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This thesis is submitted in partial fulfillment of the requirements for the Degree of Bachelor of Science in Textile Engineering.

Advance in Fabric Manufacturing Technology

July, 2015
Letter of Approval

August 2\textsuperscript{nd}, 2015

The Head of the Department  
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Subject: Approval of project report of B.Sc. in TE Program.

Dear Sir,

We are just writing to let you know that this project report titled as “Effect of machine stoppage on production efficiency of circular knitting machine” has been prepared by the students bearing ID: 113-23-2673 and ID: 113-23-2678 is completed for final evaluation. The whole report is prepared based on the proper investigation and interruption through critical analysis of empirical data with required belongings. Therefore it will highly be appreciated if you kindly accept this project report and consider it for final evaluation.

Yours Sincerely

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Finally, we would like to acknowledge with due respect the constant support and patients of our parents.
DECLARATION

We hereby declare that, this project has been done by us under the supervision of Professor Dr. Md. Mahbubul Haque, Head of the Department, Department of Textile Engineering, Daffodil International University and Ms. Shamima Akter Smriti, Lecturer of the Department, Department of Textile Engineering, Daffodil International University, Dhaka. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree and it is submitted in partial fulfillment of the requirement of Bachelor of Science in Textile Engineering degree of Daffodil International University and we also remain responsible for the inadequacies & errors.

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ABSTRACT

This project is on “Effect of Machine Stoppage On Production Efficiency Of Circular Knitting Machine”. Textile Fabric materials are used to prepare different categories and types of Fabric products in the textile industry.

For machine stoppage many defect are produced and time are waste. To fulfill buyer delivery timeline and quality it is very important to detect, to identify and to prevent these causes from reoccurring. There are many kinds of knitting machine stoppage causes found in textile industries.

This Project deals with a major problem of production loss and causes of knitting machine stoppage in knitting industry. The knitting machine has to stop when defects occurred and then faults are corrected, which results in time loss and efficiency loss. Not only that the knitted fabric may be rejected if quality requirements are not met.

An effective monitoring is required to avoid defects and to avoid productivity and quality losses. The study identifies two main categories of defects (average time required for correcting defects and machine down time) are responsible for reducing productivity. The thesis reflects that due to yarn breakage machine stopped for seen minutes per days, for maintaining machine stopped for two hours per month, for needle breakage six minutes per day and for technical problem machine stopped for several times.

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Chapter -1
1.1 Introduction
Bangladesh is known as a land of Agriculture. In past and now also most of the people of Bangladesh are depend on agriculture. But in recent past another sector is growing rapidly and that is textile. Now a days around 70% of our economy is depend on textile.

From 1947 to 1971 the textile industry like most industries in East Pakistan, were largely owned by west Pakistan. During that period in 1960, local Bangladeshi entrepreneurs had set up their own large textile factories. Following its separation from East Pakistan the newly formed Bangladesh lost access to both capital and technical expertise. Until the liberation war of Bangladesh in 1971 textile sector was primarily part of the process of import substitution industrialization (ISI) to replace import. After the liberation Bangladesh adopted export oriented industrialization (EOI) by focusing on textile and clothing industry. Particularly the readymade garment (RMG) sector.

However the Ready–Made Garments (RMG) sector has emerged as the biggest earner of foreign currency. The RMG sector has experienced an exponential growth since the 1980s. The sector contributes significantly to the GDP. It also provides employment to around 4.2 million Bangladeshis, mainly women from low income families. It was started in the late 1970s. Soon it became one of the major economical strength for Bangladesh. The RMG sector has added very much in earning foreign exchange, balancing export and import, huge unemployment problem for the country and empowerment of women along with giving them financial support.

Fabrics are the main and costly raw materials of a garment. So it is very important to use fabric efficiently and control wastage of fabric. In Bangladesh knitted fabric are more popular than woven fabric because of easy manufacturing process and its comfortable to wear. For knitting machine stoppage knitting industry face some problems and facing losses. So by this we can say machine efficiency are very important but it is affected by machine stoppage. There is some causes of stoppage the machine e.g. unskilled labor, yarn breakage, inspection, doffing, cleaning etc and those causes are mostly reducible.

A knitting machine contains different types of machine parts such as needles, cams, sinkers, Fabric take-down mechanism, creel, a yarn metering and storage device, yarn breakage indicator, feeders and lubricator. All those machine parts are responsible to increase or decrease the productivity of knit fabric production. Due to the problem of machine parts, machine has to shut down for certain period. For this it reduced productivity overall loss of efficiency of the machine. Unskilled labor is another major causes of knitting machine stoppage.

There are many other causes of stoppage knitting machine. This thesis object is to find out new causes and Reminders, efficiency of machine, variation in actual and calculated production, and
percentage of cause’s due to 100% efficiency, How to improve the efficiency and decrease the time loss.

Chapter 2 Literature survey

2.0 Recent Work:

In the book of D. J. Spencer, “Knitting Technology”, third edition, Wood head Publishing Ltd., April 2001 he wrote A knitting machine contains different types of machine parts such as needles, cams, sinkers, Fabric take-down mechanism, creel, a yarn metering and storage device, yarn breakage indicator, feeders and lubricator[1]. All those machine parts are responsible to increase or decrease the productivity of knit fabric production. Due to the problem of machine parts, machine has to shut down for certain period. For this it reduced productivity overall loss of efficiency of the machine.

In the book of Iyer, Mammel, Schach “Circular Knitting”, second edition, 1995. The demand for knit garment products all over the world are rapidly growing because of more interest in knitted fabrics due to its simple production technique, low cost, high levels of clothing comfort and wide product range. Knitting technology meets the rapidly-changing demands of fashion and usage. Knitted fabrics not only possess stretch and provide freedom of movement, but they also have good handle and easily transmit vapor from the body [2]. Knitted fabrics are also noted for their freedom of body movement in form fitting garments (due to inherent stretch), ease of care, resilience, soft draping qualities, good air porosity and Relatively low cost of simple fabrics. Various types of knitted garments are produced in Bangladesh such as polo pique, single lacoste, double lacoste, rib and interlock fabrics.

In Wikipedia Efficiency is used with the specific purpose of relaying the capability of a specific application of effort to produce a specific outcome effectively with a minimum amount or quantity of waste, expense, or unnecessary effort [3]. If outcome is greater than the input materials in this case machine is considered highly efficient. The efficiency of a machine depends on many factors such as machine speed, input materials quality, Routine maintenance, skilled machine’s operator, auto spacing and oiling, power failure etc.

The introduction of stitching motion and related mechanisms driven by electronic system in these knitting machines has given much rise in their freedom to create versatile fabric structures, and in their productivity. For example, garment-length fabrics have become applicable to seamless women’s innerwear, which can be produced by making an active use of the freedom in changing the stitch density and the number of stitch during operation [4]
In the book of Iyer, Mammel, Schach “Circular Knitting”, second edition, 1995. Knitted fabric can be classified into two categories, namely weft knitted fabric and warp knitted fabric. In weft knitting a yarn presented horizontally is kinked into a row of loops. To achieve these needles can be moved simultaneously and the loops formed one after the other or at the same time or the needles are moved successively to form the loops [5].

In a journal of Md.Solaiman, Elias Khalil; Mostafizur Rahman; Joy Sarkar they identify the causes from single, Rib Machine randomly and calculate production randomly and find the basic causes of efficiency loss [6].
Chapter 03 Theoretical Background

3.0 Fabric

Textile fabrics can be produced directly from webs of fibers by bonding, fusing or interlocking to make non-woven fabrics and felts, but their physical properties tend to restrict their potential end-usage. The mechanical manipulation of yarn into fabric is the most versatile method of manufacturing textile fabrics for a wide range of end-uses.

There are three principal methods of mechanically manipulating yarn into textile fabrics: interweaving, intertwining and interlooping. All three methods have evolved from hand manipulated techniques through their application on primitive frames into sophisticated manufacturing operations on automated machinery.

**Interweaving or Weaving**: Interweaving or Weaving is the intersection of two sets of straight threads, warp and weft, which cross and interweave at right angles to each other. Weaving is by far the oldest and most common method of producing continuous lengths of straight-edged fabric.

**Intertwining and twisting**: Intertwining and twisting includes a number of techniques, such as braiding and knotting, where threads are caused to intertwine with each other at right angles or some other angle. These techniques tend to produce special constructions whose uses are limited to very specific purposes.

**Inter-looping or Knitting**: Inter-looping or Knitting consists of forming yarn(s) into loops, each of which is typically only released after a succeeding loop has been formed and intermeshed with it so that a secure ground loop structure is achieved. The loops are also held together by the yarn passing from one to the next. (In the implied illustration this effect is not illustrated.)

Fabrics are produced mostly from yarns. Few fabrics are directly produced from fibers. Fabrics are made from yarns and are constructed mostly either by weaving or knitting. Weaving Major portion of the fabrics are produced by weaving. Among the other fabric constructions, lace making is worth mentioning. Felts are fabrics made directly from fibers without making yarns.

A wide variety of woven fabrics are available in today's market. An average consumer is unaware of many fabrics and their suitability for a specific end use. Clothing refers to the various articles used to cover the body. Apparel may be divided into two classes. First one the desire for warmth and for protection against elements, Secondly the desire for satisfaction we receive from wearing clothing that makes us appear to advantage.
Baby's cloths need not be full of frills or elaborate, since the baby's comfort should be the main criterion. Their clothes are meant to protect them from colds and chills, while allowing enough freedom of movement for the limbs. Clothes should not be tight as they will hamper the circulation and breathing.

The appearance of a garment is greatly influenced by the fabric used for construction, not all fabrics are suitable for all garments. To choose a suitable fabric for a specific end use calls for basic knowledge in fabric construction and types of fabrics available in the market.

### 3.1 Introduction of knitted Fabric

Knitting is the second most frequently used method of fabric construction. The term “Knitting” describes the technique of constructing textile structures by forming a continuous length of yarn into columns of vertically intermeshed loops. Knitted fabrics have been gaining popularity during the past two decades, thanks to the increased versatility of techniques and adaptability of the many new manmade fibers. Knitted fabrics are now widely used in the applications where woven fabrics formerly predominated. Today, the usage of knitted fabrics ranges from hosiery, underwear, sweaters, slacks, to rugs and other home furnishings.

From the beginning the art of knitting was an occupation for women. Traditional hand knitting, using knitting needles or pins, has been practiced for thousands of years. The earliest example of true knitting is a pair of knitting socks found in Egypt, dating back to 1100 A.D just over 9 centuries ago! Socks and stockings were knitted because they had to be shaped to the foot or leg. By the 16th century knitting had advanced into a craft, the first real evidence of a production knitting machine was the stocking frame, invented by the Reverend William Lee in 1589. The invention laid the foundation for the development of knitting technology. Lee’s invention enabled the knitting of loops at 10 times the speed of traditional hand pin knitting.

### 3.2 Course and Wales

There are 2 things making the knit fabric. They are course and Wales. Wales is the vertical yarn. Course is the horizontal yarn.

Wales lines are fixed by the machine gauge. This cannot be changed. Coarse lines can be altered by adjusting in the machine. This is called Texture.
Course per inch:

Measured by placing an inch glass called counting glass on the fabric and counting the number of courses are contained within the area. This value very if the fabric is distorted.

Wales per inch:

Wales per inch are measured by placing an inch glass called counting glass on the fabric and counting the number of Wales, which are contained within the area. This value very if the fabric is distorted.

3.3 Why knits are popular?

Knitted fabrics are popular today because:

- It is usually soft and drapes well.
- It molds and moves easily with body movement.
- It has good stretch ability.
- It resists wrinkles.
- Most importantly, knits relate well to contemporary life-styles.
- Good absorbency.
- Good air porosity and Relatively low cost of simple fabrics.

3.4 Classification of knitted fabrics

The knitting industry is divided into two distinct sectors:

- Weft Knitting
- Warp knitting
3.4.1 Weft knitting
In weft knitting, the loops are formed across the width of the fabric, and each weft thread is fed more or less at a right angle to the direction in which the fabric is produced. It is possible to knit with only one thread or cone of yarn, though production demands have resulted in circular weft knitting machines being manufactured with up to 192 threads.
3.4.2 Warp knitting

Warp knitting is a method of producing a fabric by using needles similar to those used in weft knitting, but with the knitted loops made from each warp thread being formed down the length of the fabric; the loops are formed vertically down the length of the fabric from one thread as opposed to across the width of the fabric, as in case of weft knitting.

**Types of warp knitting**

Two common types of warp knits are Tricot and Raschel.

1) **Tricot**

Tricot knits are made almost exclusively from filament yarns because uniform diameter and high quality are essential yarn characteristics for use with the very high speed tricot knitting machines. Fabrics constructed by the tricot knitting machine are usually plain or have a simple geometric design. The front surface of the fabric has clearly defined vertical wales and the back surface has crosswise courses.

General characteristics of tricot knits include softness, good drapability, crease resistance, non-reveling and elasticity. The wide range of textile products made from tricot knits include lingerie, sleepwear, robes, men’s shirts, blouses, dresses, waitresses and nurses uniforms, backing for bonded fabrics, and automobile upholstery. Tricot knits are made predominantly from nylon, acetate and polyester fiber.

2) **Raschel**

Raschel knits are produced from spun or filament yarns of different weights and types. Most raschel knits can be identified by their intricate, the open-space look of crochet or lace, and an almost three-dimensional surface effet design. Raschel knits are used for a diverse group of products, including lace and lace trim, sweaters, thermal underwear, swimsuits, blankets and tennis nets.
3.5 Circular knitting machine (weft knitting)
There are mainly two types of knitting machine i.e. circular knitting machine an flat bed knitting machine. Circular knitting machine is one of them. Some parts of circular knitting machine are given below:

- **Creel**: creel is called the holder of cone. Cone is placed in a creel for feeding the yarn to the feeder.
- **Feeder**: yarn is feed through the feeder. No of feeder is depends on the design of the fabric.
- **VDQ pulley**: G.S.M of the knit fabric is collected by VDQ pulley. VDQ pulley is used for controlling the stitch length of the fabric.
- **Guide**: Guide is called the supporting element. Guide is use to guide the yarn.
- **Sensor**: sensor is an automatic controlling system. When a yarn pass through this sensor then if any yarn break down or any problem occur then it automatically stop by this sensing system.
- **Cylinder**: cylinder is the main parts of a knitting machine. Adjustment of a cylinder is important. Cylinder carries needle, sinker, cam and many more.
- **Spreader**: spreader is used to spread the knitted fabric before take up roller. Knit fabric may be tube or open type. Spreader is adjusted as need.

![Fig 1: circular knitting machine parts](image-url)
3.6 Type of knit Fabric:

1. single jersey
2. Single lacoste
3. Double lacoste
4. Polo pique
5. Plain interlock
6. 1×1 Rib
7. 2×1 Rib
8. 2×2 Rib
9. Flat back rib
10. Two Thread Fleece
11. Three Thread fleece
12. Polar Fleece

3.7 Basic Knitting Element
There are 3 Basic Knitting elements. They are:

1. Needle
2. Sinker
3. Cam

**Needle:**

**Function of Needle:** Needle is raised to clear the old loop from the hook & to receive the new loop above it on the needle stem.

**Types of Needle:** In general there are 3 types of needles. They are

1. Latch needle
2. Breaded needle
3. Compound needle

According to the butt position latch needles are 4 types:

1. One butt latch needle
2. Two butt latch needle
3. Three butt latch needle
4. Four butt latch needle
CAM:
Cams are the device that convert the rotary drive into a suitable reciprocating action for the needles or other elements.

Types of cam: There are 2 types of cam. They are:

· Engineering cam
· Knitting cam

1. Knit cam
2. Tuck cam
3. Miss cam

Fig 1: cam
**Function of cam:** The function of cam is given below

1. Produce motion of needles
2. Drive the needle
3. Formation of loop

**Sinker:**

The sinker is the second primary knitting element. It is a thin metal plate with an individual or a collective action operating approximately at right angles from the hook side of the needle bed, between adjacent needles.

Sinkers capable of producing loop fabric are well known in the knitting industry. In such machines the sinkers generally include a blade having an upper edge which defines a lower knitting level and a nib having an upper edge which is at an upper knitting level. Long loops are formed at the upper knitting level of the sinkers with a loop yarn and a base yarn is knitted over the blade. The sinkers may be formed and their movement controlled to cause either the loop yarn to appear on one side of a fabric and the base yarn on the other or the loop yarn to appear on both sides.

In the past it has not been possible to producing loop cloth of ideal quality since loops would twist or coil making it difficult to finish a loop fabric into satisfactory velor. Furthermore loops which were supposed to appear on the front of a fabric would sometimes appear on the other side. The back of loop cloth was therefore apt to have objectionable loose protruding loops and double tuck stitches.
Sinkers Operation

The held loop is positioned in the throat of the sinker when the sinker moves forward and the needle moves upward for clearing. The held loop is held by the throat and hence its movement along the needle is restricted.

The sinker remains at its forward position when the needle attains its clearing position.

The sinker retracts when the needle comes down after feeding. At this stage, due to sinkers retraction, fabric or held loop is eased out. Also the sinker belly supported the fabric or held loop and hence its movements along the needle is prevented.
Sinker remains in backward position and the needle descends to its lowest position drawing the new loop through the old one.

Before the needle ascends, the sinker moves forward to push the knitted fabric a little and to hold the old loop away from the head of the needle and to be in a position to control the fabric.

![Sinker](image)

**Fig 3: sinker**

### 3.8 Needle gauge

In knitting, the word gauge is used both in hand knitting and machine knitting; the latter, technical abbreviation GG refers to "Knitting Machines" fineness size. In both cases, the term refers to the number of Needles contained in one inch of the needle bed in knitting machine. A needle gauge makes it possible to determine the size of a knitting needle. Total number of needles can be determined by the help of needle gauge. The formula is following.

\[
\text{Number of Needles} = \text{Machine Diameter} \times \text{Needle Gauge} \times \pi \times (3.1416)
\]

### 3.9 Machine Gauge:

Knitting machine gauge is used to express the number of needles in a unit length of the needle bed. This needle bed may flat or circular. In circular double knit machine it used for cylinder as well as dial. Knitting machine gauge is denoted by alphabet “E”. The formula is

\[
\text{Machine Gauge} = \text{Number of needle/inch}
\]
4.0 Guidelines for Checking of GSM

The following are the further guidelines for checking the GSM:

- Actual GSM of fabric (as explained above) should be measured at the start of new article
- Fabric roll should be cut as per counter meter reading on the machine. In this practice, weight of each roll will be same. This is the easiest way to check the GSM of each roll

4.1 Stitch Length of Fabric Sample

Stitch Length should be checked whenever starting the new order or problem arises. The use of round meter for setting the stitch length is better. However, if it is not available then, it may be checked manually. But in any case, it must be checked when starting the new article or in case of any problem.

4.2 Calibration of Round Meter

Round meter is sometimes used for the setting of stitch length. It is advised that round meter must be checked and calibrated for the correct setting. Check the stitch length manually and compare the results with the round meter reading.

4.3 Measuring Actual Stitch Length

To find the actual stitch length, take a sample of fabric and mark 100 needles and then take out at least three yarns each and measure the stitch length. Compare this value with the round meter value.

5.0 Machine Maintenance

5.1 Machine Maintenance Schedule

Maintenance of knitting machine is very important that affect the machine efficiency, machine life and fabric quality. The management should prepare a maintenance schedule and it should be followed strictly. The main parts of the knitting machine should be checked with extreme care and responsibility. If the knitting machine is too old, then maintenance became more important to avoid any major breakdown. The following are the guidelines for machine maintenance(Daily, Weekly, Monthly, Bi-Annually and Annually).
5.1.1 Daily Maintenance

The check points for daily maintenance are as follows:

**Yarn feeding device and related parts:**
- Check yarn feeding device (MPF, IRO), Slipped-off, Loose or broken MPF drive belt
- Malfunction of clutch, IRO tape flipper, etc
- Check MPF teeth
- Clean fluff from MPF area
- Remove fluff from tension washers
- QAP (Quality Pulley): diameter, loose lock nut

**Lubricators:**
- Oil level of mist lubricator
- Check oil drop rate (should be 100-120 drops/ min)
- Supply amount of compressed air
- Check lubrication points for disconnection, leakage etc.
- Check compressed air pressure

**Abnormal Noise:**
- Knitting elements (cam holders, sinker cap and dial cap)
- Yarn feeding units and related parts (QAP, change gear box, drive tape, etc)
- Frame (machine bed, take-up unit, motor drive, etc.)

**Oil leakage:**
- Lubricator main body
- Part underneath the bed
- Oil amount in the oil sump bottle
- Connection between oil mist pipes and nozzles
- Part underneath the gear ring

5.1.2 Weekly Maintenance

The check points for weekly maintenance are mentioned here under:

- Piping for lubrication oil and compressed air
- Oil amount in the bed & gear box and make up if required
- Check oil sump mist lubricator
- Draining of water from the air compressor
- Clean the lint fan
5.1.3 Monthly Maintenance
The check points for monthly maintenance are as follows:

- Lint accumulation (Check for lint and clean):
- Lint in the control panel
- Lint around lint fans and other areas
- Lint in the motor cover

Belt tension:
- Check main drive motor belt tension
- Check drive belt tension for yarn feeding device

5.1.4 Bi-Annual Maintenance
The check points for bi annual maintenance are mentioned here under:

- Change the oil in gear box
- Change the oil in needle bed
- Remove the MPF pulleys and clean with kerosene oil
- Machine cleaning should be checked very carefully for all parts

5.1.5 Annual Maintenance
The check points for annual maintenance are mentioned here under:

- Change grease in fabric roll winder
- Change grease in gear box of yarn feeding system

5.1.6 Machine Overhauling

Each knitting machine should be overhauled once a month. It is a guide line for overhauling which is followed worldwide.

6.0 Basic knitting design:

There are four basic knitting structure:

1) Single jersey
2) Rib
3) Interlock
4) Purl
6.1 The Knitting Actions:

The basic action of a needle are shown in below. Except for the manner in which the hook is closed (in this case by pressing the beard), the knitting action is similar for all needles. The arrows indicate the relative movement of the loops along the needles. (Whether the needle moves through the loops or the loops are moved over the needle by some other elements depends upon the machine design.)

1. The needle is in the (so-called) rest position, with the previously formed loop (a) held on its stem and covered by the hook.

2. The loop is cleared from the needle hook to a lower position on the needle stem.

3. The new yarn (b) is fed to the needle hook at a higher position on the needle stem than the position of the previous (‘old’) loop.

4. The yarn is formed into a ‘new’ loop.

5. The hook is closed, enclosing the new loop and excluding and landing the old loop onto the outside of the closed hook.

6. The new loop (b) is drawn through the head of the old loop (a). Simultaneously the old loop slides off the closed hook of the needle and is cast-off or knocked-over.

7. The old loop now hangs from the feet of the fully formed new loop and the knitting cycle starts again.

Fig. Basic knitting action of a needle.
7.0 Example of production calculation for single jersey Machine

Production/ hour = (No of Needle × No of Feeder × Stitch Length(mm) × RPM × 60 × efficiency) / (100×10×2.54×36×840×Count×2.2046)

= (π×D×G× No of Feeder × Stitch Length(mm) × RPM × 60) / (10×2.54×36×840×Count×2.2046)

7.1 Example of production calculation for Rib Machine

Production/ hour = (No of Needle × No of Feeder × Stitch Length(mm) × RPM × 60) / (No of feeder/course × 10×2.54×36×840×Count×2.2046)

= (π×D×G × No of Feeder × Stitch Length(mm) × RPM × 60) / (2×10×2.54×36×840×Count×2.2046)

7.2 Example of production calculation for Fleece Machine

Production calculation of three thread fleece

1) Production of base yarn

\[ \frac{rpm \times no \ of \ needle (ndg) \times no \ of \ feeder \times stitch \ length (mm) \times \text{timeshift}}{100 \times 0.9 \times 840 \times \text{count} \times 2.2046} \]  kg/shift

= x  kg/shift

2) Production of binding yarn

\[ \frac{rpm \times no \ of \ needle (ndg) \times no \ of \ feeder \times stitch \ length (mm) \times \text{timeshift}}{100 \times 0.9 \times 840 \times \text{count} \times 2.2046} \]  kg/shift

= Y  kg/shift

3) Production of loop yarn

\[ \frac{rpm \times no \ of \ needle (ndg) \times no \ of \ feeder \times stitch \ length (mm) \times \text{timeshift}}{100 \times 0.9 \times 840 \times \text{count} \times 2.2046} \]  kg/shift

= Z  kg/shift

Total production of three thread fleece fabric = (x + y + z) kg/shift
7.3 Example of production calculation for Interlock Machine

Production/ hour = (No of Needle × No of Feeder × Stitch Length(mm) × RPM × 60 )
/ (no of feeder/course × 10 × 2.54 × 36 × 840 × Count × 2.2046)

= (π×D×G × No of Feeder × Stitch Length(mm) × RPM × 60 ) / (2 × 10 × 2.54 × 36 × 840 × Count × 2.2046)

8.0 Efficiency

It is the percentage equation expression the ratio between actual production and calculated production.

Efficiency = \( \frac{Actual \ Production}{Calculated \ Production} \times 100 \)

8.1 Type of Efficiency:

1. **Running efficiency**: It is related to time. Efficiency at a certain time is known as running efficiency. Actual production of machine is always low due to interruption, minor causes of interruption are included during calculation of running efficiency.

2. **Attained efficiency**: The actual which is obtained is obtained from the machine is called attained efficiency.

3. **Overall efficiency**: Machine stopped for various reasons in the industry included major causes & minor causes for which production is called overall efficiency. It is calculated for the year round.

4. **Individual machine efficiency**
5. **Group efficiency**
6. **Mill efficiency**

8.2 Production Calculation (on 8 Hours basis):

**Production for 100% Efficiency:**

= Machine R.P.M × 8 hours × 60 minutes × (5)
= (Fabric Weight in Grams)
= (Fabric Weight in Grams) / 1000
= (Fabric Weight in Kilo Grams) ……… (8)

This will be the weight of fabric produced at 100% efficiency at that particular machine in 08 hrs. Similarly, the 100% production in 12 hrs or 24 hrs can be found.
**Production For 85% Efficiency:**

In order to set the production target for the knitting machine, multiply the 100% production value with the desirable efficiency (in our case we took it 85 %)

\[
= (8) \times 0.85 \\
= \text{Kg} \ldots \ldots \ (9)
\]

This (9) will be the production target based on the actual conditions.

**8.3 Knitting Machines Daily Efficiency:**

For calculating the actual efficiency of machines and operators (shift wise & on daily basis), a counter status check method is suggested. This counter status check is used to determine the actual production shift wise. The following example illustrates the method to calculate the actual efficiency:

For example:

I. M/C No = 1
II. Work Order No = 1685
III. RPM (Round Per Minute) = 20
IV. Total No. of Hours of One Shift = 8
V. Counters Required to Knit One Roll = 1900
VI. No. of Rolls Produced in One Shift = 3
VII. Total No. of Kilograms Produced in One Shift = 105
VIII. Counters Received from the Previous Shift = 1100
IX. Counters Forwarded to the Next Shift = 1000

So, the Total actual rounds (counters) in the shift will be:

\[
= (\text{VI} \times \text{V}) + \text{IX} - \text{VIII} \\
= (3 \times 1900) + 1000 - 1100 = 5600 \text{ Rounds}
\]

But as per the speed (rpm) 100% rounds should have been

\[
= \text{IV} \times 60 \times 20 = 9600 \text{ Rounds}
\]

The Machine Efficiency can be found as follows:

\[
= 100 \times \text{Actual Rounds} / 100\% \text{ Rounds} \\
= 100 \times 5600 / 9600 = 58.33\%
\]
8.4 Causes of Efficiency Loss and Machine Stoppage Time
Many causes are responsible for losses of machine efficiency. The following causes were the main reasons for reducing the productivity of the machine. Average time of machine stoppage and causes of machine stoppage are given following table.

<table>
<thead>
<tr>
<th>Serial No</th>
<th>Reasons for Stoppage</th>
<th>Mean Time of machine stoppage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Needle breakage</td>
<td>7 minutes/day</td>
</tr>
<tr>
<td>2</td>
<td>Program change</td>
<td>2 hours (two times in a month)</td>
</tr>
<tr>
<td>3</td>
<td>Star mark</td>
<td>7 minutes/day</td>
</tr>
<tr>
<td>4</td>
<td>Hole mark</td>
<td>5 minutes/day</td>
</tr>
<tr>
<td>5</td>
<td>Sinker mark</td>
<td>5 minutes/day</td>
</tr>
<tr>
<td>6</td>
<td>Needle mark</td>
<td>6 minutes/day</td>
</tr>
<tr>
<td>7</td>
<td>Maintenance (three person)</td>
<td>1.5 hours per month</td>
</tr>
<tr>
<td>8</td>
<td>Hole mark</td>
<td>5 minutes/day</td>
</tr>
<tr>
<td>9</td>
<td>RPM, Oil &amp; Belt check</td>
<td>6 minutes/day</td>
</tr>
<tr>
<td>10</td>
<td>Power failure</td>
<td>12 minutes/day</td>
</tr>
<tr>
<td>11</td>
<td>Yarn Breakage</td>
<td>7 minutes/day</td>
</tr>
<tr>
<td>12</td>
<td>Fabric Handling</td>
<td>15 minutes/day</td>
</tr>
</tbody>
</table>

Fig : Basic causes and Time Required to repair

8.5 The Factors that affecting Efficiency:
Many causes are responsible for losses of efficiency. The factors affect the efficiency of knitting production are given below:

1) Model to Model
2) Machine to Machine
3) Different model of same manufacture
4) Skill of operator
5) Faulty yarn
9.0 Productivity:
It is the percentage equation expression the ratio between output and input.

\[ \text{Efficiency} = \frac{\text{output}}{\text{Input}} \times 100 \]

9.1 Production Control

9.1.1 Production Targets for Feeders Machine

Daily production targets should be defined on the basis of production capacity of the machine. There is a 20 round method to measure the actual production capacity of the knitting machines. In this method, the weight of the fabric produced for 20 rounds is taken and the production is calculated in a kilogram which is based at 100 percent efficiency by using the calculations explained below. On the basis of this value, the actual efficiency of the machine and corresponding production target may be defined. The following is the procedure of the experiment that needs to be conducted on the knitting machine:

- Run the machine for 20 rounds and produce the fabric
- Cut the 20 round fabric from the roll. If possible, a colored yarn can be used to identify the fabric produced in 20 rounds
- When cutting this fabric from the roll, handle it carefully
- Now immediately place this fabric on the table in relaxed state and measure the length and width of the fabric
- Weigh the fabric

Using this data, calculates the production target as follows:

- Fabric Width = \((\text{cm})\) \(= \frac{1}{100} (\text{m}) \ldots (1)\)
- Fabric Double Width = \(1 \times 2 (\text{cm})\) \(= \frac{1}{100} (\text{m}) \ldots (2)\)
- Length of Fabric produced in the 20 rounds \(= \frac{1}{100}(\text{m}) \ldots (3)\)
- Weight of Fabric produced in 20 rounds \(= (\text{gm}) \ldots (4)\)

Weight of One Round Length

\[
\frac{(4)}{\text{No. of rounds}} = \ldots (5)
\]
\[
\frac{\text{Meter Weight}(4)}{(3) \ (\text{gram} \ / \ \text{meter})} = \ldots (6)
\]
\[
\text{GSM} (6)/ (2) = \text{gram} / \text{meter}^2 \ldots (7)
\]
9.1.2 Types of productivity:
1. Productivity of machine
2. Productivity of worker
3. Productivity of material
4. Productivity of time

9.1.3 Causes of production interruption:
- Yarn breakage
- Loose feeding of yarn
- Quality check during production
- Doffing
- Counter stoppage
- Cleaning
- Cone change
- Electric supply off
- Needle break
- Load shedding
- Maintenance
- Natural calamities
- Political unrest
Chapter 04 Material and Methods

4.0 Materials and Methods:

4.1 Materials

Single jersey, Double jersey, Interlock, fleece knitting machine were selected. For calculate machine stoppage time a stop watch is used. For calculate the calculated production stitch length, machine R.P.M, number of feeders, number of needles, machine gauge (needles per inch) and yarn count were identified. From ANON TEX GROUP we take all data.

Fig: Circular Knitted machine
### Machine Used to take Data

<table>
<thead>
<tr>
<th>For single jersey</th>
<th></th>
<th>For Rib</th>
<th></th>
<th>For Fleece</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dia X Gauge: 34 X 24G</td>
<td>Dia X Gauge: 30 X 24G</td>
<td>Dia X Gauge: 38 X 18G</td>
<td>Dia X Gauge: 38 X 18G</td>
<td>Dia X Gauge: 36 X 18G</td>
<td>Dia X Gauge: 36 X 18G</td>
</tr>
<tr>
<td>Stitch Length: 2.75</td>
<td>Stitch Length: 2.95</td>
<td>Stitch Length: 1.50</td>
<td>Stitch Length: 1.50</td>
<td>Stitch Length: Knit-3.9; Tuck-3.8; Loop-1.53</td>
<td>Stitch Length: Knit-3.9; Tuck-3.8; Loop-1.53</td>
</tr>
<tr>
<td>Yarn count: 28Ne</td>
<td>Yarn count: 22Ne</td>
<td>Yarn count: 42Ne(CD)</td>
<td>Yarn count: 42Ne(CD)</td>
<td>Yarn count: 30cvc(80/20);</td>
<td>Yarn count: 30cvc(80/20);</td>
</tr>
</tbody>
</table>
Fabric type: Fleece
Stitch Length: Knit-3.8;
Tuck-3.7; Loop-1.50

Yarn count: 34cvc(75/25);
Knit+Tuck; 22(CD) Loop.
GSM: 290

For Interlock

7) Machine No: 14
Brand & Origin: Korea
Dia X Gauge: 34 X 18G
Feeders: 68
RPM: 22
Fabric type: Interlock
Stitch Length: 1.45
Yarn count: 42Ne(CD)
GSM: 220

8) Machine No: 32
Brand & Origin: Korea
Dia X Gauge: 36 X 18G
Feeders: 72
RPM: 22
Fabric type: Interlock
Stitch Length: 1.52
Yarn count: 40Ne(CD)
GSM: 180

4.2 Methods:

4.2.1. Stitch Length Measurement Process

In industry stitch length was measured manually. At first a stitch was identified and it was marked by red color. Considering its base stitch, count hundred stitch and last stitch is marked by red color. Then the course was unloving from the fabric and its length was measured by a measuring scale. Finally the length was divided by hundred and this dividing result indicate the stitch length.

4.2.2. Number of Needles Calculation

For identifying number of needles at first identifying machine diameter by a measuring scales. Count the number of needles per inch. After multiplying Pi (π), no of needles and machine gauge, we found the number of needles.
4.2.3. Yarn Count Determination

Yarn count is determined by the Begley’s balance. At first a one lea that means one twenty yards yarn was taken by Beasley’s balance. Then by electric balance the weight of the sample was taken. Then by the following formula, yarn count is determined. \( N_e = \frac{L \times w}{l \times L} \) here, \( N_e = \) English count, \( w = \) Unit weight of the sample in pound, \( l = \) unit length of the sample in yard, \( L = \) Length of the sample in yard \( W = \) Weight of the sample in pound.

4.2.4. Time Determination Method

A stop watch was used for determine the time. When a problem was occurred on that time stop watch was on until the problem was recovered. This will determine stoppage time of machine and repairing time of the problem.

4.2.5. No. of Feeder Calculation

Actual Number of feeders was calculated by counting the number of feeders in the machine. In theoretically numbers of feeders are calculated by multiplying machine diameter by
Chapter 05 Results and Discussions

5.0 Data of Single Jersey Machine (SL 01)
The observation was carried out for 8 hours on single jersey knitting machine (SL 01). Consumed time for each machine stoppage due to various causes was tabulated and the summary of the report is given below.

Table -1: Causes of stoppage of single jersey knitting machine in 8 hours

<table>
<thead>
<tr>
<th>Serial No</th>
<th>Yarn breakage</th>
<th>Loose feeding</th>
<th>Quality check</th>
<th>Unload fabric</th>
<th>Counter stoppage</th>
<th>Cleaning</th>
<th>Cone change</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>30.5sec</td>
<td>10.30sec</td>
<td>20.50sec</td>
<td>4min 30sec</td>
<td>05.11sec</td>
<td>6min20sec</td>
<td>1min05sec</td>
</tr>
<tr>
<td>02</td>
<td>50.11sec</td>
<td>08.12sec</td>
<td>20.00sec</td>
<td>3min 10sec</td>
<td>02.55sec</td>
<td>4min10sec</td>
<td>1min55sec</td>
</tr>
<tr>
<td>03</td>
<td>20.03sec</td>
<td>05.50sec</td>
<td>18.50sec</td>
<td>3min 05sec</td>
<td>05.05sec</td>
<td>5min50sec</td>
<td>2min</td>
</tr>
<tr>
<td>04</td>
<td>40.50sec</td>
<td>11.40sec</td>
<td>21.05sec</td>
<td>4min 50sec</td>
<td>05.10sec</td>
<td>4min30sec</td>
<td>1min40sec</td>
</tr>
<tr>
<td>05</td>
<td>40.12sec</td>
<td>09.55sec</td>
<td>19.05sec</td>
<td>2min 55sec</td>
<td>05.50sec</td>
<td>5min10sec</td>
<td>1min35sec</td>
</tr>
<tr>
<td>06</td>
<td>20.50sec</td>
<td>0.34sec</td>
<td>18.00sec</td>
<td>3min 02sec</td>
<td>04.10sec</td>
<td>4min25sec</td>
<td>1min22sec</td>
</tr>
<tr>
<td>07</td>
<td>30.33sec</td>
<td>20.10sec</td>
<td>4min 10sec</td>
<td>04.30sec</td>
<td>3min50sec</td>
<td>1min15sec</td>
<td></td>
</tr>
<tr>
<td>08</td>
<td>25.50sec</td>
<td>19.10sec</td>
<td>3min 40sec</td>
<td>08.50sec</td>
<td>07.33sec</td>
<td>5min40sec</td>
<td>1min55sec</td>
</tr>
<tr>
<td>09</td>
<td>30.40sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>40.10sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>02.00sec</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>32.22sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>29.50sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>31.12sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>33.10sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>28.22sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>40.10sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>35.20sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>37.30sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>28.50sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>40.30sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>38.30sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>41.20sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13min</strong></td>
<td><strong>0.68min</strong></td>
<td><strong>3 min</strong></td>
<td><strong>30min</strong></td>
<td><strong>0.82min</strong></td>
<td><strong>39min</strong></td>
<td><strong>12.18min</strong></td>
</tr>
</tbody>
</table>

Table : 1 (Machine No 17 s/j)
5.1 Production & Efficiency Calculation of Serial No 1(S/J) :

Calculated production time required: 8x60=480 min

On the basis of Table no :1

Total time loss for those causes : 98.68 min

Actual production time : ( 480-9.68) min =381.32 min

Time Efficiency = \[ \frac{Actual \ time}{Calculated \ time} \times 100 \]

\[ = \frac{381.32}{480} \times 100 \]

\[ = 79.46\% \]

Example of production loss :

Production/ hour = (No of Needle ×No of Feeder ×Stitch Length(mm) ×RPM ×60 ) /
(10×2.54×36×840 ×Count ×2.2046)

= (\pi ×D×G× No of Feeder ×Stitch Length(mm) ×RPM ×60 ) / (10×2.54 ×36×840 ×Count ×2.2046)

= (3.1416×30×24×90×2.95 ×25 ×60 ) / (10×2.54×36 ×840 ×26 ×2.2046)

=900822384 / 44026955.48

= 20.46kg/hr

In 8 hours the production is = 20.46x 8 = 163.68 kg/shift

So in 480 min the production is = 163.68kg

In 385 min the = 6.41hr.

So , in 385 min the production is = 131.14 kg

The production loss for machine stoppage is = (Calculated production - Actual production )

\[ = 163.68-131.14 \]

\[ = 32.54 \text{ kg/shift} \]

So , Total production loss for machine stoppage is 32.54 kg /shift
5.2 Total effect on efficiency in percentage (%) for specific causes (single jersey-01):

Total effect on efficiency in percentage (%) for the causes of yarn break = 2.70%  
Total effect on efficiency in percentage (%) for the causes of Loose feeding = 0.15%  
Total effect on efficiency in percentage (%) for the causes of Quality check = 0.62%  
Total effect on efficiency in percentage (%) for the causes of Unload fabric = 6.25%  
Total effect on efficiency in percentage (%) for the causes of Counter stoppage = 0.17%  
Total effect on efficiency in percentage (%) for the causes of Cleaning = 8.12%  
Total effect on efficiency in percentage (%) for the causes of Cone change = 2.53%  
Total effect on efficiency in percentage (%) = 20.54%

Fig: 1 Efficiency loss for single jersey 01
The above illustrated analysis 5.2 and figure 1 clearly indicate that the efficiency loss % of single jersey machine is maximum for cleaning about 8%. That means the knitting machine is stopped more time for cleaning and unloading. From knitting faults view maximum efficiency loss is found for yarn break.

6.0 Data of Single Jersey Machine(SL-2)

This observation was carried out for 8 hours on single jersey knitting machine (SL02). Consumed time for each machine stoppage due to various causes was tabulated and the summary of the report is given below.

Table -2: Causes of stoppage of single jersey knitting machine in 8 hours

<table>
<thead>
<tr>
<th>Serial No</th>
<th>Yarn breakage</th>
<th>Loose feeding</th>
<th>Quality check</th>
<th>Unload fabric</th>
<th>Counter stoppage</th>
<th>Cleaning cone change</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>20.50sec</td>
<td>10.30sec</td>
<td>20.30sec</td>
<td>4min20sec</td>
<td>08.10sec</td>
<td>3min50sec 1min55sec</td>
</tr>
<tr>
<td>02</td>
<td>30.33sec</td>
<td>07.12sec</td>
<td>19.00sec</td>
<td>3min15sec</td>
<td>05.55sec</td>
<td>5min11sec 1min45sec</td>
</tr>
<tr>
<td>03</td>
<td>25.50sec</td>
<td>05.50sec</td>
<td>18.33sec</td>
<td>4min30sec</td>
<td>05.55sec</td>
<td>4min50sec 1min12sec</td>
</tr>
<tr>
<td>04</td>
<td>30.40sec</td>
<td>10.40sec</td>
<td>21.01sec</td>
<td>3min51sec</td>
<td>08.10sec</td>
<td>3min30sec 3min40sec</td>
</tr>
<tr>
<td>05</td>
<td>40.10sec</td>
<td>09.55sec</td>
<td>18.05sec</td>
<td>2min53sec</td>
<td>05.50sec</td>
<td>5min18sec 1min34sec</td>
</tr>
<tr>
<td>06</td>
<td>32.22sec</td>
<td>05.30sec</td>
<td>16.00sec</td>
<td>3min05sec</td>
<td>05.10sec</td>
<td>3min55sec 1min40sec</td>
</tr>
<tr>
<td>07</td>
<td>29.50sec</td>
<td>09.12sec</td>
<td>20.17sec</td>
<td>4min15sec</td>
<td>07.55sec</td>
<td>4min45sec 1min33sec</td>
</tr>
<tr>
<td>08</td>
<td>30.50sec</td>
<td>05.50sec</td>
<td>15.50sec</td>
<td>4min51sec</td>
<td>05.50sec</td>
<td>5min19sec 2min12sec</td>
</tr>
<tr>
<td>09</td>
<td>50.11sec</td>
<td>07.40sec</td>
<td></td>
<td></td>
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<tr>
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<td>38.30sec</td>
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<tr>
<td>19</td>
<td>41.20sec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>10.51 min</td>
<td>1.32 min</td>
<td>2.47min</td>
<td>31min</td>
<td>0.91 min</td>
<td>36.63min 16.87min</td>
</tr>
</tbody>
</table>

Table 2: (Machine No: 8 S/J)

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6.1 Production & Efficiency Calculation of serial No : 2(S/J)
Calculated production time required: 8x60=480 min

On the basis of Table no :2

Total time loss for those causes : 99.71 min

Actual production time : ( 480-99.71) min =380.29 min

Time Efficiency = \( \frac{Actual \ time}{Calculated \ time} \times 100 \)

\[ = \frac{380.29}{480} \times 100 \]

\[ = 79.22 \% \]

6.2 Total effect on efficiency in percentage (%) for specific causes (single jersey 02):

Total effect on efficiency in percentage (%) for the causes of yarn break = 2.18%
Total effect on efficiency in percentage (%) for the causes of Loose feeding = 0.27%
Total effect on efficiency in percentage (%) for the causes of Quality check = 0.51%
Total effect on efficiency in percentage (%) for the causes of Unload fabric = 6.45%
Total effect on efficiency in percentage (%) for the causes of Counter stoppage = 0.19%
Total effect on efficiency in percentage (%) for the causes of Cleaning = 7.63%
Total effect on efficiency in percentage (%) for the causes of Cone change = 3.51%

Total effect on efficiency in percentage (%) = 20.74%
Efficiency loss for single jersey 02

Fig: 2 Efficiency loss for single jersey

In the above illustrated analysis 6.2 and figure 2 clearly indicate that the efficiency loss % of single jersey machine is maximum for cleaning about 7%. That means the knitting machine is stopped more time for cleaning and unloading. From knitting faults view maximum efficiency loss is found for yarn break. The minimum efficiency loss is for counter stoppage.
7.0 Data of Rib(SL 3)

Observation was carried out for 8 hours on Rib knitting machine (SL 03). Consumed time for each machine stoppage due to various causes was tabulated and the summary of the report is given below.

Table -3: Causes of stoppage of Double jersey(Rib) knitting machine in 8 hours

<table>
<thead>
<tr>
<th>Serial No</th>
<th>Yarn breakage</th>
<th>Feeding slippage for dust</th>
<th>Quality check</th>
<th>Unload fabric</th>
<th>Counter stoppage</th>
<th>Cleaning</th>
<th>Cone change</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>11.55sec</td>
<td>09.30sec</td>
<td>12.50sec</td>
<td>4min 30sec</td>
<td>03.18sec</td>
<td>4min20sec</td>
<td>1min44sec</td>
</tr>
<tr>
<td>02</td>
<td>23.15sec</td>
<td>08.12sec</td>
<td>15.00sec</td>
<td>3min 10sec</td>
<td>03.55sec</td>
<td>5min10sec</td>
<td>2min12sec</td>
</tr>
<tr>
<td>03</td>
<td>18.53sec</td>
<td>05.50sec</td>
<td>18.50sec</td>
<td>4min 05sec</td>
<td>02.05sec</td>
<td>5min50sec</td>
<td>1min55sec</td>
</tr>
<tr>
<td>04</td>
<td>24.50sec</td>
<td>11.40sec</td>
<td>12.05sec</td>
<td>4min10sec</td>
<td>04.10sec</td>
<td>5min30sec</td>
<td>2min44sec</td>
</tr>
<tr>
<td>05</td>
<td>34.12sec</td>
<td>09.55sec</td>
<td>18.05sec</td>
<td>3min 50sec</td>
<td>03.50sec</td>
<td>3min10sec</td>
<td>1min35sec</td>
</tr>
<tr>
<td>06</td>
<td>24.50sec</td>
<td>10.40sec</td>
<td>15.00sec</td>
<td>4min10sec</td>
<td>02.10sec</td>
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<td>2min10sec</td>
</tr>
<tr>
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<td>31.35sec</td>
<td>09.30sec</td>
<td>17.10sec</td>
<td>4min30sec</td>
<td>04.30sec</td>
<td>3min51sec</td>
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</tr>
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<td>08</td>
<td>20.50sec</td>
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<tr>
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<td>10</td>
<td>36.15sec</td>
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<tr>
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<td></td>
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<td>22</td>
<td>29.44sec</td>
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<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8.77min</strong></td>
<td><strong>1.05min</strong></td>
<td><strong>2.02min</strong></td>
<td><strong>11.45min</strong></td>
<td><strong>0.52min</strong></td>
<td><strong>37.35min</strong></td>
<td><strong>10.16min</strong></td>
</tr>
</tbody>
</table>

Table :3 (machine no: 35 ; Rib)
7.1 Production & Efficiency Calculation of Serial No: 3 (Rib)

Calculated production time: 8x60 = 480 min

Actual production time: 480 - 71.32 = 408.68 min

Efficiency = \( \frac{actual \ production}{calculated \ production} \times 100\% \)

Now, Efficiency = \( \frac{408.68}{480} \times 100\% = 85.14\% \)

7.2 Total effect on efficiency in percentage (%) for specific causes (Rib 03):

Total effect on efficiency in percentage (%) for the causes of yarn break = 1.82%
Total effect on efficiency in percentage (%) for the causes of Loose feeding = 0.21%
Total effect on efficiency in percentage (%) for the causes of Quality check = 0.42%
Total effect on efficiency in percentage (%) for the causes of Unload fabric = 2.38%
Total effect on efficiency in percentage (%) for the causes of Counter stoppage = 0.16%
Total effect on efficiency in percentage (%) for the causes of Cleaning = 7.78%
Total effect on efficiency in percentage (%) for the causes of Cone change = 2.12%

Total effect on efficiency in percentage (%) = 14.89%
From the above analysis 7.2 and figure 3 it is found that the efficiency loss % of Rib machine is maximum for cleaning about 7%. That means the knitting machine is stopped more time for cleaning and unloading. From knitting faults view maximum efficiency loss is found for yarn break. Here cone change efficiency loss is above 3% and same effect is for Unload fabric.
8.0 Data of Rib (SL 4)

This observation was carried out for 8 hours on Rib knitting machine (SL 04). Consumed time for each machine stoppage due to various causes was tabulated and the summary of the report is given below.

Table 4: Causes of stoppage of Double jersey (Rib) knitting machine in 8 hours

<table>
<thead>
<tr>
<th>Serial No</th>
<th>Yarn breakage</th>
<th>Feeding slippage for dust</th>
<th>Quality check</th>
<th>Unload fabric</th>
<th>Counter stoppage</th>
<th>Cleaning</th>
<th>Cone change</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>11.55 sec</td>
<td>09.30 sec</td>
<td>12.50 sec</td>
<td>4 min 30 sec</td>
<td>03.18 sec</td>
<td>4 min 20 sec</td>
<td>1 min 05 sec</td>
</tr>
<tr>
<td>02</td>
<td>23.15 sec</td>
<td>08.12 sec</td>
<td>15.00 sec</td>
<td>3 min 10 sec</td>
<td>03.55 sec</td>
<td>5 min 10 sec</td>
<td>1 min 55 sec</td>
</tr>
<tr>
<td>03</td>
<td>18.53 sec</td>
<td>05.50 sec</td>
<td>18.50 sec</td>
<td>2 min 05 sec</td>
<td>02.05 sec</td>
<td>5 min 50 sec</td>
<td>2 min 12 sec</td>
</tr>
<tr>
<td>04</td>
<td>24.50 sec</td>
<td>11.40 sec</td>
<td>12.05 sec</td>
<td>04.10 sec</td>
<td>3 min 10 sec</td>
<td>5 min 30 sec</td>
<td>1 min 40 sec</td>
</tr>
<tr>
<td>05</td>
<td>34.12 sec</td>
<td>09.55 sec</td>
<td>18.05 sec</td>
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<td>02.10 sec</td>
<td>3 min 10 sec</td>
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<tr>
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<td>24.50 sec</td>
<td>10.40 sec</td>
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<td>07</td>
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<td>17.10 sec</td>
<td>04.30 sec</td>
<td>3 min 51 sec</td>
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<tr>
<td>08</td>
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<td>13.10 sec</td>
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<td>09</td>
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<td>20</td>
<td>31.30 sec</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7.73 min</strong></td>
<td><strong>1.05 min</strong></td>
<td><strong>2.23 min</strong></td>
<td><strong>7.40 min</strong></td>
<td><strong>0.52 min</strong></td>
<td><strong>37.35 min</strong></td>
<td><strong>9.81 min</strong></td>
</tr>
</tbody>
</table>

Table: 4 (machine no: Rib)
8.1 Production & Efficiency Calculation of serial No : 4 (Rib)

Calculated production time: $8 \times 60 = 480$ min

Actual production time: $480 - 66.09 = 413.91$ min

$$\text{Efficiency} = \frac{\text{Actual production}}{\text{Calculated production}} \times 100\%$$

Now, Efficiency = \frac{413.91}{480} \times 100\% = 86.23\%

8.2 Total effect on efficiency in percentage (%) for specific causes (Rib-04):

Total effect on efficiency in percentage (%) for the causes of yarn break = 1.62%
Total effect on efficiency in percentage (%) for the causes of Loose feeding = 0.21%
Total effect on efficiency in percentage (%) for the causes of Quality check = 0.46%
Total effect on efficiency in percentage (%) for the causes of Unload fabric = 1.54%
Total effect on efficiency in percentage (%) for the causes of Counter stoppage = 0.16%
Total effect on efficiency in percentage (%) for the causes of Cleaning = 7.78%
Total effect on efficiency in percentage (%) for the causes of Cone change = 2.04%

Total effect on efficiency in percentage (%) = 13.81%
The above illustrated analysis 8.2 and figure 4 clearly indicate that the efficiency loss % of Rib machine is maximum for cleaning about 7%. That means the knitting machine is stopped more time for cleaning and unloading. From knitting faults view maximum efficiency loss is found for yarn break. It shows the minimum cause % is for loose feed.

**9.0 Data of Fleece Machine (SL 5)**

The observation was carried out for 8 hours on Fleece knitting machine (SL 05). Consumed time for each machine stoppage due to various causes was tabulated and the summary of the report is given below.

**Table -5: Causes of stoppage of Fleece knitting machine in 8 hours**

<table>
<thead>
<tr>
<th>Serial No</th>
<th>Yarn breakage</th>
<th>Loose Feeding</th>
<th>Quality check</th>
<th>Unload fabric</th>
<th>Counter stoppage</th>
<th>Cleaning</th>
<th>Cone change</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>15.25sec</td>
<td>10.33sec</td>
<td>05.51sec</td>
<td>4min 30sec</td>
<td>05.11sec</td>
<td>4min25sec</td>
<td>1min55sec</td>
</tr>
<tr>
<td>02</td>
<td>22.15sec</td>
<td>09.15sec</td>
<td>10.00sec</td>
<td>3min 15sec</td>
<td>04.50sec</td>
<td>5min11sec</td>
<td>1min45sec</td>
</tr>
<tr>
<td></td>
<td>Time</td>
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<td>Time</td>
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</tr>
<tr>
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</tr>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>14.01min</td>
<td>1.75min</td>
<td>1.56min</td>
<td>32.50min</td>
<td>0.66min</td>
<td>39.57min</td>
<td>14.55min</td>
</tr>
</tbody>
</table>

**Table : 5 (machine no:24 fleece)**
9.1 Production & Efficiency Calculation of serial No :5 (Fleece)

Calculated production time: 8x60= 480 min
Actual production time : 480-104.60 =375.40 min

Efficiency = \( \frac{\text{actual production time}}{\text{calculated production time}} \times 100\% \)

Now, Efficiency = \( \frac{375.40}{480} \times 100\% = 78.21\% \)

9.2 Total effect on efficiency in percentage (%) for specific causes (Fleece -05):

Total effect on efficiency in percentage (%) for the causes of yarn break =2.91 %
Total effect on efficiency in percentage (%) for the causes of Loose feeding =0.36 %
Total effect on efficiency in percentage (%) for the causes of Quality check =0.35%
Total effect on efficiency in percentage (%) for the causes of Unload fabric = 6.77%
Total effect on efficiency in percentage (%) for the causes of Counter stoppage = 0.14%
Total effect on efficiency in percentage (%) for the causes of Cleaning =8.24 %
Total effect on efficiency in percentage (%) for the causes of Cone change = 3.03%

Total effect on efficiency in percentage (%) = \( 21.79\% \)
Fig : 5 Efficiency loss for Fleece 05

The above illustrated analysis 9.2 and figure 5 it is observed that the efficiency loss % of Fleece machine is maximum for cleaning about 8%. That means the knitting machine is stopped more time for cleaning and unloading. From knitting faults view maximum efficiency loss is found for yarn break.

10.0 Data of Fleece (SL 6)

The observation was carried out for 8 hours on Fleece knitting machine (SL 06). Consumed time for each machine stoppage due to various causes was tabulated and the summary of the report is given below.

Table -6: Causes of stoppage of Fleece knitting machine in 8 hours

<table>
<thead>
<tr>
<th>Serial No</th>
<th>Yarn breakage</th>
<th>Loose Feeding</th>
<th>Quality check</th>
<th>Unload fabric</th>
<th>Counter stoppage</th>
<th>Cleaning</th>
<th>Cone change</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>16.55sec</td>
<td>15.00sec</td>
<td>10.54sec</td>
<td>5min 25sec</td>
<td>06.25sec</td>
<td>5min 29sec</td>
<td>1min 05sec</td>
</tr>
<tr>
<td>02</td>
<td>25.51sec</td>
<td>10.11sec</td>
<td>09.00sec</td>
<td>4min 15sec</td>
<td>05.45sec</td>
<td>4min 55sec</td>
<td>1min 55sec</td>
</tr>
<tr>
<td>03</td>
<td>20.33sec</td>
<td>08.45sec</td>
<td>13.52sec</td>
<td>3min 12sec</td>
<td>06.41sec</td>
<td>5min 45sec</td>
<td>2min 12sec</td>
</tr>
<tr>
<td>04</td>
<td>30.55sec</td>
<td>10.41sec</td>
<td>11.25sec</td>
<td>5min 10sec</td>
<td>04.10sec</td>
<td>5min 35sec</td>
<td>1min 40sec</td>
</tr>
<tr>
<td></td>
<td>Time 1</td>
<td>Time 2</td>
<td>Time 3</td>
<td>Time 4</td>
<td>Time 5</td>
<td>Time 6</td>
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<tr>
<td>05</td>
<td>25.12sec</td>
<td>11.55sec</td>
<td>10.17sec</td>
<td>05.55sec</td>
<td>4min55sec</td>
<td>1min35sec</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>23.51sec</td>
<td>12.42sec</td>
<td>10.50sec</td>
<td>04.16sec</td>
<td>4min45sec</td>
<td>1min22sec</td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>31.33sec</td>
<td>11.43sec</td>
<td>15.40sec</td>
<td>06.11sec</td>
<td>4min31sec</td>
<td>1min15sec</td>
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<tr>
<td>08</td>
<td>25.53sec</td>
<td>13.50sec</td>
<td>14.25sec</td>
<td>05.54sec</td>
<td>5min10sec</td>
<td>1min55sec</td>
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<tr>
<td>09</td>
<td>28.40sec</td>
<td>11.44sec</td>
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<td>06.00sec</td>
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<td>10</td>
<td>35.10sec</td>
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<td>11</td>
<td>32.23sec</td>
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<td>25</td>
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<td>34.54sec</td>
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<tr>
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<td>41.40sec</td>
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<tr>
<td>Total</td>
<td>18.60min</td>
<td>2.46min</td>
<td>1.58min</td>
<td>18.03min</td>
<td>0.82min</td>
<td>41.08min</td>
<td>15.98min</td>
</tr>
</tbody>
</table>

Table: 6 (machine no: 43 ; fleece)
10.1 Production & Efficiency Calculation of serial No: 6 (Fleece)

Calculated production time: 8x60 = 480 min

Actual production time: 480-98.55 = 381.45 min

Efficiency = \( \frac{actual\ production}{calculated\ production} \times 100\% \)

Now, Efficiency = \( \frac{381.45}{480} \times 100\% = 79.46\% \)

10.2 Total effect on efficiency in percentage (%) for specific causes (Fleece-06):

Total effect on efficiency in percentage (%) for the causes of yarn break = 3.87%
Total effect on efficiency in percentage (%) for the causes of Loose feeding = 0.51%
Total effect on efficiency in percentage (%) for the causes of Quality check = 0.33%
Total effect on efficiency in percentage (%) for the causes of Unload fabric = 3.75%
Total effect on efficiency in percentage (%) for the causes of Counter stoppage = 0.19%
Total effect on efficiency in percentage (%) for the causes of Cleaning = 8.55%
Total effect on efficiency in percentage (%) for the causes of Cone change = 3.33%

Total effect on efficiency in percentage (%) = 20.53%
The above illustrated analysis 10.2 and figure 6 clearly indicate that the efficiency loss % of Fleece machine is maximum for cleaning about 8.55%. That means the knitting machine is stopped more time for cleaning and yarn break. Minimum efficiency loss % is found in Quality check and counter stoppage.

11.0 Data of Interlock Machine(SL 7)

Observation was carried out for 8 hours on Interlock knitting machine (SL 07). Consumed time for each machine stoppage due to various causes was tabulated and the summary of the report is given below.

Table -7: Causes of stoppage of Interlock knitting machine in 8 hours

<table>
<thead>
<tr>
<th>Serial No</th>
<th>Yarn breakage</th>
<th>Feeding slippage for dust</th>
<th>Quality check</th>
<th>Unload fabric</th>
<th>Counter stoppage</th>
<th>Cleaning</th>
<th>Cone change</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>10.5 sec</td>
<td>10.30 sec</td>
<td>10.50 sec</td>
<td>4 min</td>
<td>0.19 sec</td>
<td>5 min 20 sec</td>
<td>1 min 10 sec</td>
</tr>
<tr>
<td>02</td>
<td>20.11 sec</td>
<td>08.12 sec</td>
<td>15.00 sec</td>
<td>3 min</td>
<td>0.33 sec</td>
<td>4 min 10 sec</td>
<td>1 min 50 sec</td>
</tr>
<tr>
<td>03</td>
<td>18.03 sec</td>
<td>05.50 sec</td>
<td>18.50 sec</td>
<td>3 min</td>
<td>0.19 sec</td>
<td>5 min 50 sec</td>
<td>2 min 02 sec</td>
</tr>
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<tr>
<td><strong>Table 7</strong>: (Machine SL No: 7, interlock)</td>
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</tr>
</tbody>
</table>

### 11.1 Production & Efficiency Calculation of serial No:7 (interlock)

Calculated production time: 8x60= 480 min

Actual production time: 480-67.27= 412.7 min

Efficiency = \( \frac{\text{Actual production time}}{\text{Calculated production time}} \times 100\% \)

Now, Efficiency= \( \frac{412.7}{480} \times 100\% = 86.29\% \)
11.2 Total effect on efficiency in percentage (%) for specific causes (Interlock-07):

Total effect on efficiency in percentage (%) for the causes of yarn break = 1.737%
Total effect on efficiency in percentage (%) for the causes of Loose feeding = 0.222%
Total effect on efficiency in percentage (%) for the causes of Quality check = 0.414%
Total effect on efficiency in percentage (%) for the causes of Unload fabric = 2.083%
Total effect on efficiency in percentage (%) for the causes of Counter stoppage = 0.108%
Total effect on efficiency in percentage (%) for the causes of Cleaning = 7.572%
Total effect on efficiency in percentage (%) for the causes of Cone change = 1.87%

Total effect on efficiency in percentage (%) = 13.71%

Fig : 3 Efficiency loss for Interlock 07

The above illustrated analysis 11.2 and figure 7 clearly indicate that the efficiency loss % of single jersey machine is maximum for cleaning about 7%. That means the knitting machine is
stopped more time for cleaning and unloading. From knitting faults view maximum efficiency loss is found for yarn break. Minimum efficiency loss is found on counter stoppage and loose feeding.

12.0 Data of Interlock Machine (SL 8)

The observation was carried out for 8 hours on Interlock knitting machine (SL 08). Consumed time for each machine stoppage due to various causes was tabulated and the summary of the report is given below.

Table -8: Causes of stoppage of Interlock knitting machine in 8 hours

<table>
<thead>
<tr>
<th>Serial No</th>
<th>Yarn breakage</th>
<th>Feeding slippage for dust</th>
<th>Quality check</th>
<th>Unload fabric</th>
<th>Counter stoppage</th>
<th>Cleaning</th>
<th>Cone change</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>11.51sec</td>
<td>11.33sec</td>
<td>10.52sec</td>
<td>5min</td>
<td>03.15sec</td>
<td>4min22sec</td>
<td>1min54sec</td>
</tr>
<tr>
<td>02</td>
<td>21.10sec</td>
<td>10.00sec</td>
<td>12.00sec</td>
<td>2min</td>
<td>02.55sec</td>
<td>5min15sec</td>
<td>2min08sec</td>
</tr>
<tr>
<td>03</td>
<td>19.11sec</td>
<td>06.44sec</td>
<td>15.50sec</td>
<td>2min</td>
<td>02.45sec</td>
<td>4min52sec</td>
<td>1min56sec</td>
</tr>
<tr>
<td>04</td>
<td>21.50sec</td>
<td>11.45sec</td>
<td>13.44sec</td>
<td>1min</td>
<td>04.12sec</td>
<td>5min35sec</td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>31.11sec</td>
<td>09.50sec</td>
<td>14.05sec</td>
<td></td>
<td>04.01sec</td>
<td>5min18sec</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>19.50sec</td>
<td>11.46sec</td>
<td>13.00sec</td>
<td></td>
<td>03.10sec</td>
<td>2min52sec</td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>32.33sec</td>
<td>10.55sec</td>
<td>16.12sec</td>
<td></td>
<td>04.35sec</td>
<td>3min55sec</td>
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<tr>
<td>08</td>
<td>20.50sec</td>
<td>12.33sec</td>
<td>14.11sec</td>
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<td>04.50sec</td>
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<td>25.40sec</td>
<td>09.50sec</td>
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<td>03.00sec</td>
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<td>34.10sec</td>
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<tr>
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<td>35.55sec</td>
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<td><strong>Total</strong></td>
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<td><strong>1.54min</strong></td>
<td><strong>1.81min</strong></td>
<td><strong>10 min</strong></td>
<td><strong>0.53min</strong></td>
<td><strong>37.95min</strong></td>
<td><strong>5.96min</strong></td>
</tr>
</tbody>
</table>

**Table : 8 (machine no:14 ; interlock)**

12.1 Production & Efficiency Calculation of serial No :8 (Interlock)

Calculated production time: 8 x 60 = 480 min

Total time loss for those causes : 69.37

Actual production time : 480 - 69.37 = 410.63 min

\[
\text{Time Efficiency} = \frac{\text{actual Production time}}{\text{calculated production time}} \times 100\%
\]

\[
= \frac{410.63}{480} \times 100\% = 85.54\%
\]

12.2 Total effect on efficiency in percentage (%) for specific causes (Interlock -08):

Total effect on efficiency in percentage (%) for the causes of yarn break = 2.41%

Total effect on efficiency in percentage (%) for the causes of Loose feeding = 0.32%

Total effect on efficiency in percentage (%) for the causes of Quality check = 0.37%

Total effect on efficiency in percentage (%) for the causes of Unload fabric = 2.08%

Total effect on efficiency in percentage (%) for the causes of Counter stoppage= 0.11%

Total effect on efficiency in percentage (%) for the causes of Cleaning = 7.90%

Total effect on efficiency in percentage (%) for the causes of Cone change = 1.24%

Total effect on efficiency in percentage (%) = 14.43 %

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The above illustrated analysis 12.2 and figure 8 clearly indicate that the efficiency loss % of single jersey machine is maximum for cleaning about 7.9%. That means the knitting machine is stopped more time for cleaning and cone change.
13.0 Particular causes % for S/J; Interlock; Fleece; Rib Machine:

Yarn Break percentage (%):

Table 9: Comparison of loss of efficiency of different types knitting machines due to yarn breakages.

<table>
<thead>
<tr>
<th>Sl .No</th>
<th>Name of machine</th>
<th>Efficiency %</th>
<th>Machine 1</th>
<th>Machine 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>S/J</td>
<td>2.70%</td>
<td>2.18%</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Rib</td>
<td>1.82%</td>
<td>1.62%</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Fleece</td>
<td>2.91%</td>
<td>3.87%</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Interlock</td>
<td>1.74%</td>
<td>2.41%</td>
<td></td>
</tr>
</tbody>
</table>

From above illustrated analysis and figure 9 it is observed that the yarn breakage percentage is maximum for fleece machine in compare with the other. The cause behind it may be more
number of feeder and used three thread yarn for one course. In Single Jersey machine the yarn breakage rate of second one is high than first one. Because of higher feeders and Dia & gauge .In Rib machine the yarn break percentage is not so much difference between two machines. Because of faulty yarn it may break more in first machine than second machine. In first rib machine the break percentage is 1.82% and the second one is 1.62%. In fleece it is observed that the second machine yarn breakage is more than first one. In interlock it is observed that between two interlock machines second one breaks more yarn than first one and the percentage is 1.74% and 2.41%. It may occur for faulty yarn.

Table 10: Comparison of loss of efficiency of different types knitting machines due to loose Feeding.

<table>
<thead>
<tr>
<th>Sl .No</th>
<th>Name of machine</th>
<th>Efficiency %</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Machine 1</td>
<td>Machine 2</td>
</tr>
<tr>
<td>01</td>
<td>S/J</td>
<td>0.15%</td>
<td>0.27%</td>
</tr>
<tr>
<td>02</td>
<td>Rib</td>
<td>0.21%</td>
<td>0.21%</td>
</tr>
<tr>
<td>03</td>
<td>Fleece</td>
<td>0.36%</td>
<td>0.51%</td>
</tr>
<tr>
<td>04</td>
<td>Interlock</td>
<td>0.22%</td>
<td>0.32%</td>
</tr>
</tbody>
</table>

Table-10

Fig :10
From upper fig. no 10 it is found that the maximum efficiency loss due to loss feeding is held in fleece machine as compared with the other. In single jersey the second machine give more loss percentage of loose feeding than the first one. In rib the percentage between two machines is same. In fleece and interlock the second machine give more loss percentage of loose feeding than the first one. Loose feeding is occurring due to the dust. The dust block the sensor so that the sensor are not detected correctly then the machine is stopped.

Table 11: Comparison of loss of efficiency of different types knitting machines due to Quality check.

<table>
<thead>
<tr>
<th>Sl .No</th>
<th>Name of machine</th>
<th>Efficiency %</th>
<th>Machine 1</th>
<th>Machine 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>S/J</td>
<td>0.61%</td>
<td>0.51%</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Rib</td>
<td>0.42%</td>
<td>0.46%</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Fleece</td>
<td>0.35%</td>
<td>0.33%</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Interlock</td>
<td>0.41%</td>
<td>0.46%</td>
<td></td>
</tr>
</tbody>
</table>

Fig :11

In above illustrated table 11 and fig. no 11 clearly indicate that due to quality check the efficiency loss percentage is maximum for single jersey machine. One of the reason of it may be
higher rpm and higher machine gauge. So the possibility of needle breakage is more in single jersey. It is also observed that in rib and interlock the second machine give more efficiency loss percentage due to quality check than the first one. Quality check is a regular work when the machine is on production. It helps to produce fault free fabric. The loss of efficiency depends on worker and the type of fault.

Table 12: Comparison of loss of efficiency of different types knitting machines due to unload fabric.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Name of machine</th>
<th>Efficiency %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Machine 1</td>
</tr>
<tr>
<td>01</td>
<td>S/J</td>
<td>6.25%</td>
</tr>
<tr>
<td>02</td>
<td>Rib</td>
<td>2.38%</td>
</tr>
<tr>
<td>03</td>
<td>Fleece</td>
<td>3.75%</td>
</tr>
<tr>
<td>04</td>
<td>Interlock</td>
<td>2.08%</td>
</tr>
</tbody>
</table>

Table-12

![Fig:12](image_url)

From table12 and fig. no 12 it is observed that more time is required for unloading in single jersey machine than the others. Because the production capacity is high in single jersey machine. So efficiency loss % is more in single jersey machine due to unloading. In rib machine, because
of low amount of fabric unload the loss percentage is much lower than single jersey. In fleece and interlock machine the loss percentages are same between specific two fleece and interlock machines.

**Table 13: Comparison of loss of efficiency of different types knitting machines due to counter stoppages.**

<table>
<thead>
<tr>
<th>Sl .No</th>
<th>Name of machine</th>
<th>Efficiency %</th>
<th>Machine 1</th>
<th>Machine 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>S/J</td>
<td>0.17%</td>
<td>0.19%</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Rib</td>
<td>0.16%</td>
<td>0.16%</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Fleece</td>
<td>0.14%</td>
<td>0.15%</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Interlock</td>
<td>0.11%</td>
<td>0.11%</td>
<td></td>
</tr>
</tbody>
</table>

**Table-13**

![Graph](image)

**Fig :13**

From table 13 and fig. no 13 it is observed that the efficient loss % is maximum in single jersey machine due to counter stoppage than the others. The counter is set by operator and when the countdown is over then the machine is automatically stopped. One of the reason of it is that the
rpm of the single jersey machine is higher than the others. In rib and interlock it is observed that the percentage is same for two particulate rib machine and interlock machine.

Table 14: Comparison of loss of efficiency of different types knitting machines due to cleaning.

<table>
<thead>
<tr>
<th>SI .No</th>
<th>Name of machine</th>
<th>Efficiency %</th>
<th>Machine 1</th>
<th>Machine 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>S/J</td>
<td>8.12%</td>
<td>7.63%</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Rib</td>
<td>7.78%</td>
<td>7.78%</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Fleece</td>
<td>8.24%</td>
<td>8.55%</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Interlock</td>
<td>7.57%</td>
<td>7.90%</td>
<td></td>
</tr>
</tbody>
</table>

In above table 14 and fig. no 14 It is found that the efficiency loss percentage due to cleaning is maximum in Fleece machine that the others. This is because lower count used in fleece machine. So the possibility of dust formation is higher in that machine. Cleaning is a regular activity when the machine is on production. It depends on worker skill and amount of dust.
Table 15: Comparison of loss of efficiency of different types knitting machines due to cone change.

<table>
<thead>
<tr>
<th>Sl .No</th>
<th>Name of machine</th>
<th>Efficiency %</th>
<th>Machine 1</th>
<th>Machine 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>S/J</td>
<td>2.54%</td>
<td>3.51%</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Rib</td>
<td>2.11%</td>
<td>2.04%</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>Fleece</td>
<td>3.03%</td>
<td>3.32%</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Interlock</td>
<td>1.87%</td>
<td>1.24%</td>
<td></td>
</tr>
</tbody>
</table>

In above table 15 and fig. no 15 it is observed that the efficiency loss % due to cone change is maximum for single jersey and fleece machine. One of the reason behind it is the higher number of feeder in single jersey and fleece machine. Cone change depends on number of feeder in machine, size of cone and also amount of fault presence in cone.

**Fig :15**

![Graph showing efficiency loss for different machines](image)

**Table -15**

**14.0 Percentages (%) of total efficiency loss for S/J; Interlock; Fleece and Rib Machine:**

<table>
<thead>
<tr>
<th>Sl .No</th>
<th>Name of machine</th>
<th>Total Efficiency loss %</th>
<th>Machine 1</th>
<th>Machine 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>S/J</td>
<td>20.54%</td>
<td>20.74%</td>
<td></td>
</tr>
<tr>
<td>02</td>
<td>Rib</td>
<td>14.89%</td>
<td>13.81%</td>
<td></td>
</tr>
</tbody>
</table>
In above table 16 and fig. no 16 it is observed that efficiency loss is maximum for fleece machine as compared with the other ones. The cause behind it may be the higher number feeder required for three thread fleece and more cleaning time. It is also found that the efficiency loss for single jersey is also higher than rib and interlock machine but lower than fleece machine. The variation of efficiency loss is because of those causes that are observed from particular machine. E.g. yarn break, cleaning etc.
6.0 CONCLUSION:
From the above analysis and calculation it is found that 11 hours per shift (1 shift = 8 hours) are wastage due to machine stoppage. If we calculate the production in kg, this is about 66 kg/shift for single jersey fabric and 20 kg/shift for double jersey fabric. In economic point of view this is a huge loss for an industry. By increasing m/c speed, improving operator skill, developing suctioning system, production can be increased to overcome the loss but it has to make sure that excess tension is not imposed on yarn. Production is also related to the number of feeders and machine gauge. If the number of feeders and machine gauges are increased then production can be increased. Excess machine stoppage can be eliminate by applying yarn supply through plastic tube that eliminates the possibilities of damage, using yarn feed control device and using auto lints removal.
Reference:


6. Efficiency Losses Calculation and Identify Causes of Losses of Circular Knitting Machine during Knit Fabric Production
   Md.Solaiman, Elias Khalil ;Mostafizur Rahman; Joy Sarkar