or 1440 minutes.

There are many variables which affects the efficiency of a knitting machine. Like type and brand of knitting machine, yarn quality and atmospheric conditions. For instance the quality of yarn which is knitted to fabric plays a vital role in the efficiency of a knitting machine. It is obvious that efficiency will changed if different type of yarn (Carded / combed) is used. Again yarn count, evenness and yarn strength will affect the efficiency of a knitting machine. In near future the authors hope to study the effects of different variables on efficiency of knitting machine.

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