

PVC Manufacturing Presentation Extrusion and applications

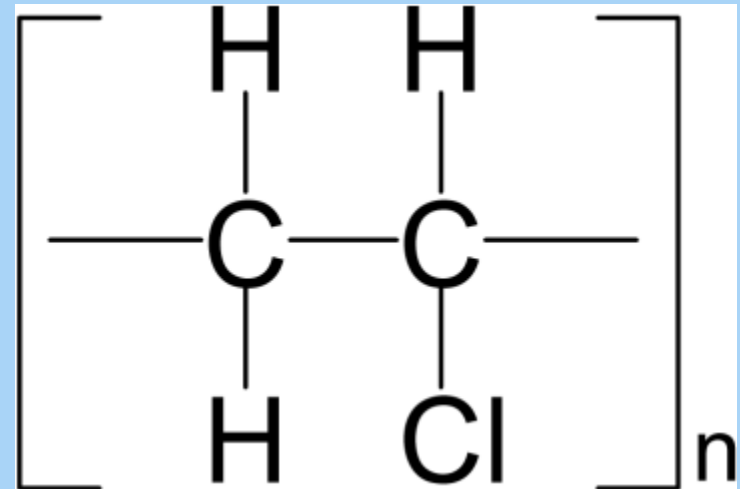
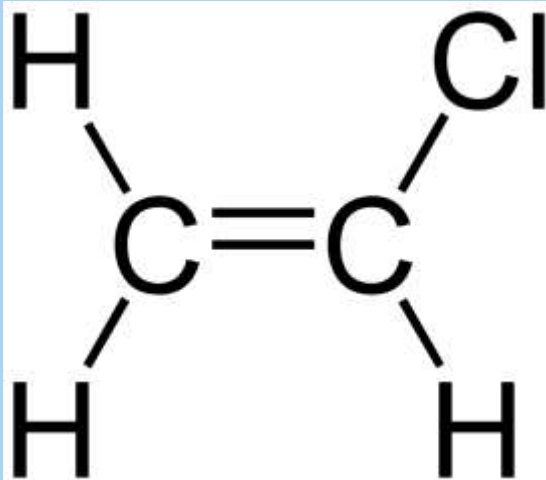
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What is PVC???

- Polyvinyl chloride , more correctly but unusually poly(vinyl chloride), commonly abbreviated PVC, is the world's third-most widely produced synthetic plastic polymer, after polyethylene and polypropylene.
- PVC comes in two basic forms: rigid (sometimes abbreviated as RPVC) and flexible. The rigid form of PVC is used in construction for pipe and in profile applications such as doors and windows. It is also used for bottles, other non-food packaging, and cards (such as bank or membership cards). It can be made softer and more flexible by the addition of plasticizers, the most widely used being phthalates. In this form, it is also used in plumbing, electrical cable insulation, imitation leather, signage, phonograph records, inflatable products, and many applications where it replaces rubber.
- Pure poly(vinyl chloride) is a white, brittle solid. It is insoluble in alcohol but slightly soluble in tetrahydrofuran.

PVC COMPOUND FORMULATION



Discover the PVC :

PVC was accidentally synthesized in 1872 by German chemist Eugen Baumann. The polymer appeared as a white solid inside a flask of vinyl chloride that had been left exposed to sunlight. In the early 20th century the Russian chemist Ivan Ostromislensky and Fritz Klätte of the German chemical company Griesheim-Elektron both attempted to use PVC in commercial products, but difficulties in processing the rigid, sometimes brittle polymer thwarted their efforts. Waldo Semon and the B.F. Goodrich Company developed a method in 1926 to plasticize PVC by blending it with various additives. The result was a more flexible and more easily processed material that soon achieved widespread commercial use.

MARKET & DEMAND ASPECTS :

PVC pipes are used for a variety of purposes e.g. water supply schemes, spray irrigation, deep tube well schemes and land drainage schemes. PVC slotted and corrugated pipes are ideal systems for drainages of water from land where water logging is inevitable. It is widely used by various utility services now-a-days too. The major consumer of PVC pipes are the Public Health Engineering Department (PHED) and Irrigation Departments. Besides these two, it is used by the Municipal Corporations, Tea estates as well as in N.E. Region. The usage of PVC pipes also depends upon the size of these pipes too. It is manufactured in different sizes having innumerable usage value.

The World Bank has recently given top priority in rural water supply in developing and under-developed countries. India has also received large amounts from World Bank aid for Rural Water Supply Schemes. However, due to the acute shortage of appliances including pipes this money could not be utilized to a large extent in our country. Thus PVC/HDPE pipe manufacturing industry has received higher priority. The requirement of PVC pipes in N.E. Region is around 10,000 MT out of which the requirement in Assam is more than 50% followed by Tripura and other five states of N.E. Region. At present there exist around 5 PVC pipes manufacturing units in the region.

RAW MATERIAL

| Sl.no. | Item | Parts by wt. |
|--------|------------------------|--------------|
| i) | PVC Resin | 100 |
| ii) | Stabilizer (Non toxic) | 5 |
| iii) | Primary Plasticizer | 1.5 |
| iv) | Secondary Plasticizer | 5 |
| v) | Internal Lubricant | 3 |
| vi) | External Lubricant | 4 |
| vii) | Epoxy Plasticizer | 1.5 |
| viii) | Pigment base | 3 |
| ix) | Pigment | As required |

PROCESSING

- **Extrusion**
- **Plasticizers**
- **Stabilizers**
- **Lubricants**
- **Fillers**
- **Sizing**
- **Traction**
- **Cutting**

PROCESSING:

The basic material which on Polymerization produces P.V.C. Pipes is Poly vinyl chloride which in resin form is hard and rigid. The rigidity can be controlled by controlling the percentage of plasticizer at the time of compounding. Production of Rigid PVC pipe is based on plasticizing and homogenizing PVC compound and then passing the compound through an extruder. The hot molten PVC compound is extruded through a circular slit. Circular slit governs the size of pipe to be extruded. Different dies are used for manufacturing different size of pipes.

The Pipes thus extruded through the die is then passed through a vacuum sizing tank wherein the dimensions of the pipe can be accurately set. It also helps in surface finish of the pipes. Vacuum sizing reduces the percentage of wastage considerably.

PROCESSING:

As the pipe being extruded is rigid in form they cannot be wound into coils. So an inline motorized cutting device should be provided for cutting the pipes into required sizes. For ascertaining the consistency in product quality the unit should be equipped with process control laboratory for preliminary testing of raw materials. The unit may also have arrangement for quality testing of finished products.

PROCESSING:

- **Extrusion:**

PVC uncompounded resin, unlike some other thermoplastics is not suitable for direct processing. To confer the required processing and end instability, it is necessary to mix additives to the PVC resin. Following are some of the additives which are generally used for the manufacture of rigid PVC pipes.

- **Plasticizers:**

The common plasticizer in use are DOP, DIOP, DBP, DOA, DEP, Reoplast, Paraplex etc.

PROCESSING:

- **Stabilizers:**

The common stabilizers are lead, barium, cadmium, tin, stearate etc.

- **Lubricants:**

Widely used lubricants are Buty-Stearate, Glycerol Mono-Stearate, Epoxidised Monoester of oleic acid, stearic acid etc.

PROCESSING:

- **Fillers:**

Fillers are also used for producing special quality product (e.g. calcined clay is used to improve the electrical properties of cable compounds).

Before the extrusion operation PVC resin is to be compounded with plasticizers, stabilizers, lubricants and fillers to improve processibility and improve the endure stability. PVC resin is compounded with other ingredients in a high speed mixer. The compound resin is fed to the double screw extruder where the inserts and die body for the required pipe diameter are fitted. The PVC compounds are then passed through a heated chamber and they get melted under the compression of the screw and temperature of the barrel. The marking on the pipe is done at the time of extrusion.

PROCESSING:

- **Sizing:**

- The pipes coming out from the extruder is cooled in the sizing operation. There are basically two types of sizing used for manufacturing of pipes. They are (i) Pressure sizing & (ii) Vacuum sizing.

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- **Traction:**

- The next operation needed after sizing is traction. The tube traction unit is required for continuous haulage of the pipes being extruded by the extruder.

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- **Cutting:**

- The last operation needed is cutting. There are basically two cutting techniques for rigid PVC pipes viz. manual and automatic. The pipes are then tented for ISI marks and are ready for dispatching.

UTILITY:

- ❖ Electricity
- ❖ Gas
- ❖ Water

Environmental Impact

- ⊠ Toxic level
- ⊠ Pollution level
- ⊠ Impact on Local community
- ⊠ Impact on environmental resources

Environmental Impact

- ⊠ Polyvinyl Chloride, more commonly known as PVC or just vinyl, has been in widespread usage since the early-mid 20th century.
- ⊠ PVC is strong, resistant to oil and chemicals, sunlight, weathering and flame resistant. It's everywhere around us. PVC is an incredibly versatile material use in bottles, packaging, toys, construction materials, bedding, clothing, piping, wire coatings, imitation leather, furnishings and more.
- ⊠ PVC ranks the third in both global plastic output and consumption. Over 33 million tons of PVC is being produced each year and that figure is increasing annually. Around 57% of PVC's mass is chlorine, so it requires less petroleum than many other polymers.

Market Demand

- ⊠ Demand is the quantity of a good or service that consumers and businesses are willing and able to buy at a given price in a given time period. Market demand is the sum of the individual demand for a product from buyers in the market. The total market demand of PVC pipes in Bangladesh is approximately 2200 Core Tk.

| S.no. | Item | Qty./rate | Amount in Tk. |
|-------|-------------|----------------|------------------|
| 1. | PVC Resin | 58,000 @ Tk.54 | 31,32,000 |
| 2. | D.O.P. | 2200 @Tk. 60/- | 1,32,000 |
| 3. | Stabilizers | 1200 @Tk. 60/- | 72,000 |
| 4. | Lubricants | 600 @Tk. 62/- | 37,200 |
| 5. | Colours | 200 @ Tk.140/- | 28,000 |
| 6. | Fillers | 3800 @ Tk.10/- | 38,000 |
| | | TOTAL : | 34,39,200 |

Other contingent Expenditure (P.M.):

| | | | | |
|----|-----------------------------|--|--|--------|
| 1. | Postage and stationery | | | 3,000 |
| 2. | Advertisement and publicity | | | 10,000 |
| 3. | Traveling | | | 4,000 |
| 4. | Telephone | | | 700 |
| | | | | 17,700 |

Properties

| Property | Rigid PVC | Flexible PVC |
|--|-----------------------|-----------------------|
| Density [g/cm ³] | 1.3–1.45 | 1.1–1.35 |
| Thermal conductivity [W/(m·K)] | 0.14–0.28 | 0.14–0.17 |
| Yield strength [psi] | 4500–8700 | 1450–3600 |
| Young's modulus [psi] | 490,000 | |
| Flexural strength (yield) [psi] | 10,500 | |
| Compression strength [psi] | 9500 | |
| Coefficient of thermal expansion (linear) [mm/(mm °C)] | 5×10^{-5} | |
| Vicat B [°C] | 65–100 | Not recommended |
| Resistivity [Ω m] | 10^{16} | 10^{12} – 10^{15} |
| Surface resistivity [Ω] | 10^{13} – 10^{14} | 10^{11} – 10^{12} |

Thermal and fire properties

- ⊠ The heat stability of raw PVC is very poor, so the addition of a heat stabilizer during the process is necessary in order to ensure the product's properties. PVC starts to decompose when the temperature reaches 140 °C (284 °F), with melting temperature starting around 160 °C (320 °F). The linear expansion coefficient of rigid PVC is small and has good flame retardancy, the Limiting oxygen index (LOI) being up to 45 or more. The LOI is the minimum concentration of oxygen, expressed as a percentage, that will support combustion of a polymer and noting that air has 20% content of oxygen.

Electrical properties

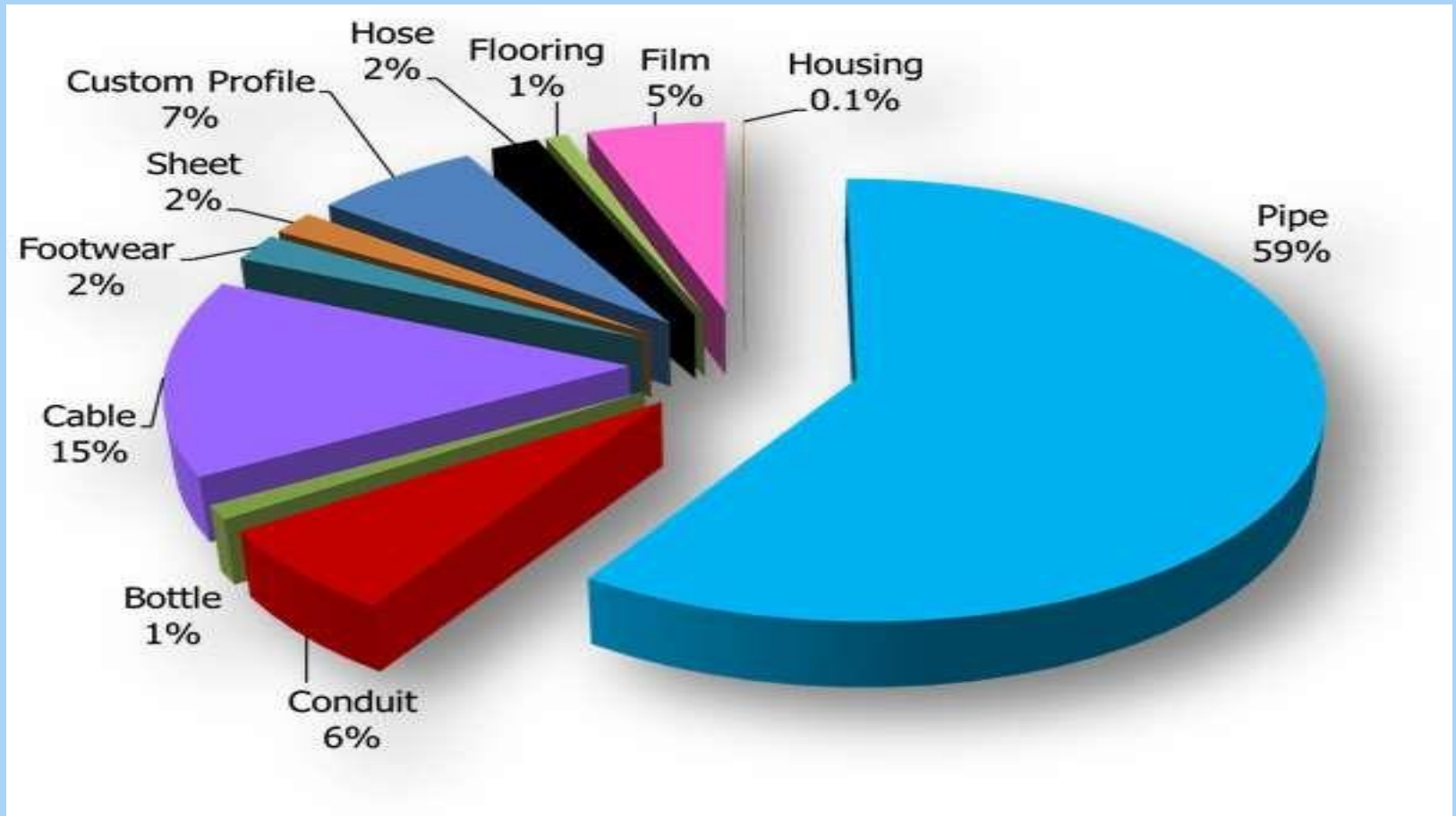
- PVC is a polymer with good insulation properties, but because of its higher polar nature the electrical insulating property is inferior to non polar polymers such as polyethylene and polypropylene.

Since the dielectric constant, dielectric loss tangent value, and volume resistivity are high, the corona resistance is not very good, and it is generally suitable for medium or low voltage and low frequency insulation materials.

Chemical properties

⊠ PVC is chemically resistant to acids, salts, bases, fats, and alcohols; therefore, it is used in sewerage piping. It is also resistant to some solvents, mainly uPVC. Plasticized PVC, also known as PVC-P, is in some cases less resistant to solvents. For example, PVC is resistant to fuel and some paint thinner. Some solvents may only swell it or deform it but not dissolve it, but some of them, like tetrahydrofuran or acetone, may damage it.

Uses diagram of PVC



Applications:

Pipes

- PVC is used extensively in sewage pipe due to its low cost, chemical resistance and ease of jointing
- PVC's relatively low cost, biological and chemical resistance and workability have resulted in it being used for a wide variety of applications. It is used for sewerage pipes and other pipe applications where cost or vulnerability to corrosion limit the use of metal. With the addition of impact modifiers and stabilizers, PVC scrap has become a popular material for window and door which is 50% less than the cost of a wooden window and door. By adding plasticizers, it can become flexible enough to be used in cabling applications as a wire insulator. It has been used in many other applications. In 2013, about 39.3 million tones of PVC were consumed worldwide. PVC demand is forecast to increase at an average annual rate of 3.2% until 2021.

Electric cables

- PVC is commonly used as the insulation on electrical cables; PVC used for this purpose needs to be plasticized.
- In a fire, PVC-coated wires can form hydrogen chloride fumes; the chlorine serves to scavenge free radicals and is the source of the material's fire retardance. While HCl fumes can also pose a health hazard in their own right, HCl dissolves in moisture and breaks down onto surfaces, particularly in areas where the air is cool enough to breathe, and is not available for inhalation.[27] Frequently in applications where smoke is a major hazard (notably in tunnels and communal areas) PVC-free cable insulation

ADVANTAGES:

- Processed by thermoplastic methods
- Wide range of flexibility possible with varying levels of plasticizer
- Plastisol processing possible
- Non-flammable
- Dimensional stability
- Comparatively low cost
- Good resistance to weathering

DISADVANTAGES AND LIMITATIONS:

- Attacked by several solvent types
- Limited thermal capability
- Thermal decomposition evolves HCl
- Stained by sulphur compounds
- Higher density than other plastics

what's the problem with PVC?

- For starters, oil and chlorine aren't what you'd call "green" substances in regards to their extraction, refining and by-products. So much of our modern life is based on oil that if production were to suddenly increase, it's not just transport that would suffer – it would affect every aspect of our lives. We really need to kick our fossil fuel addiction before we are forced into withdrawals.
- PVC's durability is also its downfall environmentally speaking – it's not biodegradable or degradable. Items made from PVC will retain their form for decades and the breakdown that occurs is just granulation – the pieces simply become smaller. Animals can ingest these pieces and the plastic can block their digestive tracts.

Alternatives to PVC

- This is a tough one. Some new materials with most of the desirable properties of PVC, without the health and environmental concerns are now being produced. These degradable plastics are engineered to breakdown under landfill conditions (darkness, heat and moisture) within a few years without emitting toxic gases or other pollutants. At this point in time, these sorts of materials aren't widely available and are quite expensive.
- However, the more environmentally friendly materials that PVC originally replaced are still around. These are economical and widely available. For a list of PVC alternatives, check out this article on Greenpeace's site – [PVC_Solutions](#).

