


ENERGY PROFILE

PUNE RUBBER CLUSTER

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The Energy and Resources Institute

SHAKTI
SUSTAINABLE ENERGY FOUNDATION

Promoting Energy Efficiency in SMEs
SAMEEEKSHA


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Abbreviations

Abbreviation	Full form
AIRIA	All India Rubber Industries Association
CFL	Compact Fluorescent Lamp
DIC	District Industries Centre
EE	Energy Efficiency
EPDM	Ethylene Propylene Diene Monomer
hsd	High speed diesel
HT	High Tension
kWh	kilowatt-hour
LDO	Light Diesel Oil
LED	Light-emitting Diode
LT	Low Tension
MS	Mild steel
MSEDCL	Maharashtra State Electrcity Distribution Company Limited
MSME	Micro Small and Medium Enterprises
NBR	Nitrile butadiene rubber
OEM	Original Equipment Manufacturer
SS	Stainless steel
SSEF	The Shakti Sustainable Energy Foundation
TOD	Time of Day
toe	tonne of oil equivalent
VFD	Variable Frequency Drive

Acknowledgements

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The TERI team is indebted to All India Rubber Industries Association (AIRIA), Pune Chapter, for providing support and information related to rubber units in Pune region. TERI especially acknowledges the support provided by the following office-bearers of AIRIA, Pune: Mr Vikram Makar, Senior Vice President, Mr Sunil Bansal, Chairman, Mr Milind K Joshi, Member; Mr D T Keswani, Member, and Mr Kishor Mandke, Secretary.

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 the cluster analysis.

Pune Rubber Cluster

Overview of cluster

Pune, in the state of Maharashtra, is a well know hub of engineering and automotive industries in India. A number of well-known automotive companies such as Tata Motors, Bajaj Auto, Mahindra, Force Motors, JCB, Hyundai, and so on have their manufacturing plants in Pune. Large pump manufacturers like Crompton and KSB pumps are also based in the city. The city also has a large number of MSMEs located in industrial areas such as Pimpri Chinchwad, Chakan, Sanaswadi, and Ranjangaon.

Around 80 to 90 industries manufacturing rubber components are located in Pune region. The industry caters to both the automotive and non-automotive sectors. Various rubber products like seals, hoses, pipes, anti-vibration pads, belts, vipers, rollers, and so on are manufactured in the cluster.

Location map of Pune (Source: Google maps)

Products, market and production capacities

The major raw material for the rubber units in the cluster are natural rubber and synthetic rubbers such as nitrile rubber, also called NBR, styrene butadiene rubber, butyl rubber, and EPDM. In addition, compounding materials like curative, protective, and reinforcing agents are also used. Natural rubber accounts for between 25–40% of the raw material consumption. The major producers of natural rubber in India are Kerala and Assam. The natural latex rubber is vulcanised before being supplied to the component manufacturers usually in the form of rolled sheets. Synthetic rubber is largely imported.

The major products manufactured in cluster are as follows:

- Automotive parts like seals, bushes, O rings, washers, vipers, tubes, belts, hoses, etc.
- Non-automotive parts such as seals, sleeves for pumps and other like rotating machines, hoses, bellows in mining, construction etc. A number of electrical and domestic supplies like rubber mats, shoes, insulators, cushion pads and so on are also produced.

Based on the quantity of raw material consumed in tonne per annum, the categorisation of units is given in following table.

Rubber seal

Categorisation of units

Capacity	No. of units	Raw material consumption (tonne/annum)
Micro	25	20 to 100
Small	45	100 to 500
Medium	10	500 to 1000

Production process

The major steps involved in manufacture of rubber products are mixing of raw materials using mixers/kneaders, and preforming before manufacture of the final products through process like injection moulding, extrusion, manual forming and so on. Certain products require curing in ovens to about 150 °C–160 °C. A process how diagram is given in the figure. The major process steps are briefed below:

Master batch preparation

Raw materials like natural synthetic rubber and compounding ingredients are mixed and ground in mixing mills, also called kneaders to break the rubber into smaller sizes and master batch is prepared.

Sheet formation

The rubber sheets are formed using rolling mill. Preforming of the rubber sheets using a small forming machine is undertaken before processing.

Roller for rubber sheet

Processing operations such as injection moulding, compression moulding, and extrusion

The preformed rubber sheet is feed into injection moulding, compression moulding or extrusion machines, for making the final rubber components. Some components like hose pipes, are made by manual forming process as well.

Autoclave oven curing

The formed rubber components are vulcanized through steam curing in an autoclave at about 150°C. Some industries use electrical ovens for curing. Curing is a batch process after which the components are sent for inspection.

Autoclave

Quality check, packing and dispatch

Final products are manually inspected for quality check. Samples are tested for various parameters like compression stress etc. The final products are packed for dispatch. Utilities like air compressors, cooling towers and chillers are used by the units. Cooling water is used for roller cooling and extrusion cooling, while chilled water is used for cooling of the hydraulic oil of the moulding machines. Compressed air is required for operating the pneumatic compression and mould-cleaning operations.

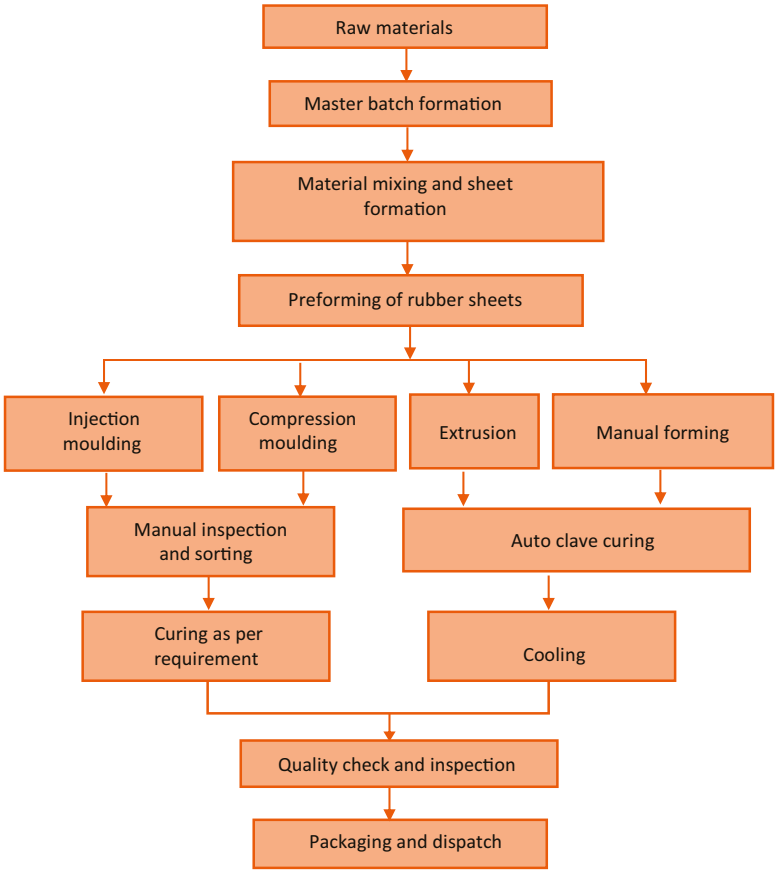
Technologies employed

A number of technologies are employed in the cluster, some of which are elaborated below.

Roller mixer

Kneader and roller mixers

Dispersion kneader mixers are used to mix and grind the raw materials into



Manufacturing process of rubber industry

fine particles. The capacity of these mixers varies between 45–250 litres. These mixers have electric motors between 40–200 hp. Compressed air is required for actuation in the dispersion kneaders.

Most units in the cluster use roller mixers. These mixers have two rolls. The capacity of the mixers range between 2–200 kg/hr. The electric motor rating varies between 7.5–300 hp, with sizes between 30–60 hp, being more common. Cooling water is circulated through the rollers to maintain temperature.

Dispersion kneader mixer

Roller mixer

Injection moulding, compression moulding and extrusion

Injection moulding machines have heaters to heat the mould plates upto 180 °C–200 °C. The mould plates are held with hydraulic pressure during moulding. After moulding, the part is removed and made ready for the next job.

Larger parts are usually manufactured using compression moulding. Extrusion is continuous process used for

making extruded wires, hose, etc. Utilities like cooling water and chilled water are used for cooling the hydraulic oil in the injection moulding and extrusion machines.

Injection moulding

Extrusion

Compression moulding

Vulcanization/curing in autoclaves and ovens

Rubber components made by cold extrusion and manual forming usually requires vulcanization/curing to achieve the desired properties. The process is undertaken in autoclaves where steam at 3 to 5 bar is injected to achieve 150°C. The vulcanisation time varies between 1–4 hours depending on the thickness of component. Some industries also use thermic fluid heaters for heating the autoclaves for some components and curing is done in electric ovens as well.

Air compressor

Cyclose dust controller

Cooling tower

Curing oven

Energy scenario in the cluster

Electricity is the main source of energy in most of the rubber units in the cluster. Almost all the units use electricity from grid. Grid electricity is supplied by Maharashtra State Electricity Distribution Company Limited (MSEDCL). Thermal energy, in form of Light Diesel Oil (LDO), is used in boilers for steam generation by some units. Small amounts of High Speed Diesel (HSD), is used for standby DG set operation. The details of the major energy sources and tariffs are shown in the following table:

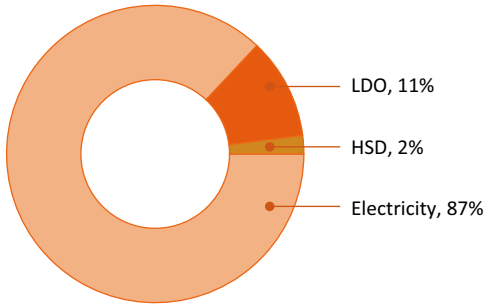
Prices of major energy sources

Source	Remarks	Price
Electricity (MSEDCL)	LT – Industry – General	Demand charges: For first 20 kW of billing demand ₹270/ kWA/month Above 20 kW of billing demand ₹185/ kVA/month Energy Charges: Up to 20 kW: ₹4.76/ kWh Above 20 kW: ₹6.38/ kWh ToD Tariffs (in addition to above base Tariffs): 2200 Hrs-0600 Hrs: (-) ₹1.5/kWh 0900 Hrs-1200 Hrs: ₹0.80/kWh 1800 Hrs-2200 Hrs: ₹1.1/kWh
	HT – Industry	Demand charges: ₹270/- per kVA per month Energy charges: @ ₹6.98/kWh Power factor penalty: average PF is less than 0.9, penal charges shall be levied at the rate of the following: 2% of energy charges for PF between 0.885 to 0.894 (~0.89) 1% of energy charges for every point drop in PF below 0.89 ToD Tariffs (in addition to above base tariffs): 2200 Hrs-0600 Hrs: (-) ₹1.5/kWh 0900 Hrs-1200 Hrs: ₹0.80/kWh 1800 Hrs-2200 Hrs: ₹1.1/kWh
LDO	From local market	₹45 per litre (price subject to market fluctuations)
HSD	From local market	₹65 per litre (price subject to market fluctuations)

Energy consumption

Unit level consumption

The energy consumption for typical micro, small, and medium scale units in the cluster is given in the following table.



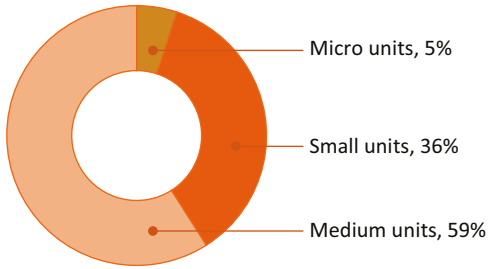
Share of different forms of energy in the cluster

Typical energy consumption of rubber units

Type of industry	Electricity consumption, million kWh/year	LDO consumption, kg/hr	HSD consumption kg/hr	Total energy, toe/year
Micro	0.084	0	172	7
Small	0.36	4,464	430	36
Medium	2.4	33,480	5160	244

Cluster level consumption

The overall energy consumption of the cluster is about 4,226 tonne of oil equivalent (toe) per annum leading to carbon emmissions of 36,624 tonnes of CO_2. The overall energy bill of the cluster is estimated to be ₹350 million.



Share of energy consumption in the cluster

Energy consumption in the Pune rubber cluster (2017-18)

Type	Annual consumption	Equivalent energy (toe)	Total CO_2 emissions (tCO_2/year)
Electricity	42.3 million kWh	3,638	34,686
LDO	536 tonne	523	1,707
HSD	75 tonne	65	231
Total		4,226	36,624

Potential energy efficient technologies

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

Use of energy efficient injection moulding machines with servo drives

Use of injection moulding machines are common in the cluster. In new injection moulding machines are fitted with servo drives, to reduce idle running of the motors. This leads to energy saving of 20-30%.

Improved insulation of the heated plates

Older injection moulding machines use asbestos insulation which deteriorates and lead to higher heat losses. Improved insulation materials are available which can be used to reduce the heat losses.

Thyristor based control of electrical heaters

Normally on-off control is used for controlling the electrical heaters. Thyristor, based control can lead to energy savings of 7–15% and improved coil life.

Use of roller bearings instead of bush bearings

The roller mixing machines uses bush bearings which increase friction losses. Use of roller bearings and new type of gear boxes, could save energy by 20–25%.

Variable frequency drives and energy efficient motors

The roller mixer machine is taking huge inrush currents during start and also during mixing the machine gets off or reduces speed due to over-load. Use of variable frequency drives in roller mixer machines will lead to energy savings. Also, all old rewound motors should be replaced with energy efficient IE3 motors.

Efficiency improvement of boilers and steam system

Presently there is no monitoring of the efficiencies of the boilers used in the cluster. Efficiency can be monitored based on direct method with quantity of steam generation and fuel consumption or by indirect method with flue gas analysis. There is scope to improve their efficiency by monitoring and control of parameters like air-to-fuel ratio and flue gas temperature. Other improvements in steam systems like reducing leakages, improved insulation, condensate collection and flash steam generation will lead to additional savings.

Optimum loading of ovens/autoclaves

Poor loading of the ovens/autoclaves increase energy consumption. Optimum loading of the ovens/autoclaves, with better production planning, will lead to energy saving.

Reducing deadweight of racks used in autoclaves/ ovens

The products, cured in autoclaves/ ovens, are kept on trolleys with multiple racks made of MS plates. The MS racks account for around 90% of the total weight of trolley structure. The weight of trolleys can be reduced by adopting

SS mesh. This would enhance the product to fixture ratio and lead to reduction in fuel consumption. The potential energy saving with this arrangement is estimated to be around 5–15%.

Improved operating practices of air compressors, chillers, and cooling towers

Compressed air is used for mould cleaning and mixer machines for actuating the cylinder. Most of the units are using reciprocating compressors and some are using screw air compressors. The operating pressure of air compressors is kept about 8–11 bar. It is possible to reduce the air pressure to 5–8 bar, which will lead to reduction in energy consumption of the air compressors. It is possible to adopt variable frequency drives in the screw air compressors to reduce their energy consumption. Other operating practice improvements such as improved insulation, decrease of chiller water temperature, better maintenance of the cooling tower, along with temperature-based control of the cooling tower fan and so on will lead to energy savings.

Use of solar energy for electricity and hot water generation

Use of solar energy can be explored for electricity generation and pre-heating of the boiler feed water among the rubber units in the cluster.

Lighting

A large number of T-12 tube lights and CFL lamps are used in the cluster. Replacing these lamps with energy efficient LED tube lights would lead to better illumination and energy savings.

Major cluster actors and cluster development activities

The leading association for the rubber component industries in Pune is the All India Rubber Industries Association (AIRIA), Pune Chapter. It has more than 90 members. The association holds conferences and exhibitions for promotion of rubber products and addresses regulatory issues related to their member industries. The other major stakeholders are District Industries Centre (DIC), MSME Development Institute (MSME DI), banks/financial institutions (FIs), other government agencies and regulatory bodies, research and academic institutions, and testing and training institutes. These cluster actors provide various services to the MSME units, such as training programmes, testing facilities, financial services, technical know-how, regulatory and advisory services.

Cluster development activities

There has been no major development activities in the cluster.

Notes

Notes

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 SSEF

Shakti Sustainable Energy Foundation established in 2009, is a section-25 not-for-profit company that works to strengthen the energy security of the country by aiding the design and implementation of policies that encourage renewable energy, energy efficiency and sustainable transport solutions. Based on both energy savings and carbon mitigation potential, Shakti focuses on four broad sectors: Power, Transport, Energy Efficiency and Climate Policy. Shakti act as a systems integrator, bringing together key stakeholders including government, civil society and business in strategic ways, to enable clean energy policies in these sectors.

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 of SAMEEEKSHA platform are (1) Swiss Agency for Development and Cooperation (2) Bureau of Energy Efficiency (3) Ministry of MSME, Government of India (4) Shakti Sustainable Energy Foundation, and (5) The Energy and Resources Institute.

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

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