



# Participant Handbook

Sector  
**Rubber Industry**

Sub-Sector  
**Tyre & Non-Tyre**

Occupation  
**Extrusion**

Reference ID: **RSC/Q2601, Version 1.0**  
**NSQF Level 4**



**Rubber Extruder  
Operator**

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**Shri Narendra Modi**  
Prime Minister of India

“ Skilling is building a better India.  
If we have to move India towards  
development then Skill Development  
should be our mission. ”



## Certificate

### COMPLIANCE TO QUALIFICATION PACK – NATIONAL OCCUPATIONAL STANDARDS

is hereby issued by the  
RUBBER SKILL DEVELOPMENT COUNCIL  
for

### SKILLING CONTENT : PARTICIPANT HANDBOOK

Complying to National Occupational Standards of  
Job Role/ Qualification Pack: 'Rubber Extruder Operator' QP No. 'RSC/Q26o1 NSQF Level 4'

Date of Issuance: May 17<sup>th</sup>, 2021  
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\*Valid up to the next review date of the Qualification Pack or the  
'Valid up to' date mentioned above (whichever is earlier)

  
Authorised Signatory  
(Rubber Skill Development Council)

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We are also grateful to the partner organizations for their efforts in reviewing and endorsing this participant handbook.

## About this book

The participant handbook for 'Rubber Extruder Operator' is designed for participants to enable them to get trained and upgraded for the knowledge and basic skills of 'Rubber Extruder Operator' in 'Rubber Industry' sector. All the aspects of skills required by the participant, are covered in this handbook. This participant handbook is designed to enable training for the specific Qualification Pack (QP) drafted by Rubber Skill Development Council (RSDC) and ratified by National Skill Development Corporation (NSDC). It covers following National Occupational Standard (NOS) across Unit/s:

- RSC/N2612 - Perform pre rubber extrusion activities
- RSC/N2613 - Perform rubber extrusion operation
- RSC/N2614 - Undertake post rubber extrusion activities
- RSC/N5001 - Carry out housekeeping in rubber product manufacturing
- RSC/N5002 - Carry out reporting and documentation
- RSC/N5003 - Carry out quality checks
- RSC/N5004 - Carry out problem identification and escalation
- RSC/N5007 - Carry out health and safety

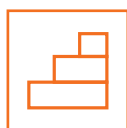
This handbook is designed to provide the necessary knowledge and skill to the participants to carry out their duties in an organized and disciplined manner by following safe working practices.

Key Learning Objectives for the specific NOS mark the beginning of the Unit/s for that NOS. The symbols used in this book are described below.

## Symbols Used



Key Learning  
Outcomes



Steps



Time



Tips



Notes



Unit  
Objectives



Activity



Exercise



Summary

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# 1. Introduction to Rubber

Unit 1.1 – Introduction to Rubber Industry

Unit 1.2 – Extrusion Basics

Unit 1.3 – Equipment used in Extruding

Unit 1.4 – Job Role of a Extruder Operator



## Key Learning Outcomes

**At the end of this module, you will be able to:**

1. Discuss about rubber industry
2. Explain different sources of rubber
3. Discuss about major Indian Rubber Associations
4. Explain the extrusion terminology
5. Explain the basics of extrusion process
6. Define material used in extrusion
7. Explain equipment used for extrusion
8. Define Roles and responsibilities for extruder operator

## UNIT 1.1: Introduction to Rubber Industry

### Unit Objectives

**At the end of this unit, you will be able to:**

1. Discuss rubber and rubber industry
2. Define types of rubber
3. Explain about rubber manufacturing processes
4. Explain different uses of rubber
5. Discuss about various rubber bodies and associations in India

### 1.1.1 The Rubber

Rubber is a polymer material, which has elastic properties. It is also called as 'caoutchouc'. It normally has long chain molecules known as "polymers". Rubber being elastic, is also called "elastomers". Products made from rubber have a flexible and stable – three-dimensional chemical structure and are able to withstand higher force and large deformations. For example: the material can be stretched repeatedly to at least twice of its original length and upon immediate release of the stress, will return with force, approximately to its original length. Under load, the product should not show creep or relaxation. Besides these properties, the modulus of rubber ranges from hundred to ten thousand times lower, as compared to other solid materials like steel, plastics and ceramics. This combination of unique properties, gives rubber its specific applications like seals, shock absorbers and tyres.

Based on the source of raw material, there are two kinds of rubber, Natural Rubber (NR) and Synthetic Rubber (SR). However, there is third type of rubber - reclaimed rubber, which is produced by recycling scrap rubber.



*Fig. 1.1.1. Rubber*

#### **Natural rubber**

Natural rubber is mainly harvested from rubber plants. There are many plant species that generate natural rubber and there are many other plants that contain rubber latex. For quality and economic considerations, rubber plant is a major source of natural rubber. 'Latex' is a sticky, milky white, liquid material. The process used for extracting latex is called 'tapping'.



Fig. 1.1.2. Rubber Plant



Fig. 1.1.3. Collection of rubber by tapping process

This latex is further processed for making rubber, which can be used for making some useable products. Latex is processed in following ways –

1. Sheets
2. Creep
3. Block rubber
4. Preserved latex concentrates

Most of the natural rubber is sold in the form of sheets, creep and block rubber.

### Sheets

This form is most easy to produce; hence it is the most saleable form of natural rubber. There are 2 types of sheets –

1. Ribbed Smoked Sheets (RSS)
2. Air Dried Sheets (ADS)

Out of above types, Ribbed Smoked Sheets are more common in market. There are five grades of Ribbed Smoked Sheets based on quality. These grades are established by international rubber quality and packing conference. Only completely dried sheets are allowed to be sold in this category. Based on different conditions, these ratings are called as RSS1, RSS2, RSS3, RSS4 and RSS5



Fig. 1.1.4. Rubber sheets

### Creep

Creeps are derived from coagulated latex / field coagulum after getting rolled many times between rollers and then dried in Air. There are many types of creeps, namely – pale latex creeps, estate brown creeps, Thin brown creeps, Thick blanket creeps, Flat blanket creeps, standard flat bark crepe and pure smoked blanket crepe.

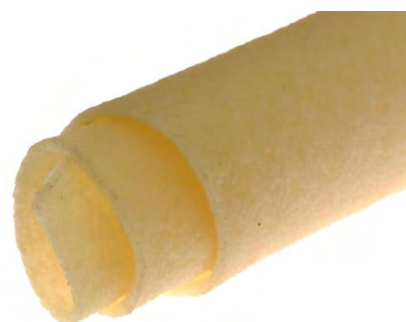


Fig. 1.1.5. Rubber creps

### Technically specialized Natural Rubber

Natural dried rubber is graded based on technical specification. It was initially proposed by ISO (International Standard Organization) and then Malaysia adopted it in 1965. Later on all natural rubber producing countries adopted the system. In this system, two letters of the countries name used for making code. For ex - Indian natural rubber is coded as ISNR (Indian Standard Natural Rubber)



Fig. 1.1.6. TSR rubber

### Synthetic Rubber

As the name suggest, it is man made rubber, which is derived from petroleum, coal, oil, natural gas and acetylene. It has more than 10 major classes, many of these are copolymers i.e. polymers consisting more than one monomer. Initially, Styrene-Butadiene copolymers (SBR) synthetic rubbers were invented. Which is one of the widely used elastomer. Synthetic rubber is used as a replacement for natural rubber in many cases, especially when improved material properties are needed. Common used synthetic rubber are –

1. Emulsion Styrene Butadiene (ESBR)
2. Butadiene Rubber (BR)
3. Solution Styrene Butadiene (SSBR)
4. Isobutylene Isoprene Butyl (IIR)
5. Acrylonitrile Butadiene (NBR)
6. Ethylene Propylene Diene Monomer (EPDM)



Fig. 1.1.7. Synthetic rubber

### Used or Reclaimed Rubber

Used or reclaimed rubber is the product, which is recovered from the processing of vulcanized scrap rubber tyres, tubes and miscellaneous waste rubber goods. The Process includes use of heat and chemical agents. The process also includes heavy mechanical working. This reclaimed rubber has plasticity which is near to the original plasticity. This rubber can be compounded, processed and re-vulcanized as fresh rubber. During the process of reclamation the molecular weight of the elastomeric component is substantially reduced.



Fig. 1.1.8. Reclaimed rubber

## 1.1.2 Uses of rubber

Rubber is a widely used product now a days. It is used in automobiles, household and industrial applications. Some of the most common uses are as following -

- Tyres and Tubes - Automobile and agriculture tyres and tubes are the largest consumers of rubber. This category consume around three fourth of total rubber consumption.
- 'Under the bonnet' products for automobile - It includes, Door and window profiles, noses, bells, matting, flooring and dampeners (anti-vibration mounts).
- Conveyor Belt – for various industrial use.
- Hoses and pipes – for air and water circulation.
- Medical equipment - Gloves (medical, household and industrial), toy balloons, rubber bands, etc.
- Adhesives – Many manufacturing industries and products also use rubber product as adhesives. It is mostly used in paper and the carpet industry.
- Textile industry – Rubber is also widely used in textile industry.
- Shock absorbers – Impact absorbing property of rubber is very useful in shock absorber application.
- Machine mounting pads – it is widely used as a machine mounting mount, which helps in reducing vibration transfer to floor from machine.



Fig. 1.1.9. Rubber products

### 1.1.3 Rubber industry

Initially rubber industry started in South America during 19<sup>th</sup> century. Where it was restricted for a long time from export. In 1876, English brought it to India, Sri Lanka and other parts of Asian countries. Initially rubber trees were planted in Kolkata and then later it was grown in coastal areas of Kerala, Tamil Nadu and Karnataka.

Rubber products manufacturing started in India, in the year 1920. Now, rubber industry is one of the key industries of the Indian economy.

Following are some of the facts on rubber industries –

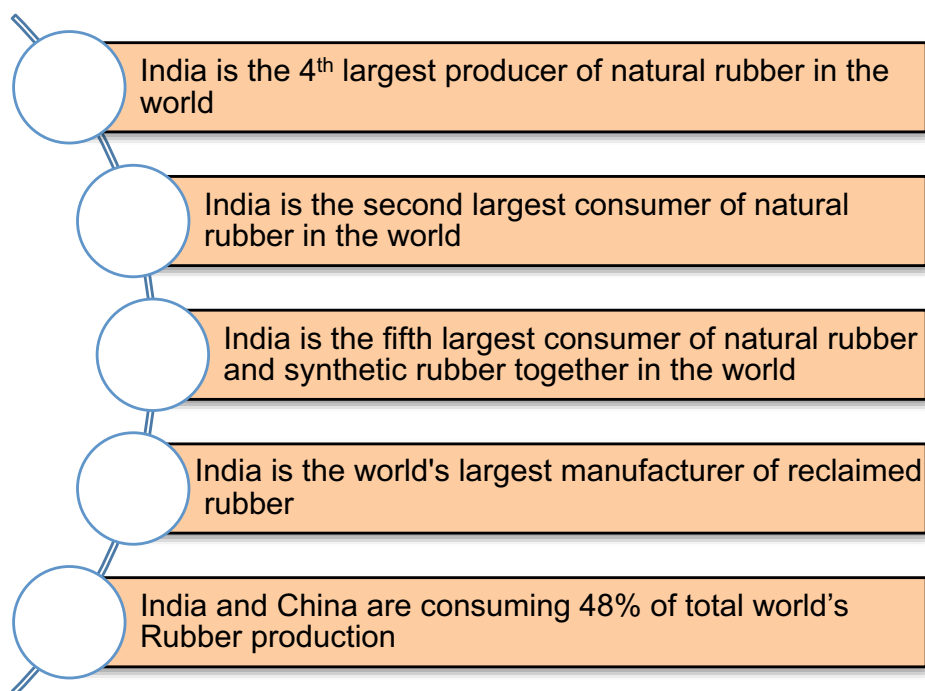


Fig. 1.1.10. Rubber industry facts

#### Overview of India Rubber Industry

India produces approx. 7 Lakh tons of rubber, annually . In India there are approximately 6000 rubber product companies. Out of these some 35 large scale companies, 320 medium scale and more than 5000 small scale industries. These companies do total turnover of around Rs. 12,000 Crore. These units are manufacturing more than 35000 rubber products, employing four crore people, which also includes 22000 technically qualified support personnel. India's rubber industry has growth rate of 8-9% per annum.

India consumes nearly 20 lakh tones of rubber (including natural, synthetic and reclaim) annually (as per the data of 2018-19) for producing a wide range of rubber products. Tamil Nadu (3.7 lakh tones), Maharashtra (2.09 lakh tones) and Kerala (2.02 lakh tones) are the top three rubber consuming states in the country (as per the data of 2018-19).

**Trend of Rubber Consumption in India**

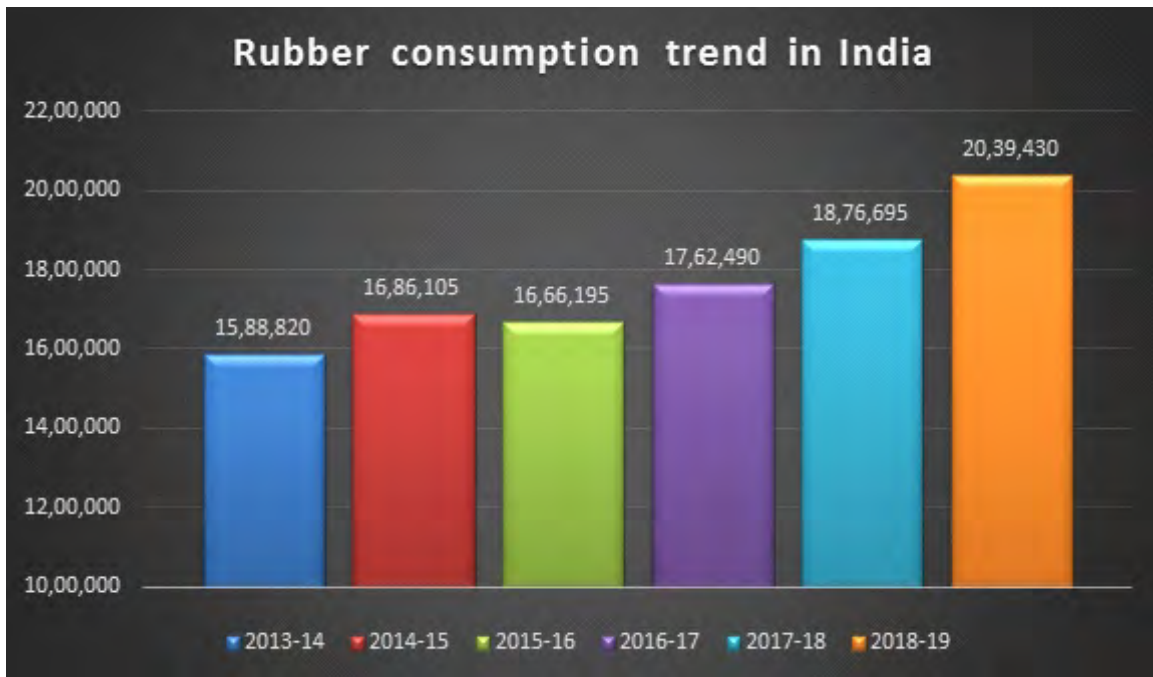


Fig. 1.1.11. Trend of rubber consumption

**Rubber Consumption in India**

The major rubber consuming sectors in India are as follows:

- 1 Automotive tyre sector
- 2 Bicycles tyres and tubes
- 3 Footwear
- 4 Camelback and latex products
- 5 Belts and hoses
- 6 Rest of products

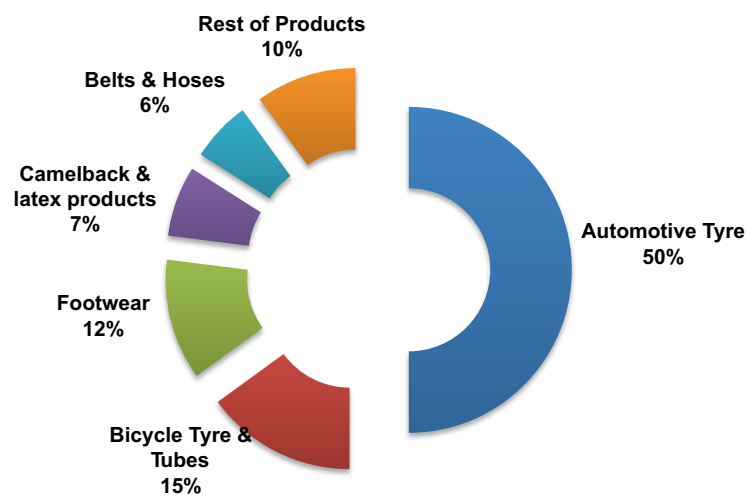


Fig. 1.1.12. Rubber consumption details

## UNIT 1.2: Extrusion Basics

### Unit Objectives

**At the end of this unit, you will be able to:**

1. Describe common terminology used in rubber industry.
2. Explain what is extrusion.
3. Describe the constituent material of a extruded part.
4. Explain the application of extrusion process.
5. Define types of extrusion.

### 1.2.1 Basic Terminology

Before studying extrusion, we will learn basic rubber terminology which is commonly used in rubber Industry. These are as follows -

**Accelerator-** Chemicals which are used for accelerating vulcanization or curing process, called accelerator.

**Autoclave-** An equipment used for vulcanization of rubber with heat and pressure.

**Compression Moulding-** It is a process of rubber moulding by heat and pressure. Due to heat rubber melt and flows in mould.

**Compound-** A homogeneous mixture of many polymers and other chemicals like - zinc oxide, carbon black and oil etc.

**Co-Polymer-** This is polymer which is made by mixing two different monomers. Some of the examples are EPDM, NBR and SBR etc.

**Cure-** A chemical process in Rubber under heat and pressure which changes its chemical structure. This process makes rubber more useful by increasing its resistance for aging, swelling and gives desired elasticity.

**Drag Flow-** The resistance to the forward movement induced by dragging against the walls. This is the basic phenomenon by which the material gets conveyed to the other end of the screw.

**Elasticity-** It is a property of rubber, due to which it comes back to its original shape after leaving from a pulled or pressed condition.

**Elongation-** This is a ratio of original length of rubber and maximum elongated length.

**Flashes-** This is extra rubber which comes out from various exit points and joints of mould, like - air vent or mould closing surfaces.

**Fillers-** Fillers are some chemicals which are used to give some special properties to rubber like - high/low elasticity, durability etc.

**Hardness-** This is way of measuring Rubber's relative resistance towards pre-defined indentation.

**Injection Moulding -** A type of moulding in which molten rubber under heat and pressure fed to mould.

**Master Batch-** It is a mix of single or 2 or more polymers with bulk ingredients. It is used in parts for making final rubber compound/s.

**Moulding-** It is a process by which uncured green rubber compound is converted to a cured elastic rubber part of desired shape and size using pre-designed moulds.



**Polymer-** A material which has a molecular structure built up chiefly or completely from a large number of similar units bonded together, e.g. many synthetic organic materials used as rubber, plastics and resins.

**Shelf Life-** Safe period within which the rubber compound or finished rubber product can be used without any loss of properties such as appearance and performance.

**Shrinkage-** Decrease in rubber volume during moulding and due to prevailing environment.

**Swell-** Increase in rubber volume due to oil, liquids and other things.

**Vulcanization-** This is another term used for cure.

**Pressure Flow-** The high pressure at the head side and the relatively low pressure at the feed end of the screw induces the screw to attempt a back-flow against the drag flow. This results in the back outs while running the extruder.

**Leakage-** The backward flow through the clearance between the screw and wall as a result of the increased pressure gradient from the hopper to head. Depends on screw-barrel clearance manifests undesirable extrusion characteristics Increased residence time and therefore scorch The negative flows as above reduces the output of the extruder.

## 1.2.2 What is Extrusion?

Extrusion process is pushing or pulling a material through a pre-designed shape, for creating desired shape and length. This could be any material, such as steel, aluminum and polymer. Here we are studying about polymer or rubber extrusion.

### Rubber Extrusion

As explained in extrusion, it is a process is pushing or pulling a material through a pre-designed shape, for creating desired shape and length. These profiles can be in straight lengths or in coil form. In rubber extrusion, various types of rubber compound is pushed through a die head, which has desired shape. Rubber compound is chosen based of properties required of final extruded product.

The machine used in extrusion process is called extruder, which is barrel shaped. It is having a screw type mechanism. From one side of barrel rubber compound is fed and this is forced out from another side from a die head.

Temperature of compound during this process needs to be maintained, else it might get cured before process taking place. If temperature is less than it may become hard and would not come out of die head.

Hot and cold both type extruder are in use. Selection of extruder is depending on the part to be produced and it properties.

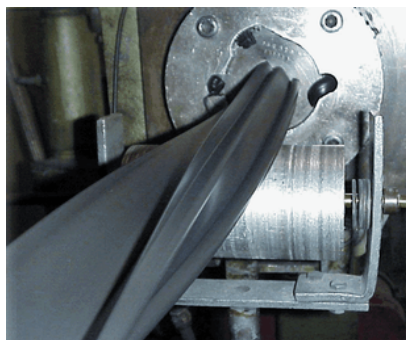


Fig. 1.2.1. Rubber Extrusion

### Extruder Output

Output of Extruder(Q) = Q(Drag) - Q(Pressure) - Q(Leakage)

Theoretical out put = Rpm of screw X Volume per flight

Volume per Flight =  $\pi L[D^2/4 - d^2/4]$

For Single flight Screw

Where,

L is the length of the flight,

D is the Diameter of the screw,

d is the diameter of the root

Actual out put = Theoretical output – Back flow

Back flow = Pressure Flow + Leakage

Screw efficiency = Actual output

### Types of Rubber Extrusion

Rubber extrusion is used to create parts for various purpose. Some common types of rubber extrusions are following -

1. Tube extrusion.
2. Tyre tread/sidewall extrusion.
3. Hose extrusion.
4. Extrusion for wire / cable coating.



Fig. 1.2.2. Tube Extrusion



Fig. 1.2.3. Tyre Tread/Sidewall Extrusion



Fig. 1.2.4. Hose Extrusion



Fig. 1.2.5. Wire coating

### Material Used in Rubber Extrusion

Material used in rubber extrusion is depends on uses of final product. But commonly used rubber types are following -

1. Natural Rubber.
2. SBR.

3. Nitrile rubber.
4. Chloroprene.
5. EPDM.
6. Thermoplastic rubber.

### Size and Shape of Rubber Extrusion

Size and Shape of rubber extrusion could be any type depending on part design, but some shapes are commonly used in rubber extrusion -

1. Door seal Profile.
2. D-Section.
3. Window seal profile.
4. Side seal profile.
5. Boot seal profile.



Fig. 1.2.6. Door Seal Profile

Fig. 1.2.6. Door Seal Profile



Fig. 1.2.7. D-Section

Fig. 1.2.7. D-Section



Fig. 1.2.8. Window Seal Profile



Fig. 1.2.9. Side Seal Profile



Fig. 1.2.10. Boot Seal Profile



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