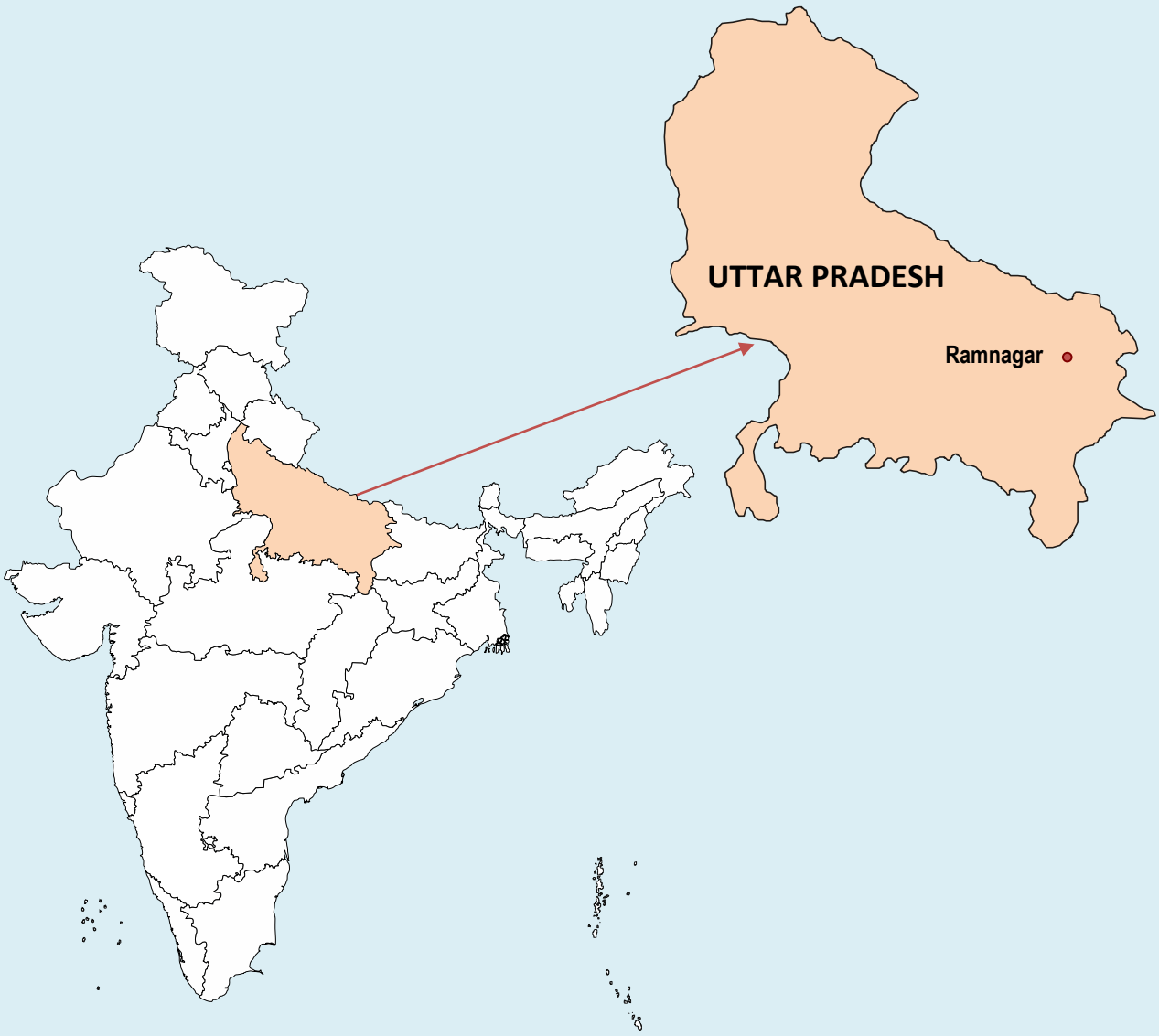
Cluster Profile
Ramnagar plastic industries



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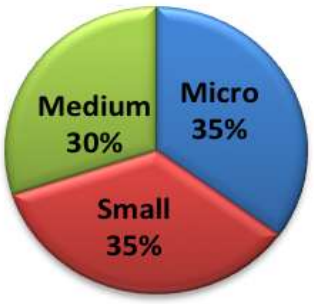
Last but not least, our sincere thanks to MSME entrepreneurs and other key stakeholders in the cluster for providing valuable data and inputs that helped in cluster analysis

Ramnagar plastic industries

Overview of cluster

Ramnagar (Chandauli) is one of the prominent plastic clusters in the country. Ramnagar district has more than 3000 industries. The cluster comprises large, medium, small and micro industries, manufacturing products like chemicals, papers, engineering equipment, electronic products, plastic and textiles. The plastic industry in Ramnagar provides employment to about 600 people. Majority of them is associated with plastic sacks and plastic pipe manufacturing industries. There are about 52 plastics industries located in the cluster. These plastic industries fall under the category of micro, small and medium and have been registered accordingly.



Distribution of plastic units as per size

Product types and production capacities

The major products manufactured by Ramnagar plastic industries include plastic sacks/bangs and plastic pipes. The typical production capacities of the units and estimated annual production are shown in table.

Plastic products production by Ramnagar plastic industries

Product category	Number of units	Production (tonne/year)
Plastic sacs & bags	22	2500-7500
Plastic pipes and components	20	950-1250
Master batches	10	5000-7000

Raw material usage in cluster

The basic raw material for making PVC is monomer, and linking these monomer molecules together in the polymerisation process. PVC manufactured from monomers through polymerisation, are solid and chemically stable substances. Ethylene and chlorine are raw materials for PVC. Upstream industries are those that provide these materials and include producers of basic petrochemicals (sometimes known as feedstock, which supplies ethylene, and the chlor-alkali (caustic soda) industry, which supplies chlorine.

Energy scenario in the cluster

Electricity is the main energy source for the plastic industries in Ramnagar cluster is supplied by PUVVNL (Purvanchal Vidyut Vitran Nigam Limited). Diesel, used in DG set during power cuts is procured from local market. The details of major energy sources and tariffs are shown in table.

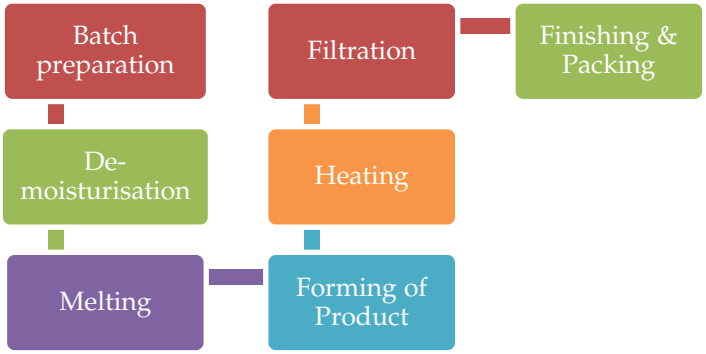
Prices of major energy sources

S No	Energy source	Availability	Tariff details				
			Particular	For supply at 11 kV	For supply above 11 kV and up to & including 66 kV	For supply above 66 kV and up to & including 132 kV	For supply above 132 kV
1	Electricity	Supplied by PVVNL (Tariff category –HV -2)	**Base rate**				
			Demand charges	Rs. 250.00/ KVA/month	Rs. 240.00/ KVA/month	Rs. 220.00/ KVA/month	Rs. 220.00/ KVA/month
			Energy charges	Rs. 6.65/ kVAh	Rs. 6.35/ kVAh	Rs. 6.15/ kVAh	Rs. 5.95/ kVAh
			TOD rate (% of energy charges)				
			22:00 hrs to 06:00 hrs	(-) 7.5%	(-) 7.5%	(-) 7.5%	(-) 7.5%
			06:00 hrs to 17:00 hrs	0%	0%	0%	0%
			17:00 hrs to 22:00 hrs	(+) 15%	(+) 15%	(+) 15%	(+) 15%
2	HSD	HPCL, BPCL, Indian Oil	Rs. 51.5 (inclusive of taxes) as on 27th November 2015				

Production process

The plastic products are made either in continuous mode following extrusion methods or intermittently by moulding process. In extrusion method, initial forming of the ready-to-shape batch material takes place in pre-designed die heads and is further passed through different process steps based on the nature of final product. In moulding process, the ready-to-shape batch material is injected into the pre-shaped mould to produce the target products in one step. Both methods follow broadly similar primary steps such as preparation of ready-to-shape batch, forming and finishing operations. The generic process steps of manufacturing plastic products are explained below. The generic production steps for plastic products are shown in figure.

- *Batch preparation*: Fresh raw material granules, recycled shop floor reject material of similar product, colouring batch master and relevant additives are mixed and appropriately grinded.
- *De-moisturising:* The moisture from prepared batch is removed in this phase. The final batch composition is transferred either manually or automatically to hopper for next process step.



Generic process steps for plastic products

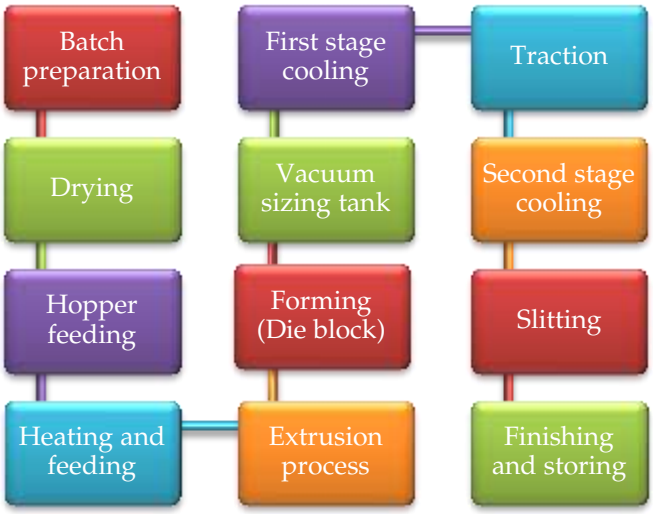
- *Filtration:* Contamination present, if any from the batch is removed using both filtering element and demagnetiser. Filtration is also carried out again after melting of the raw material batch before it is fed to screw in the barrel.
- *Melting and heating:* Temperature of dry composition is increased to change the solid phase to liquid phase while it is conveyed through barrel with the help of barrel screw. Temperature of the molten batch is further increased to pre-set temperature with the help of PID based automatic electrical heater placed on the barrel surface.
- *Forming:* Depending upon the end product, forming is done using appropriate shaping mechanism such as moulding, extrusion, blowing, spinning and drawing.
- *Finishing:* It includes all operations carried out after forming to final product. It may include stretching, sizing, burr removal, printing & embossing, flattening, lamination, stitching, etc.
- *Packaging:* The final marketable products are packed as per marketing and despatch requirement.

The production process for each primary plastic product manufactured in the cluster is explained below.

(i) Plastic pipe and fitting manufacturing units

Plastic pipes are made in various size and length using extruder. These pipes are very suitable for various applications like corrosive environment in chemical industries and municipal application (sewage and water piping), electrical conduit, agricultural pipes, etc.

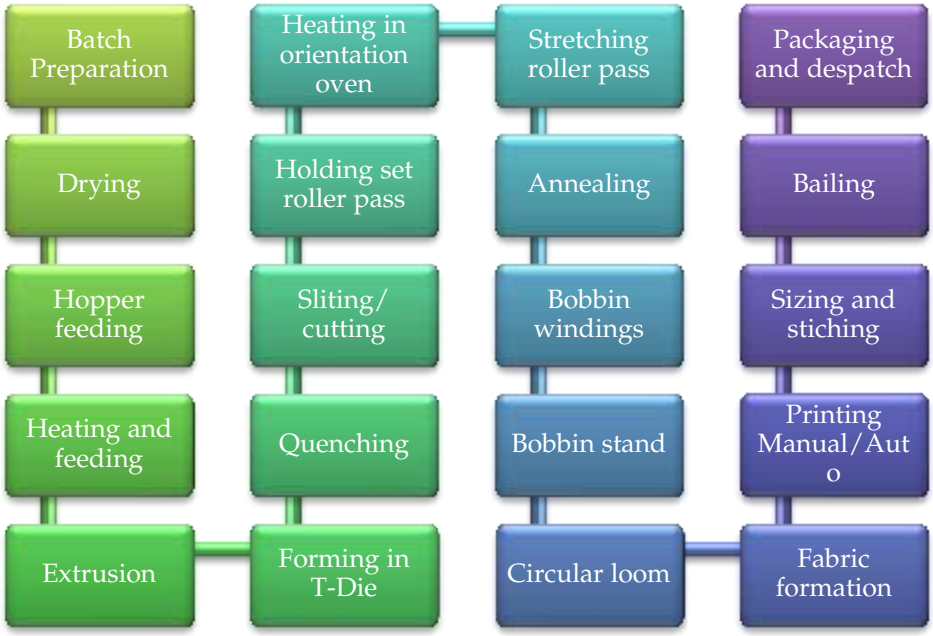
The primary raw materials used in pipe & fittings include HDPE and PVC. Pipes of different colour can be manufactured using appropriate colouring chemical during batch preparation. Pipe diameter depends on die block as well as working pressure in vacuum calibration tank installed in the line.



Process flow chart for plastic pipe manufacturing

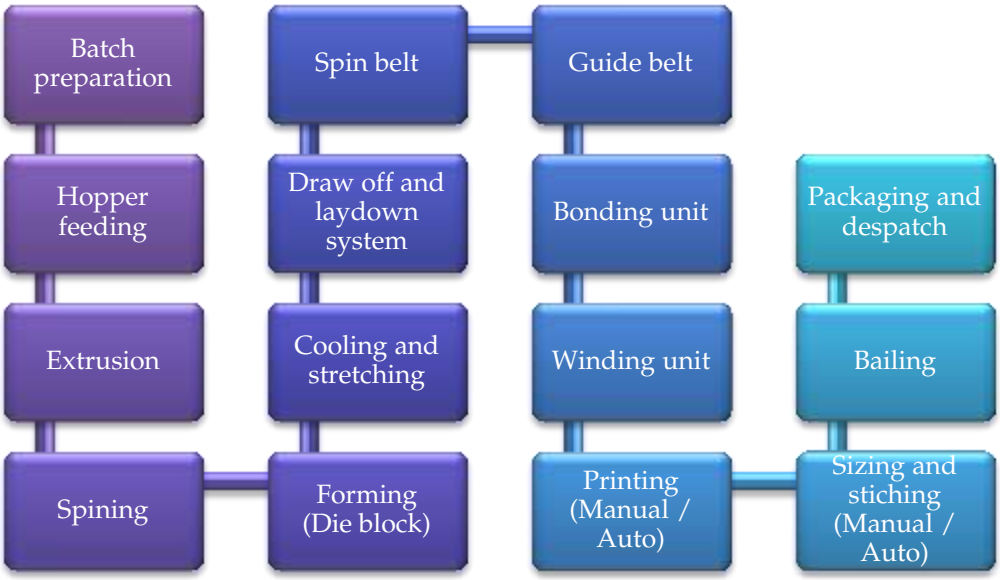
Plastics pipe extrusion commonly uses plastic chips or pellets, which are usually dried to remove moisture and conveyed to a hopper before sent to the feed screw for forming in die. After forming, pipes are cooled and strengthened in cooling and traction phases before slitting automatically to a pre-set length with the help of limit switch. A 'caterpillar haul-off' (commonly called a "puller") is used to provide tension with consistent pull on the extrusion line which is essential for overall quality of the extrudate. The extrudate like fiber-reinforced tube is pulled through a very long die, in a process called "pultrusion".

(ii) Plastic sack and bag manufacturing units



Process flow chart for woven sacks

PP or HDPE or UPVC is used as base material in plastic sacks manufacturing using extrusion method. Sacks could be either woven or non-woven type depending upon process steps in place after die head. Multiple threads from bobbin stand is fed to circular loom to make circular sheet, which is later cut to target size to make woven sacks whereas in non-woven sacks, threads produced after spinning is passed over multiple belts/ rollers arrangement in series to produce continuous sheet roll, which is later used to make non-woven sacks of different sizes. These products are mostly custom made as per order or market demands. The internal surfaces of sacks are also laminated and printed on external surface to meet particular application. Process flow charts for woven and non-woven sacks are provided below.



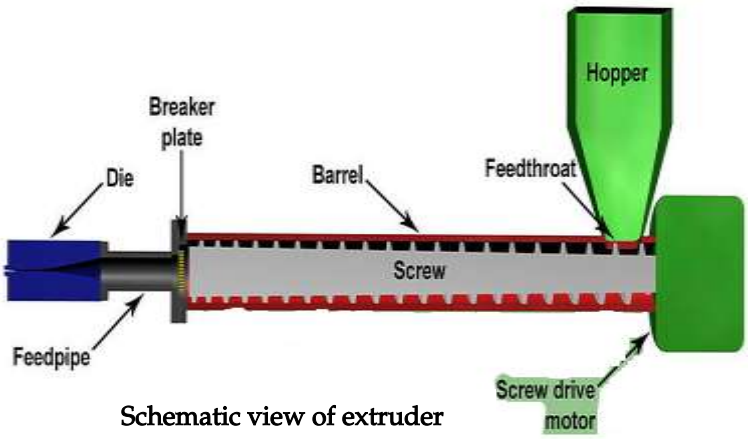
Process flow chart for non-woven sacks

Technologies employed

Plastic industries in the industries cluster use product based forming technology like extruder, injection mould, roto-mould along with connected auxiliary equipment as required for smooth operation of these machines. Apart from forming machines, thermic fluid heater, air compressor, chiller, cooling tower, electrical heating elements, printing and lamination machines, diesel operated generator as power back up is mostly used in plastic manufacturing plants. Some of the primary process technologies are explained below.

(i) Heating coils for melting and heating

Two types of electrical heating elements are placed over the heating barrel to achieve set temperature with built in control mechanism, either on/off or PID (Thyristor based) controller. Most of the conventional electrical heaters are poorly insulated leading to higher surface heat loss. One of the energy efficient heating coils is PID controlled barrel band type with better and compact insulation.

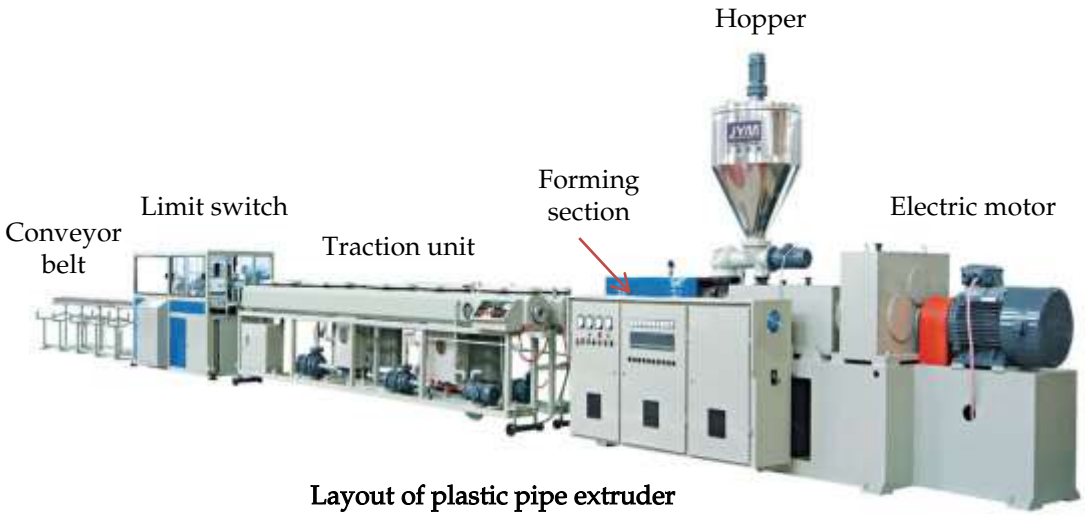


Schematic view of extruder

Source: https://en.wikipedia.org/wiki/File:Extruder_section.jpg as assessed on 28/08/2015

(ii) Extruder

Extruder primarily consists of two sections namely extrusion and calibration as well as strengthening. Extrusion includes screw, hopper, barrel, heating assembly and forming die (figure). The other section has vacuum calibration tank, quenching, traction or caterpillar haul-off, cutting arrangement with limit switch and belt conveyor. Screw movements effect transport of liquid plastic to dies for extrusion process. The formed plastic product cools under blown air or in water bath and gets hardened on a moving belt. High-end advance extrusion machines have built in programmable automatic controlling panel, which is highly efficient. These are used in forming pipes, woven and non-woven sacks as well as blown film. A generic layout view of a plastic pipe extruder system is shown in the figure.

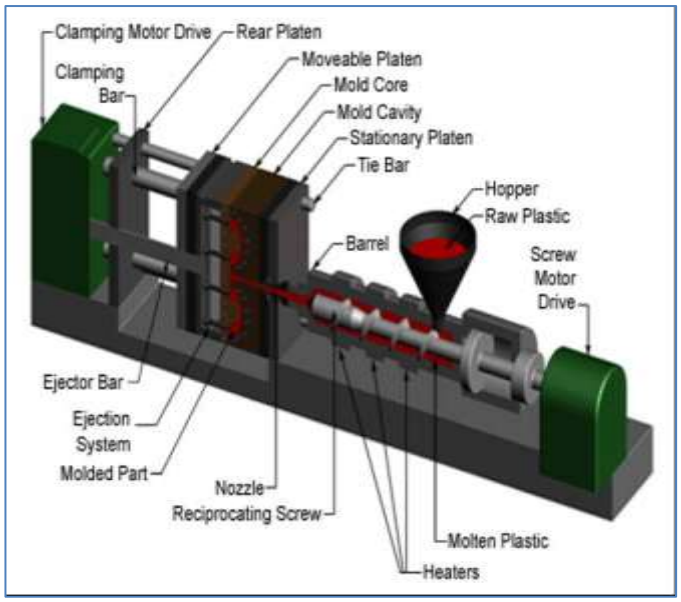


Layout of plastic pipe extruder

Source http://www.eagle-machinery.com/Pipe-Extrusion-Line-1.html as accessed on 28/08/2015

(iii) Injection moulding

Like extruder, injection moulding machine is used to form different plastic products like chair, table, bucket, mug etc. with the help of appropriate mould in place. It basically operates with hydraulic pressure provided by hydraulic power pack. Injection moulding has primarily two sections viz. (1) injection section (includes hopper, barrel, screw, barrel heaters, hydro motor) and (2) clamping section (movable platen (core), fix platen (cavity), clamping shutter arrangement) for clamping force.

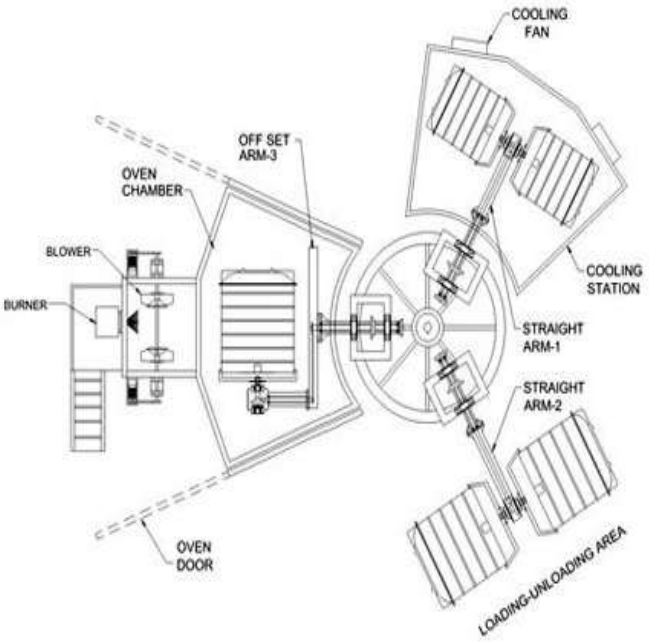


Schematic view of injection mould system
Source: http://www.custompartnet.com/wu/InjectionMolding

Hydraulic system of injection moulding system is equipped with one of the pressure generation and control mechanism out of variable displacement pump, variable frequency drive (VFD) for hydraulic pump and servomotor for hydraulic pump (figure). Of these, servomotor arrangement is the most energy efficient system.

(iv) Roto moulding

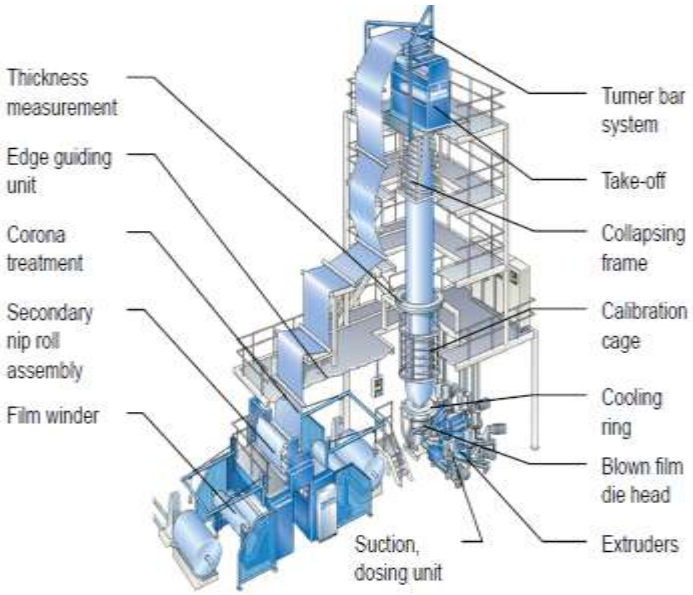
This is specially designed equipment for manufacturing plastic water storage tanks of different capacities. Moulds are fitted at the end of its arm, which can be rotated on its circular axis. The final raw material batch in powder form is manually poured into the mould cavity and later mould is slowly heated to 230 ^{o}C in a closed oven. Conventionally these ovens were oil fired; presently most of them are designed to use LPG. Machine can have multiple arms with maximum two moulds at the end of each arm. At time only one arm is placed inside the heating oven and moulds are rotated in circular axis inside the oven to ensure even heating of the mould body and proper distribution of raw material. On attaining the set temperature and completion of heating, the mould is taken out from the oven and allowed for natural cooling. The product is taken out after cooling down.



Roto mould with three arms
Source: http://www.naroto.com/Rotational-rotomoulding-

Blown film extruder

It is special purpose extruder where extruded raw material pass through the specially designed slit die and blown with adequate air pressure to form circular film tube. Later films are passed through nip rollers and followed with annealing before it is rolled after collapsing for downstream processes. Blown film is used to make plastic sheets and bags of different size for diverse applications.



Schematic of blown film extruder
Source: http://www.polyregion.org/files/attachments/13135/449165_02_Extrusion_of_tubular.pdf) as accessed on 28/08/2015

Energy consumption

Electricity is the main source of energy for most of the plastic units accounting for about 84% of total energy consumption in the cluster. Electricity is sourced from grid. The average connected loads the plastic industry depends on type of products and installed capacities.

Other energy forms used in the cluster include Used Engine Oil, LPG and high speed diesel (HSD). HSD is used mainly in DG sets to meet the requirements during power failure. Power failure is common in the cluster.

Cluster level energy consumption

The total energy consumption of the cluster is estimated to be 2,860 toe per year. Electricity accounts for about 84% of total energy consumption by the plastic industries. The breakup of estimated energy consumption of different types within the cluster is shown in the table.

Annual energy consumption of Ramnagar plastic industries cluster

Type	Annual consumption	Energy equivalent (toe/year)	Equivalent CO_2 emissions (tonne/yr)	Annual energy bill (million INR)
Electricity	27.8 million kWh	2,389	27,244	181
HSD	452 kilo litre	429	1,152	24
LPG	36 tonne	42	107	2
	Total	**2860**	**28,503**	**207**

Pipe & fittings is the largest consumer of energy industries account for more than 60% of energy consumption in the cluster.

Break-up of energy consumption of Ramnagar plastic industries

Industry sector	Energy consumption (toe/year)
Pipe & fittings	1,755
Sacks & bags	450
Household items	220
Others	435
Total	**2,860**

Energy saving opportunities and potential

Some of the major energy-saving opportunities in the plastic units in the cluster are discussed below.

(i) Radiant barrel heater band

Barrel heating is one of the largest energy users at most facilities. Conventionally, it is done with the help of ON-OFF type electrical heating system with improper insulation on its surface. Accuracy of ON-OFF type temperature controller is not very good. Further, improper insulation on the barrel surface results higher heat loss from this surface causing higher power consumption. Thyristor based temperature controllers with appropriate insulation can reduce power consumption in barrel heating. The latest radiant heater band design is more promising solution which is easy to install and maintain. The innovative design hastens warm-up times and can make cool-down systems more effective and efficient. Facilities that have incorporated radiant barrel heater band technology with extrusion machines have seen energy use reduced significantly. Depending on the base case potential energy saving could be in the range of 20-30%.

(ii) All electrical injection moulding machines

Most of the injection moulding machines in the cluster is hydraulic-injection moulding machines. This could be replaced all electrical injection moulding machines, which can significantly decrease energy use of about 50-80%. Electrical injection moulding system has additional control benefits such as improved repeatability and precision and improved cycle times in some applications resulting in faster and more-efficient production with less rejects.

(iii) Application of variable speed drives

Motor driven systems often are oversized and inefficiently controlled. The "variable speed drives" (VSDs) can provide a cost effective method for reducing flow or pressure at the source by varying the speed of the connected load to match the process requirements. Energy savings in VSD applications usually range from 20-50%. Some of the potential applications of VSDs in plastic industry are mentioned below.

(a) Extrusion motor

The barrel screw normally driven through gearbox at constant speed irrespective of load variations on the screw barrel, which is variable at different stages of operation. Hence use of variable frequency drive in place of constant speed will reduce of power consumption up to 20%.

(b) Injection moulding

Hydraulic oil pressure is used to generate forces at time of loading but during unloading phase pressure is released to the tank via return line. Pumping system could be equipped with appropriate arrangement to meet the variable pressure demand in cycle which will result in decrease of overall power consumption for a given cycle. This could be achieved with one of the options out of VSD, servo drive motor for hydraulics or variable displacement hydraulic pump. Out of this, 'servo drive motor' for hydraulics is the best option, which could save of about 30%.

(c) Bobbin winding drive

Use of VSD in place of magnetic eddy current in bobbin windings can save energy to extent of 50-60% per 200 tapes winding.

(d) Optimization of process cooling circuit

This includes the staging of chillers, reducing condenser water temperature and improving pumping efficiency through the use of VFDs and controls. Depending on the required process temperature and application, some of the chilled water demand can be eliminated by using dry coolers or cooling towers in place of chillers. Very often the pumps used in cooling tower system are inefficient and selection is not correct resulting in higher power consumption. The inefficient pumps may be replaced with energy efficient pumps. Optimizing process cooling can reduce cooling costs by 10-25%.

(iv) Compressed air

Compressed air system offers significant energy saving. In some cases it is as high as 40% by improving supply side and reducing end-use demands. Opportunities can be found in the supply side by installing new or optimizing existing equipment and reducing the system pressure. Demand can be reduced through improving end uses and repairing leaks. Blow-off nozzles can be upgraded to high-efficiency engineered nozzles or replaced with a low-pressure electric blower. Some of the potential areas of compressor system with specific option are mentioned below

(a) Arresting the compressed air leakage

Compressed air is an expensive utility in a plant. However, in most cases, air leakages in piping system are quite high (more than 20%) and go unnoticed. The compressed air leakage can be reduced to about 5% with better operating practices. Plant can reduce significant energy consumption by controlling compressed air leakages with no or minimum investment.

(b) Reduction in pressure setting of air compressor

The pressure setting of air compressors are often much higher than the actual air pressure requirement at the point of use in the plant. The typical unload and load pressure settings are 8.5 and 7.5 bar respectively. Reducing the compressed air pressure as per end-use requirements will result in high energy savings. Reduction of generation pressure by one bar can lead to energy saving of 6%.

(c) Retrofitting air compressor with variable frequency drive:

During normal operation, screw air compressor operated on unloading position for more than half the time. Installation of variable frequency drive (VFD) to such compressors will minimise the unload power consumption.

(v) Replacement of rewound motors with energy efficient motors

Rewinding of motors may result in efficiency drop of about 3-5%. It is better to replace old, inefficient motors which have undergone rewinding three times or more. The old rewound motors may be replaced with EE motors (IE3 efficiency class). This would results into significant energy savings with simple payback period of 2 to 3 years.

(vi) Improve power factor at main incomer

The electrical power supply to the most of the plastic industries in the cluster is from Purvanchal Vidyut Vitran Nigam Limited (PUVVNL) utility grid under the tariff schedule HV-2. The initial survey shows that the average power factor at main incomer was in the range of 0.95-0.97. The billing is based on two-part tariff with maximum demand recorded and the energy consumed in kVAh. KVAh billing system is based on the apparent power (kVA) drawn by the industry which do not includes the power factor in the calculation. Due to poor power factor (power factor less than unity), apparent power shall increase and the unit has to pay additional charges as the energy consumption charges. Installation of automatic power factor correction system will lead to reduction in the electricity cost as well as to maintain the billing demand.

(vii) Use of energy efficient lighting

The illumination system for lighting the workspace is using inefficient lighting systems such as FTL (T-8) tube lights, incandescent lamps (200 W) and CFLs (18 - 85 W) and mercury vapour lamps (250-500 W). Use of energy efficient lighting such as induction lamps and LED lighting may lead to reduction in illumination cost up to 50%.

Major stakeholders

The primary stakeholders in Ramanagar plastic industries cluster include the following: manufacturing units and the leading industry association of the region- Ramnagar Industries Association (RIA). The other key stakeholders include Indian Industry Association, District Industries Centre (DIC), NSIC, Naini, Allahabad, machinery suppliers and various government agencies. These actors provide various services to the plastic units, such as training of workers, testing facilities, financial services, technical know-how, raw materials supply and supply of technologies.

Similarly, RIA is another prominent industry association enrolling the local plastic industries including other industries as its members and very proactive to the cluster development. It is very common that the members and plastic entrepreneurs in particular meet together to discuss about the common problems faced by the plastic industries.

Cluster development activities

District Industries & Export Promotion Centre at District Level, Chandauli and Branch office of MSME – Development, Chandpur Industrial estate, Varanasi organises various activities related to technical know-how and marketing and export assistance. The World Bank with the support from GEF has initiated a project to increase demand for energy efficiency investments in target MSME clusters and to build their capacity to access commercial finance.

About TERI

A dynamic and flexible not-for-profit organization with a global vision and a local focus, TERI (The Energy and Resources Institute) is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to tackling issues of global climate change across many continents and advancing solutions to growing urban transport and air pollution problems, TERI's activities range from formulating local and national level strategies to suggesting global solutions to critical energy and environmental issues. The Industrial Energy Efficiency Division of TERI works closely with both large industries and energy intensive Micro Small and Medium Enterprises (MSMEs) to improve their energy and environmental performance.

About SDC

SDC (Swiss Agency for Development and Cooperation) has been working in India since 1961. In 1991, SDC established a Global Environment Programme to support developing countries in implementing measures aimed at protecting the global environment. In pursuance of this goal, SDC India, in collaboration with Indian institutions such as TERI, conducted a study of the small-scale industry sector in India to identify areas in which to introduce technologies that would yield greater energy savings and reduce greenhouse gas emissions. SDC strives to find ways by which the MSME sector can meet the challenges of the new era by means of improved technology, increased productivity and competitiveness, and measures aimed at improving the socio-economic conditions of the workforce.

About SAMEEEKSHA

SAMEEEKSHA (Small and Medium Enterprises: Energy Efficiency Knowledge Sharing) is a collaborative platform set up with the aim of pooling knowledge and synergizing the efforts of various organizations and institutions - Indian and international, public and private - that are working towards the development of the MSME sector in India through the promotion and adoption of clean, energy-efficient technologies and practices. The key partners are of SAMEEEKSHA platform are (1) SDC (2) Bureau of Energy Efficiency (BEE) (3) Ministry of MSME, Government of India and (4) TERI.

As part of its activities, SAMEEEKSHA collates energy consumption and related information from various energy intensive MSME sub-sectors in India. For further details about SAMEEEKSHA, visit http://www.sameeeksha.org