## Formulas for the determination of production in length:

$$\text{1. Fabric length} = \frac{\text{Course/Minute}}{\text{Course/cm}}$$

**2. Course/Min** = No. of feeder X Cylinder speed

**3. Stitch density** = Course/cm X Wales/cm

$$\text{4. Fabric width} = \frac{\text{No. of Wales}}{\text{Wales/cm}}$$

$$\frac{\text{No. of Needle}}{\text{Wales/cm}} = \frac{\pi \text{ X Cylinder Dia X Gauge}}{\text{Wales/cm}}$$

## Formulas for the determination of production in weight:

$$\text{1. Fabric weight} = \frac{\text{Course/min X Yarn length per course}}{\text{Yarn count}}$$

**2. Yarn length per course** = Total needle no. of machine X Loop length

**3. Total needle no. m/c** = π X Cylinder dia X Gauge = πDG

**Some mathematical problems and its solutions**

**1. Calculate the production per day in kg of a plain single jersey knitted at 30 inch diameter, 24 gauge circular machine having 96 feeders and 0.25 cm stitch length produced by 30/1's. The machine operates at 25 rpm at 70% efficiency.**

**Solution:**
Here data given,

- Machine dia = 30"
- Machine gauge = 24
- No. of feeders = 96
- Stitch length = 0.25 cm
- Yarn count = 30/1'
- Machine rpm = 25
- Efficiency = 70%
- Now, length of yarn in a loop = 0.25 cm

**So, Length of yarn in full course** = π X G X D X 0.25 cm

= π X 24 X 30 X 0.25 cm [0.25 S.L]

**So, Length of yarn used in a minute for producing course,**

= 0.25 X π X 24 X 30 X 96 X 25 cm [25 RPM]

**We get, Production per day at 70% efficiency,**

$$= \frac{0.25 \times \pi \times 24 \times 30 \times 96 \times 25 \times 60 \times 24 \times 70}{2.54 \times 36 \times 840 \times 30 \times 100 \times 2.204} \quad \left[ N_e = \frac{L \times w}{W \times l} \right]$$

= 269.85 kg (Ans)

**Or,**

$$\text{Production in weight} = \frac{\text{RPM of cylinder X No. of feeder X } \pi \text{ X Cylinder dia (inch)}}{1000 \text{ X } 1000} \text{ X } \frac{\text{Gauge X Loop length (mm) X tex X 60 X 24 X Efficiency}}{1000}$$

$$= \frac{25 \text{ X } 96 \text{ X } \pi \text{ X } 30 \text{ X } 24 \text{ X } 0.25 \text{ X } 10 \text{ X } 590.5/30 \text{ X } 60 \text{ X } 24 \text{ X } 0.70}{1000 \text{ X } 1000 \text{ X } 1000}$$

= 269 kg/day **(ANS)**

**2. Calculate the production of a single jersey circular knitting m/c per shift from the following data (assume others parameter if necessary) –**
Here,

- Cylinder dia = 30”
- Cylinder speed = 20 rpm
- No. of feeder = 36
- No. of course per inch = 30
- Machine eff = 80%

**3. Determine the no. of course per cm of a fabric from the following data. This fabric is produced 1152 m per shift in a single jersey circular knitting machine.**

Here,

- Knitting m/c speed = 20 rpm
- No. of feeder = 48
- Machine efficiency = 75%

**Solution:**

Given,

- Knitting m/c speed = 20 rpm

- No. of feeder = 48
- Machine efficiency = 75%
- Length of produced fabric per shift = 1152 m
- No. of course per cm =?
  We know,

  **Fabric production per shift,**

$$= \frac{\text{Course per min}}{\text{Course per cm}} \text{ X 60 X 8 X Efficiency}$$

$$= \frac{\text{No. of feeder X Machine speed X 60 X 8}}{\text{Course per cm}} \text{ X Efficiency}$$

$$\textbf{Or}, 1152 \text{ X } 100 = \frac{48 \text{ X } 20 \text{ X } 60 \text{ X } 8}{\text{Course/cm}} \text{ X } \frac{75}{100}$$

$$\textbf{Or}, \text{Course/cm} = \frac{48 \text{ X } 20 \text{ X } 60 \text{ X } 8 \text{ X } 75}{1152 \text{ X } 100 \text{ X } 100} = 3 \textbf{ (ANS)}$$

**Example 01:**
Find out the production per shift for single jersey and rib from the following data:

**For single jersey,**

Fabric width = 53 ", GSM = 150, Yarn count (Ne) = 26's
Stitch length = 2.85 mm, Cylinder Dia(D) = 25", Cylinder Gauge(G) = 24
No. of feeder = 75, R.P.M.of cyl.= 25, Time =8 hrs, Effi.= 80%

**Solution:**

**Production/8hrs,**

$$\frac{\pi DG \text{ X S.L (mm) X No. of feeder X RPM X 60 X 8 X Efficiency}}{}$$

$$= \frac{\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots}{2.54 \times 36 \times 840 \times 26 \times 2.2046}\ \text{kg}$$

$$= \frac{3.1416 \times 25 \times 24 \times 75 \times 25 \times 60 \times 0.80}{2.54 \times 36 \times 840 \times 26 \times 2.2046}\ \text{kg}$$

= 87.85 kg **(Ans)**

**For Rib,**

Fabric width = 41", GSM = 460 , Yarn count,Ne = 24S
Stitch length = 2.90 mm, Cylinder dia,D= 32", Cylinder Gauge,G= 18
No. of feeder = 62, R.P.M.of cyl.= 15, Time =8 hrs, Effi.= 80%

**Production/8hrs,**

$$= \frac{\pi DG \times S.L\ (mm) \times \text{No. of feeder} \times RPM \times 60 \times 8 \times \text{Efficiency} \times \text{Feeder/course (kg)}}{2.54 \times 36 \times 840 \times Ne \times 2.2046}$$

$$= \frac{3.1416 \times 32 \times 18 \times 2.90 \times 62 \times 15 \times 60 \times 8 \times 0.80}{2.54 \times 36 \times 840 \times Ne \times 2.2046} \times 2\ \text{kg}$$

= 92.22 kg **(Ans)**

**Example 02:**

Calculate nominal production of a single jersey-knitting machine per hour from the data given:

- Machine Gauge = 24
- Machine Dia = 30 inches
- Number of Feeders = 90
- Machine RPM = 26
- Yarn Count = 24
- Stitch length = 4 mm
- Efficiency = 85%

**Solution:**

**Step one**

First we will calculate number of needles and number of stitches produced in one revolution. This would help us in calculating the total length of yarn consumed in one revolution.

**Number of needles** = Machine dia X Gauge X p (3.14)

= 30 X 24 X 3.14

= 2260 (Exact 2260.8 but needles are always in even number so we will take nearest even figure)

**Number of stitches produced in revolution**

Every needle is making one stitch on every feeder because machine is producing single jersey fabric (full knit fabric).

**Number of stitches produced in one revolution** = Number of needles X Number of feeders

= 2260 X 90

= 203400

This machine is making 203400 stitches in one revolution.

**Step Two**

Length of stitch is 04 mm (stitch length is always calculated in metric system)

From this we can calculate yarn consumption in yards in one hour

**Yarn Consumption (in yards) in one hour,**

$$= \frac{\text{Number of stitches X length of (mm) X RPM X60 (minutes)}}{\text{1000(to convert mm into meters)}}$$

$$= \frac{203400 \text{ X } 4 \text{ X } 26 \text{ X } 60}{1000}$$

= 1269216 meters or

= 1388015 yards

**Step Three**

In previous step we calculated quantity of yarn consumed in yards. We can easily calculate weight of this yarn while its count is known (see example 03).

**Weight of cotton yarn,**

$$= \frac{\text{Length of yarn}}{\text{Count X 840}}$$

$$= \frac{1388015}{\text{Count X 840}}$$

= 68.85 pounds or

= 31.23 Kilo grams

Efficiency 85% = 26.55 Kilo grams

Answer: This machine can produce 26.55 Kgs fabric in one hour at 85 % efficiency

**Essential Formula for Knitting:**

**WPI:** Wales per inch is called WPI.
**CPI:** Course per inch is called CPI.
**GSM:** Grams per square meter of the fabric are called GSM.

**Needle calculation:**

- Single jersey circular knitting machine needle = ∏DG

- Rib/Inter lock /Double jersey circular knitting machine needle = ∏DG×2 (two needle bed is here)
- Single bed flat knitting m/c's needle = width× gauge
- GSM = {WPI× CPI × (39.37)2×stitch length (mm) ×Tex /1000× 1000} g/m2
- Stitch density = (WPI × CPI) $inch^2$ = (WPC ×CPC) $cm^2$
- No of sinker = No of needle
- No Wales =No of needle
- No of course = No of feeders =No of yarn (per revolution of cylinder)
- Course per minutes = No of feeders ×cylinder rpm
- Course length = yarn required for each course. = No of needle × stitch length
  *** V bed flat knitting m/c's needle = 2× width× gauge

  Ne= 590.5 Tex
  Here,
  D = cylinder diameter ,G = Machine gauge ,Needle pitch = 1/G.

  *** **Fabric width** = wale spacing ×Total no of Wales
  = (1/WPI ×No of Needles) inch
  = (No of Needles/WPI× 39.37) meter

  *** **For single jersey fabric** = (∏DG/WPI×39.37) meter (open width)
  = (∏DG/WPI×39.37) meter/2(Folded/Tubular width)

  *** **For double jersey fabric** = (2 × ∏DG/WPI×39.37) meter (open width)
  = (2×∏DG/WPI×39.37) meter/2(Folded/Tubular width).

  *** **Fabric Length** = Course spacing ×Total course pr hour
  = {(Feeder× cylinder rpm× 60)/CPI} inch/hour
  = {(Feeder× cylinder rpm× 60)/CPI ×39.37} m/hour