



Participant Handbook

Sector
Rubber

Sub-Sector
**Manufacturing/
Plastics Processing**
Occupation
Plastics Extrusion

Reference ID: **RSC/Q4601 (CPC/Q0303),
Version 1.0, NSQF level: 3**



**Machine Operator
Assistant -
Plastics Extrusion**

Published by

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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: 'Machine Operator Assistant - Plastics Extrusion'
QP No. 'RSC/Q4601 (CPC/Q0303), NSQF Level 3'

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The preparation of this handbook would not have been possible without the rubber industry's support. Industry feedback has been extremely beneficial since inception to conclusion and it is with their guidance that we have tried to bridge the existing skill gaps in the industry. This participant handbook is dedicated to the aspiring youth, who desire to achieve special skills that will be a lifelong asset for their future endeavours.

About this book

A machine operator assistant (Plastics Extrusion) is responsible for helping the operator in calibrating, setting up, and operating the blow moulding machine, for converting raw materials into good-quality plastic for various applications. The individual should be diligent, inclined to learn new things, logical and result-oriented. He or she must have manual dexterity, high physical stamina, good eye for visual quality, and good attention to detail. Among others, the individual must have decent communication skills and be able to prioritise tasks. The trainee will enhance his/her knowledge under the trainer's guidance in the following skills:

- **Knowledge and Understanding:** Adequate operational knowledge and understanding to perform the required task
- **Performance Criteria:** Achieve the required skills via hands-on training and perform the required operations within the specified standards
- **Professional Skills:** Ability to make operational decisions related to the area of work

The handbook incorporates well-defined responsibilities of a machine operator assistant (Plastics Extrusion).

Symbols Used



Key Learning
Outcomes



Unit
Objectives



Exercise



Tips



Notes



Activity



Summary

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1. Introduction

Unit 1.1 - History of Plastic

Unit 1.2 - Industrial Association



Key Learning Outcomes



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

1. Explain the developmental history of plastic
2. Describe current industrial scenario of plastics and prospects
3. Identify types of plastic
4. List major industrial associations related to plastics extrusion
5. Identify equipment used for plastics extrusion
6. Describe roles and responsibilities for a machine operator assistant - plastics extrusion

UNIT 1.1: History of Plastic

Unit Objectives

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

1. State the history of the development of plastic
2. Recognise the current industrial scenario of plastic
3. Compare different types of plastic

1.1.1 Developmental History of Plastic

The word 'plastic' is derived from pliable and easily shaped. The Plastics are made of several polymers. Polymers are composed of long molecular chains. One of the examples of natural polymer is cellulose, which makes up the cell wall of plants. Synthetic polymers are made using plentiful carbon atoms provided by petroleum and other fossil fuels. The synthetic polymers are made of long-chain of atoms arranged in repeating units. Some of the examples of a synthetic polymer are- nylon, polyethylene, polyester, Teflon, etc. Depending on the length of these chains and the pattern in which they are arrayed, the polymers are strong, lightweight or flexible.

The first synthetic polymer was invented in the year 1869 by John Wesley Hyatt. It was revolutionary discovery as the discovery of plastic came as a replacement of natural ivory, which was obtained through the slaughter of wild animals. The development of plastic also helped reduce the constraints imposed by the scarcity of natural resources.

In 1907, Leo Baekeland invented Bakelite, which was the first fully synthetic plastic. Bakelite is durable, heat resistant, and unlike celluloid suited for mechanical mass production. Nylon invented by Wallace Carothers in 1935 as synthetic silk was used during World War II for parachutes, ropes, body armour, helmet liners and more. During World War II, the production of plastic increased by 300% in the United States.

Plastics are critical to modern life and have made possible the development of computers, cell phones, and most modern-day lifesaving drugs. Plastics are lightweight and good for insulation. They help save fossil fuels used in heating and transportation. Inexpensive plastics raised the standard of living and made material abundance more easily available. The replacement of natural material with plastics has made many of our possessions cheaper, lighter, safer and stronger. Recent technologies focus upon the development of bioplastics made from plant crops instead of fossil fuel. A scientist has been working towards the development of a technology, which converts plastic back into fossil fuels.

1.1.2 Current Economic Scenario – Rubber and Plastics

Whenever you take a look around, you find at least a few items made of rubber or plastic. Rubber and plastics are two of the most popular materials used in manufacturing items of our daily use. It is very difficult to find a sector, business, or household in India, and the world, where rubber and plastic items are not used. Such wide popularity of rubber and plastics is primarily due to their easy availability of raw material and labour, low cost, the flexibility of use, and convenience of handling.

Rubber – Industry Highlights (Sources: www.indianmirror.com and RSDC)

The below points summarise the current position of the Indian rubber industry and how it contributes to the national economy.

- India is currently the world's fifth-largest producer and the fourth largest consumer of natural rubber (Source: RSDC)
- Kerala and Tamil Nadu are the dominant rubber-producing states in India

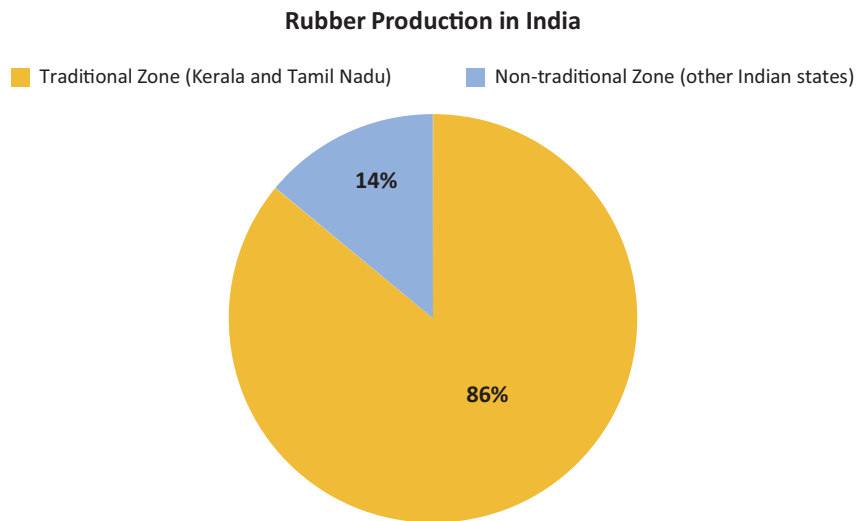


Fig. 1.1.1: Rubber-producing states in India (Source: www.indianmirror.com)

- The Indian Rubber industry proudly declares an average annual turnover of Rs 12000 crores
- About six thousand large-scale, medium-scale, and small-scale industrial units contribute to the Indian rubber industry

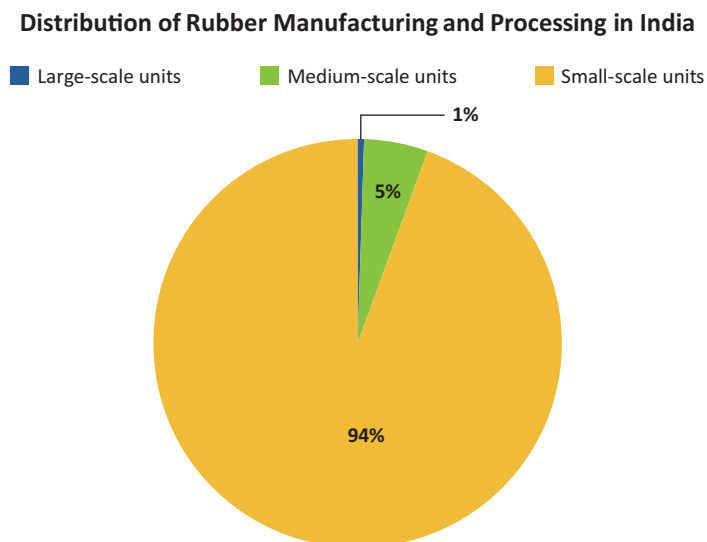


Fig. 1.1.2: Distribution of rubber manufacturing and processing in India (Source: www.indianmirror.com)

- The average annual production of the Indian rubber industry ranges is 6.5 lakh tons
- The current market size of the Indian rubber industry stands at the huge figure of Rs. 3000 crores

Rubber Consumption Pattern in India

Natural, synthetic, and reclaim rubber are the variants widely consumed pan-India by segments like automotive tyre, bicycle tyres and tubes, footwear, belts and hoses, camelback and latex products, and other miscellaneous products.

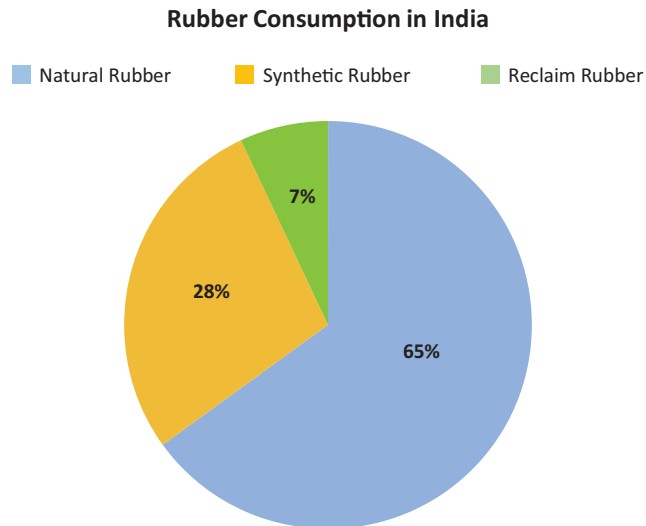


Fig. 1.1.3: Consumption of natural, synthetic, and reclaim rubber in India (Source: RSDC)

Segment-wise Rubber Consumption in India

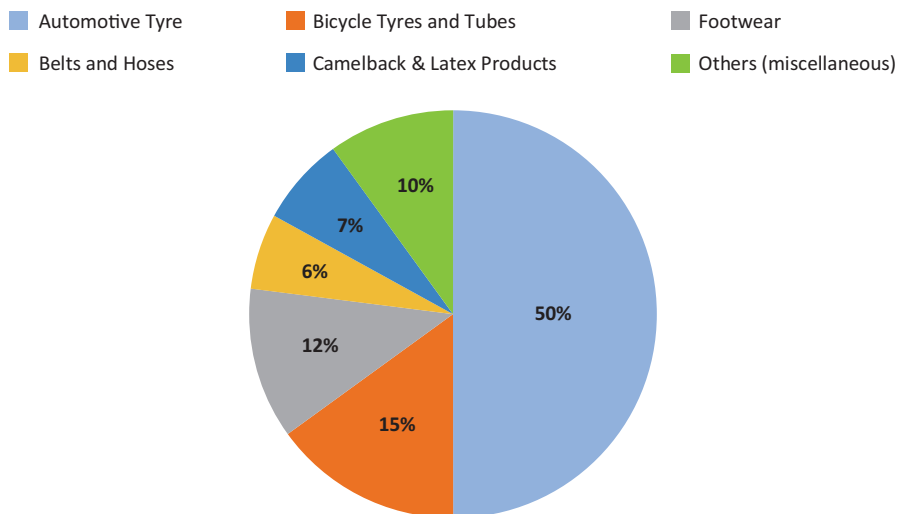


Fig. 1.1.4: Consumption of rubber by various commercial segments in India (Source: www.indianmirror.com)

Market Size of Indian Rubber Industry

- The below points highlight the current market size of the Indian rubber industry:
 - About six thousand units in India are:
 - manufacturing above thirty-five thousand rubber products
- providing a livelihood to about four hundred thousand Indian people
- Huge demand and consumption of rubber products in India has led to high volumes of import
- India currently imports an average annual quantity of about fifty thousand tons of rubber to meet the huge demand
- About 70% of the country's total rubber production is comprised of Ribbed Smoked Sheets (RSS) of rubber

Employment Opportunities in the Indian Rubber Industry

Adequately skilled individuals can pursue a fruitful career in the Indian rubber industry. Individuals can get employed in the below sectors:

- Aeronautics
- Aviation
- Automotive
- Construction
- Consumer goods
- Healthcare
- Industrial manufacturing
- Mining
- Pharmaceuticals
- Railways
- Steel plants
- Textile engineering
- Wire and cables manufacturing

The National Rubber Policy 2019, by the Ministry of Commerce & Industry, Govt. of India, is currently focused on recognising and supporting marginal population with a better and long-term livelihood.

According to a recent report published by Research and Markets, the Indian rubber industry has been forecasted to grow at 5.6% CAGR (Compound Annual Growth Rate; constant and compounded annual return over a given period of time) during FY2019-24. This would be driven mainly by the huge demand in the Indian automotive industry.

Plastics – Industry Highlights

Plastic manufacturing and processing are very important for the economic growth of India. The below points summarise the current position of the Indian plastic industry and how it contributes to the national economy.

- The state of Gujarat is the leading plastic processing hub in India and houses the largest number of plastic manufacturers, with over 5,000 plastic firms
- The growth rate of the Indian Plastics industry is one of the highest in the world with plastic consumption growing at a rate of 16% p.a. (per annum)
- Per capita Virgin plastic (resin produced directly from petrochemical raw materials and has never been used or processed before) consumption in India currently stands at 11 Kg, as against the global per capita consumption of 28 Kg
- Contribution of Plastics industry to the Indian economy is moving towards 8% of Indian GDP (Gross Domestic Product)
- The Indian plastics industry comprises about 22000 plastic processing units and more than 150 manufacturers of plastic processing machinery
- About 50% of the domestic demand for plastic goods is met by domestic production
- The plastics processing capacity in India stands currently at 330 MMT (Million Metric Tonne; 1 MMT = 1×10^9 Kg)

Plastics Consumption Pattern in India

Plastics and plastic-based products are widely consumed pan-India by various segments, as shown in the below chart:

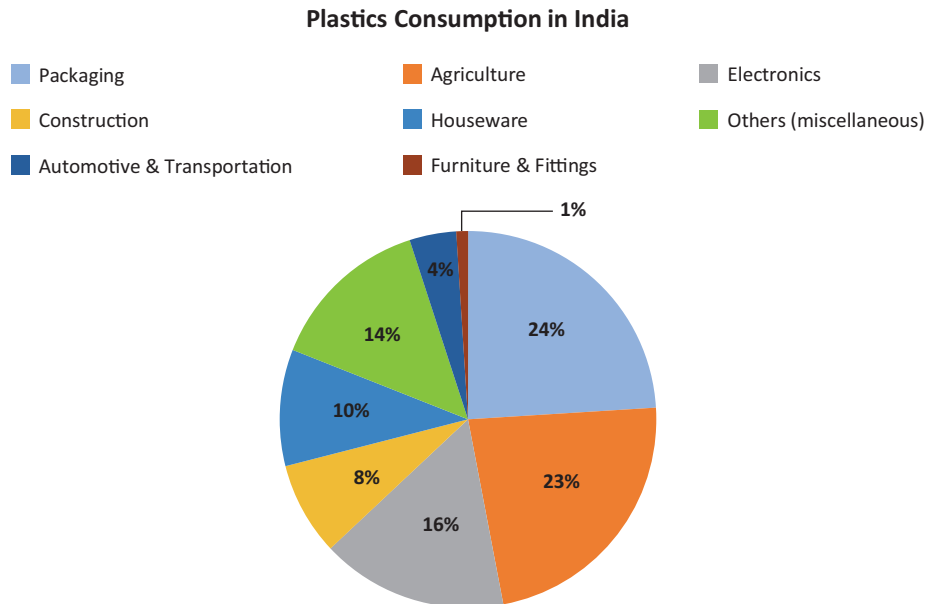


Fig. 1.1.5: Consumption of plastics by various commercial segments in India (Source: “Plastics Industry in India” by the British Plastics Federation)

Indian Plastics Industry - Market Size and Employment Opportunities

The below points highlight the current market size of the Indian plastics industry:

- The current turnover (the amount of funds used by a business over a given period of time) of the Indian plastic and polymer industry stands at Rs. 1,44,000 crores
- The industry currently comprises almost 25,000 companies and provides a livelihood to about 3 million people in India
- The Indian plastic industry is forecasted to grow at 8.23% CAGR for the period FY 2018–24
- Such promising growth would open the doors to various youths in India, and adequately skilled individuals would be able to pursue fruitful and long-term career opportunities

1.1.3 Current Industrial Scenario of Plastics

Plastic products form an important part of global economic growth. Plastic processing serves as the pillar of the economy. World per capita consumption of plastic is 28 kg, whereby the consumption of India is 11kg, China 38 kg, Brazil 32 kg. This means India has big potential to grow, as its per capita consumption of plastic is the lowest in Asia.

India’s per capita consumption of Virgin plastic (Resin produced directly from petrochemical feedstock such as natural gas or crude oil is 11kg and recycled plastic is 3.8 kg. Few of the statistics related to plastic production have been discussed below:

1. Virgin polymer consumption in the year 14-15= 14 MMT
2. No. of converting/processing units in the organised sector= 30,000 plus

3. No. of converting/processing units in the unorganised sector= 20,000
4. No. of processing machines= 113,000
5. Processing Capacity= 30 MMT
6. Processing capacity CARG= 13% last 5 years
7. No. of plastic machinery manufacturing units in India= 200 plus
8. Investment in machinery= US \$ 5 Billion
9. Investment required for next 5 years= Around 10 billion US\$
10. Size of plastic and polymer industry= 1,44,000 crores

The Indian plastics market comprises of 25,000 companies and employs 3 million people. The domestic capacity for polymer production was 5.72 tonnes in the year 2009. The state of Gujarat in Western India is the leading plastic processing hub and accounts for the largest number of plastic manufacturers, with over 5,000 plastic firms. Indian Plastics industries has one of the highest growth rate in the world with plastic consumption growing at a rate of 16% per annum. It is assumed that plastic consumption is likely to reach 16kg per head by 2015. There has been complains from different plastic companies regarding labour shortage This has led to increased investment in technology, such as automation and conveyor belt systems. Reliance Industries stated in January that India's polyolefin market is expected to grow 12 percent to about 7.5 million metric tonnes in 2011 with growth in consumption of polypropylene and polyethylene. It is estimated that 75-80% of propylene demand in India is met by Reliance Industries with around 20% coming from four Government-run companies Indian Oil Corporation Ltd (IOCL), Haldia Petrochemicals, Bharat Petroleum Ltd. (BPCL) and the Gas Authority of India Ltd. (GAIL). The demand for PVC is exceptionally high with domestic production meeting 50% of the demand. The break-up of plastic consumption in India has been given below as:

Plastic consumption by application:

- Building- 8%
- Packaging- 24%
- Electronic- 16%
- Transportation-4%
- Furniture-1%
- Agriculture- 23%
- Houseware-10%
- Others-14%

1.1.4 Plastic and its Types

The term “plastic” means “a thing that can be shaped or moulded”. A “plastic” item can be cast into moulds, pressed, and converted into items of various shapes like bottles, fibres, boxes, bags, tubes, utensils, etc.

Plastics can be scientifically defined as semi-synthetic or synthetic (not natural; manmade) organic (containing carbon) materials that can be bent to build solid two and three-dimensional items of various shapes, weight, and sizes.



Fig. 1.1.6: Various types of plastic items

Types of Plastics

Based on utility, plastics can be broadly classified as:

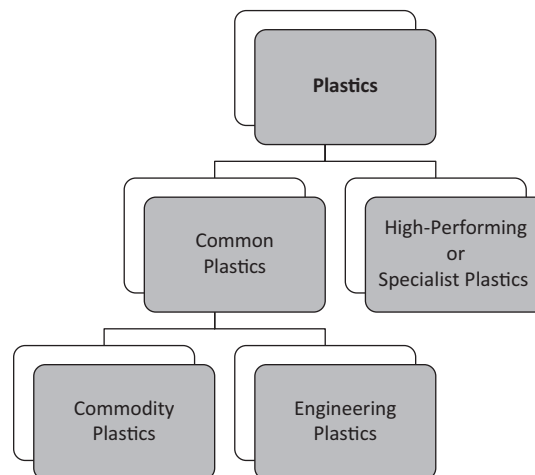


Fig. 1.1.7: Broad classification of plastics

Common plastics

Common plastics are used daily, for a wide variety of applications, and in large quantities. Common plastics are further classified as **commodity** and **engineering plastics**.

- **Commodity plastics:**

Commodity plastics are used in very common items of daily use like household items (utensils, kitchen shelves, housekeeping equipment, etc.), packaging, photographic films, magnetic tape, stationery items, carrying trays, medical trays, trash bins, furniture covers, etc. Commodity plastics are very cheap. Examples of commodity plastics include polyethylene, polystyrene, polypropylene, polymethyl methacrylate, polyvinyl chloride (PVC), etc.

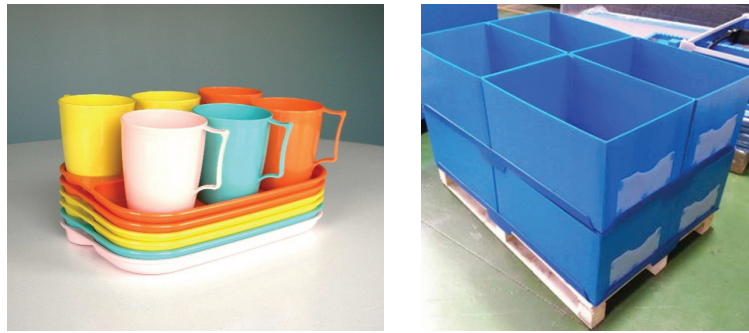


Fig. 1.1.8: Items made of commodity plastics

- **Engineering plastics:**

Engineering plastics are used in selected applications due to their better mechanical properties than commodity plastics. As compared to commodity plastics, these are expensive, manufactured in lesser quantities, and used for special applications like building small mechanical parts of cars, bike helmets, ski boots, computer hardware, etc.

Examples of engineering plastics are polycarbonates, which are used in building bike helmets, acrylonitrile butadiene styrene (ABS), which are used in building car bumpers, and polyamides (nylons), which are used for making ropes and clothes.



Fig. 1.1.9: Items made of engineering plastics

High-performing/Specialist plastics

Specialist plastics are called “high-performing” plastics because, as compared to common plastics, they are:

- less affected by temperature changes (thermally stable)
- less affected by chemical changes (chemically stable)
- less affected by impact (mechanically stable)

Specialist plastics are manufactured for industrial use. Such industrial applications include fibre optics, construction, electrical wire insulators, and fluid flow tubes. Each type of high-performance plastics specialise in a single property like heat stability, chemical resistance, or mechanical stability, and is put to use accordingly. These are more expensive than engineering plastics.

Examples of high-performance plastics include polytetrafluoroethylene (PTFE) or Teflon, polymethyl methacrylate (PMMA) or acrylic, polyepoxide or epoxy, etc.

Thermoplastics and Thermosetting Plastics

Thermoplastics are plastics that undergo no change in chemical composition and can be moulded repeatedly. These are used in the manufacture of highly heat-resistant items. Thermoplastics include polyethylene (PE), polystyrene (PS), polyvinyl chloride (PVC), and polypropylene (PP).

Nylon, a thermoplastic, is used in making clothes, ropes, parachutes, and mechanical parts like power tool casings, gears, and machine screws. Another thermoplastic, Acrylic, is very strong and is used as a good substitute for glass, in helmet visors, car headlights, display signs, aircraft windows, and aquariums.



Fig. 1.1.10: Helmet visors are often made of acrylic

Thermosetting plastics, commonly called thermosets, undergo an irreversible chemical reaction under high temperatures, melt, and can be moulded only once. On solidification, they retain the moulded form permanently.



Fig. 1.1.11: Thermoplastic and thermoset items

Biodegradable Plastics

Biodegradable plastics can break down and decompose when exposed to ultraviolet radiation, sunlight, and bacteria. These are very environment-friendly and non-toxic. However, this technology is still under development and quite costly. Polyhydroxybutyrate (PHB) is an example of biodegradable plastics.



Fig. 1.1.12. Items made of biodegradable plastic

1.1.5 Common Plastics – Characteristics and Uses

The different kinds of plastics, along with their uses and recyclable properties, have been discussed below:









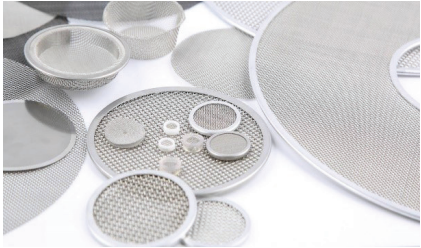


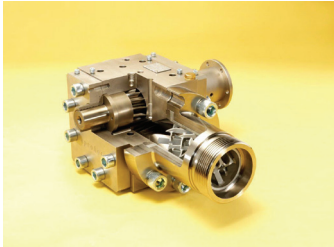
Sl. no.	Polymer name	Abbreviation	Symbol	Used to make	Recyclable
1	Polyethylene Terephthalate	PETE or PET	 01 PETE	Textiles, carpets, pillow, life jackets, storage containers, clothing, boat sails, sleeping bags, shoes, winter coats	Yes
2	Polyvinyl Chloride	PVC	 03 PVC	Flooring, window frames, sewage pipes, squeezable bottles	Yes
3	High-density Polyethylene	HDPE	 02 HDPE	Plastic crates, fencing, Tote bags, plumbing pipes, Grocery bags, tiles, etc.	Yes
4	Low-density Polyethylene	LDPE	 04 LDPE	Garbage cans, Lumber, flexible container, kitchenware, Tupperware	Yes
5	Polypropylene	PP	 05 PP	Ice scrapers, rakes, battery cables, prescription bottles, bottle caps, Take-out containers, disposable cups and plates, plastic food boxes	No
6	Polystyrene	PS	 06 PS	Insulation, licence plate frames, rulers, plastic cutlery, packing foam	No
7	Miscellaneous plastics	N/A	 07 OTHER	They are often used in outdoor decks, moulding and park benches, baby bottles, medical storage containers, exterior lighting fixtures	Yes/No

Table 1.1.1: Plastics – Characteristics and Uses

1.1.6 Equipment Used for Plastic Processing

The different kinds of equipment used in plastic processing have been discussed below:

Different equipment used in plastic processing		
<p>Hydraulic Press</p>	<ul style="list-style-type: none"> Hydraulic presses are used to exert external pressure on fluids to crush or flatten a material Hydraulic presses are based on the Pascal's Law that states that when a fluid is worked on in an enclosed area, the pressure remains the same throughout 	
<p>Extruder Screens</p>	<ul style="list-style-type: none"> Extruder screens are wired mesh screens that act as filtration tools Filtration during plastic extrusion is the process of passing melted material through extruder screens in order to remove any impurity or contamination 	
<p>Mixers and blenders</p>	<ul style="list-style-type: none"> Blending systems are integrated, multi-dispensing mixing devices designed to combine materials together 	
<p>Cooling tank</p>	<ul style="list-style-type: none"> Chillers and cooling tanks are used to transfer heat out of the mould The cooler protects the machine from getting overheated 	
<p>Melt pump</p>	<ul style="list-style-type: none"> The Melt pump is known as an accurate metering device, which eliminates surging of the extruder screw The Melt pump reduces backpressure and increases the output of the complete line by up to 20% 	


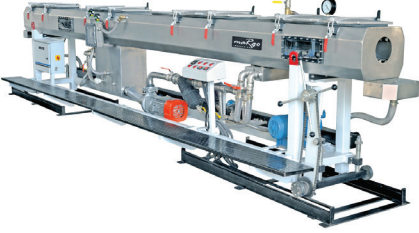
<p>Granulators and Shredders</p>	<ul style="list-style-type: none"> • Granulators and shredders increase recycling efficiency by reducing waste • Shredders are specifically designed for scrap size-reduction 	
<p>Vacuum tank</p>	<ul style="list-style-type: none"> • A vacuum is used to improve the shape and of the plastics • Water is used within a vacuum sizing tank for cooling and lubrication of the plastics 	

Table 1.1.2: Different equipment used in plastic processing

Activity

Objective

Learn about different types of plastics based on utility

Materials required

Pen and paper

What to do

- Take a paper and make 4 columns
- Write about four major types of plastics based on their utility (common plastic, commodity plastic, high performing plastic and engineering plastic)
- Jot down their features and application in the industry
- Make a list of items manufactured using different plastics in each of the columns accordingly