SMALL AND MEDIUM ENTERPRISES: ENERGY EFFICIENCY KNOWLEDGE SHARING

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Promoting Energy Efficiency in SMEs

SAMEEEKSHA

VISION

SAMEEEKSHA envisages a robust and competitive SME sector built on strong foundations of knowledge and capabilities in the development, application, and promotion of energy-efficient and environment-friendly technologies.

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CONSERVE IT
Bureau of Energy Efficiency

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Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development
and Cooperation SDC

teri
The Energy and Resources Institute

MSME
MICRO, SMALL & MEDIUM ENTERPRISES

A PLATFORM FOR PROMOTING ENERGY EFFICIENCY IN SMEs

IN THIS ISSUE...

This issue focuses on two of the most energy intensive MSME sub-sectors in India—the ceramic and glass industries. The articles in this issue underline the importance of these two industrial sub-sectors to the nation's overall growth: not only because of their contributions in terms of manufacturing output, export earnings and employment generation, but because glass and ceramic products produced by MSMEs—ranging from glass bottles, tumblers and bangles to ceramic tiles, crockery and sanitary ware—have become a basic and indispensable part of the daily lives of people in every stratum of society.

The theme story provides an overview of the Indian glass and ceramics industries, with a broad outline of the MSMEs operating in each sub-sector and their products and markets. Two cluster profiles follow: on the Thangadh ceramic cluster and the Firozabad glass cluster. In each case, brief descriptions are provided of the technologies and processes in use, and possible energy saving measures that could be adopted by the MSMEs. Also presented is a case study on an MSME unit in the Khurja ceramic cluster that has successfully implemented energy conservation measures, with technical and capacity building support from UNIDO and BEE under a project funded by GEF and co-financed by Ministry of MSME and Ministry of New and Renewable Energy.

SAMEEEKSHA Secretariat

GLASS AND CERAMIC INDUSTRIES IN INDIA

Overview

The ceramic and glass industries are important contributors to the Indian economy in terms of manufacturing output, export earnings and employment generation. The Indian ceramic industry is ranked among the top three in the world in production, with a share of 5.6% in the global ceramic market during 2012–2013: the production of ceramic tiles alone was about 681 million square metres, valued at 195 billion rupees (19,500 crores)[1]. Likewise, the Indian glass industry is among the largest in Asia, in terms of manufacturing capacity and market share; the Indian glass market was estimated at 225 billion rupees in 2012[2].

About ceramics and glass

The history of ceramics began when humans first discovered that moistened clay could be moulded into objects of different shapes, dried, and hardened by heating or firing. Ceramic animal and human figurines dating back to 27,000 BCE have been found in former Czechoslovakia. Glass itself is considered to be a special form of ceramic; it is made in molten state by mixing and heating sand with soda ash and other minerals. Glass is believed to have been discovered in Egypt around 8000 BC, when overheating of ceramic kilns produced a colored, glass-like coating (glaze) on the products. By 1500 BCE, glass was being made independently of ceramics and fashioned into small vases and jewellery items.

In general all ceramics, including glass, share certain characteristics such as high melting points, physical strength, and high resistance to chemical attack, wear, heat, fire and electricity (see Table 1). Because of these properties, ceramics and glass products are used in virtually every aspect of life.

Table 1. Glass and ceramics—comparison

Similarities	Differences	
	Glass	Ceramics
▪ Hard and strong, but brittle ▪ Impermeable to fluids ▪ High heat insulation ▪ High electrical insulation ▪ Can withstand compression	Made from sand; main component is silica	Made from clay; main components are aluminosilicates
	Amorphous (like liquids)	Crystalline
	Transparent or translucent	Opaque
	Can be melted and reshaped	Very high melting points, cannot be reshaped
▪ Chemically inert	Can be recycled	Difficult to recycle

Products and processes

Both ceramic and glass industries have existed in India for millennia as cottage-level units. While large-scale ceramic and glass manufacturing plants have come up during the last century, clusters of MSME units continue to operate in both sub-sectors, using diverse technologies to manufacture a range of products for domestic as well as overseas markets. Prominent MSME ceramic clusters are located at Morbi and Thangadh (Gujarat) and Khurja (Uttar Pradesh). Among glass industry clusters, the Firozabad cluster (located in Uttar Pradesh) produces almost all the glass bangles consumed in India, and accounts for 70% of the

Tunnel kiln in ceramics plant

1 TERI. 2014. Widening the coverage of PAT Scheme: Sectoral Manual – Ceramic industry

2 ASSOCHAM. May 2014. White Paper on Glass Industry. Available at http://www.aigmf.com/white-paper.php

total glass production in the MSME sector. Smaller MSME glass clusters are found in Baroda, Ahmedabad, Mumbai, Kolkata, Bengaluru and Hyderabad. The major ceramic and glass products manufactured in India are shown in Table 2.

Table 2. Major ceramic and glass products manufactured in India

Ceramic		Glass	
Category	Products	Category	Products
Tiles	Wall, floor, vitrified tiles	Container glass	Bottles, jars, phials, etc. for beverages, food, perfumes and pharmaceuticals
Sanitary ware	Lavatory bowls, bidets, wash basins, cisterns	Flat glass	Sheet/plate glass, rolled glass, cast glass etc. for residential and commercial buildings, automotive and architectural applications
Pottery	Tableware, crockery, earthenware, fine stoneware, ornamental ware	Fibre glass	Glass wool; fibre reinforced polymer (FRP) for insulation of roofs, walls, panels
Electrical porcelain	Fuses, insulators	Specialty glass	Products for technical applications in optics, electronics, lighting, engineering, ophthalmology, etc.
Technical ceramic	Elements for aerospace and automotive industries, electronics, biomedical applications	Others	Laboratory glassware, table and kitchen glassware, glass bangles, ornamental products, etc.

Pot furnace for glass melting

Potential for energy saving

The ceramic and glass industries are among the most energy intensive industrial sub-sectors in the country, with energy costs making up a significant portion of production costs(35–40%). While large-scale units have in recent years evolved to adopt modern processes and automation in a large way, many MSMEs in both sub-sectors continue to use traditional, low-efficiency technologies and practices. By way of illustration, Table 3 shows the relatively poor overall energy performance of ceramic wall and roof tile manufacturing units in India as compared to China and Italy.

Table 3.Energy performance of wall and roof tile manufacturers in India compared to other countries

Country	Specific energy consumption	
	Electrical (kWh/ tonne)	Thermal (million kcal/tonne)
India	210	1.34
China	259	1.05
Italy	139	1.16

Source: TERI, 2015. Sectoral Manual—Ceramic Industry

Significant initiatives have been undertaken, with some success, to promote energy efficiency among MSMEs in the Indian ceramic and glass sub-sectors. They include the GEF–UNIDO–BEE Project for Energy Efficiency in MSMEs, being implemented in 11 MSME clusters including the ceramic clusters in Morbi and Thangadh (Gujarat) and Khurja (Uttar Pradesh); and the TERI–SDC Partnership Project implemented in various energy-intensive MSME clusters including the Firozabad glass cluster. As outlined in the articles that follow, there is still considerable potential to improve the energy efficiency of MSME ceramic and glass units through the adoption of energy efficient technologies and improved operating practices.

FIROZABAD GLASS CLUSTER

Background

The Firozabad glass cluster is located around 40 kilometres from Agra, and accounts for 70% of the total glass production in the Indian MSME sector. Glass bangles in India are almost exclusively produced in this cluster. Other glass products include jars, tumblers, signal lamp covers, headlight covers for automobiles, lamp shades, thermos flasks and their refills, and laboratory ware. The total glass melt processed daily in the cluster is about 3100 tonnes.

There are about 415 MSME units in the Firozabad cluster (Table 1). Apart from these basic glass production units, there are a large number of tiny (cottage-level) units in various localities in Firozabad and surrounding villages, engaged in various finishing operations on glass bangles. Three kinds of glass melting furnaces are used by units in the cluster: (1) open pot furnaces, which mainly produce glass bangles; (2) closed pot furnaces, which produce beads, rods, and export quality mouth-blown products; and (3) tank furnaces, engaged in the production of container glass, tableware, bulb shells, tubes, and in some cases, bangles as well. Muffle furnaces are used at the final stage of glass bangle production, for annealing (heat treatment) of bangles to yield the finished products.

Table 1. Profile of glass units in Firozabad glass cluster

Unit category	No. of units	Product	Unit production capacity (tpd*)
Open pot furnace	114	Bangles	7
Closed pot furnace	6	Beads, rods, decorative items	5
Tank furnace	30	Bangles, bulbs, tubes	40
	10	Bulbs, tubes, container glass	50
	5	Container glass, tableware	120
Muffle furnace**	250	Baked (annealed) bangles	–
Total	415		

*tpd—tonnes per day; **0.25 million bangles daily

The major industry associations in the cluster are listed in Table 2. Other important stakeholders include GAIL (India) Limited, which supplies piped natural gas (PNG) as fuel for the cluster; Centre for Development of Glass Industry (CDGI); and the District Industries Centre, Firozabad.

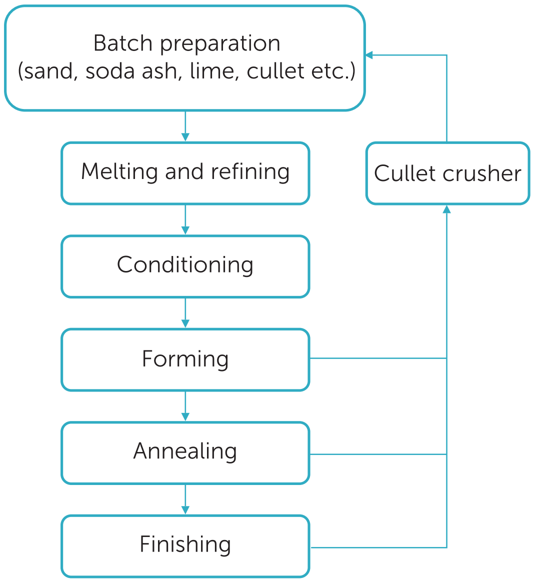
Table 2. Industry associations in Firozabad glass cluster

Unit category	Association
Tank furnaces	Uttar Pradesh Glass Manufacturer Association
Pot furnaces	The Glass Industrial Syndicate
Muffle furnaces	Kada Bangle Association
	Laghu Udhyog Pakai Bhatti Chamber
	Kaanch Audhyogic Sehkari Samiti Ltd
	Bajrang Pakai Bhatti Samiti
	Sahara Nagla Mirza Churi Pakai Bhatti Samiti
	Durbin Samiti
	Janhit Pakai Bhatti Seva Samiti
	Firozabad Sangh
	Kadachaal Pakai Bhatti Cottage Works

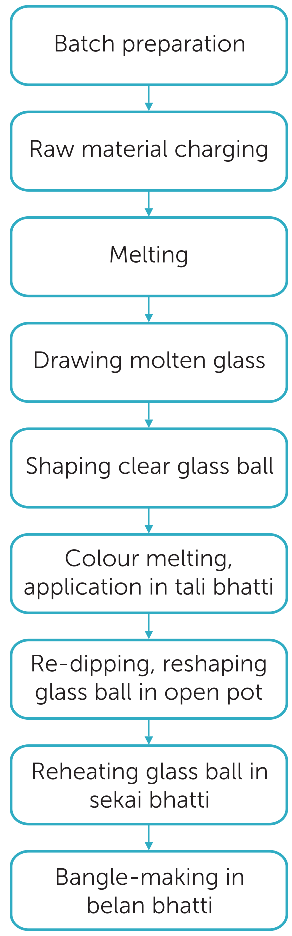
Technology status and energy use

The primary system in a glass unit is the melting furnace, i.e. tank furnace or pot furnace. These are continuous type furnaces fired by natural gas (NG). The primary raw materials used in both tank furnace and pot furnace units comprise silica (sand) and soda ash, along with additives such as lime, cullet, etc.

A tank furnace consists of melting chamber, refining chamber, feeder chamber, and a 'regenerator' that recovers waste heat from flue gases and uses it to preheat combustion air to about 600° C. Molten glass is drawn from the feeder chamber to be formed into the desired glass products, either in automatic



Process—tank furnace unit



Process—open pot furnace unit

presses or blowing machines. In some units, mouth blowing is also practiced for specialized glass products. The formed products are annealed in NG-based annealing furnaces (known as 'lehrs'), and then sent for finishing operations like cleaning, grinding, polishing, cutting, painting and grading (see flowchart).

A pot furnace is an integrated system, wherein multiple small-capacity pots are each charged with manually-mixed material for glass making, and heated simultaneously inside the pot furnace to produce glass melt of different colours. The glass melt is drawn continuously from the pots for processing into finished products. Most pot furnace units produce 'raw' bangles, in the form of uncut spiral-lengths, in a series of steps that involve three other NG-fired 'auxiliary' furnaces: (1) tali bhatti or colouring furnace; (2) sekai bhatti or reheating furnace, and (3) belan bhatti or bangle-making furnace (see flowchart). The bangle spiral-lengths are cut, bundled and sent to cottage units for finishing operations. The finished bangles are annealed in muffle furnace units to obtain the final products.

Energy use

Melting is the most energy intensive operation in the Firozabad glass cluster, accounting for 60–70% of total energy consumption at unit level in both tank furnace units and pot furnace units. Natural gas (NG) is the main energy source for the cluster, used for melting glass as well as other operations within and outside both categories of units. The muffle furnace units in the cluster, which were earlier using coal, have switched over to NG for baking bangles. The cluster consumes about 310,000 tonnes of oil equivalent (toe) annually, as shown in Table 3.

Table 3.Cluster-level energy consumption

Energy source	Annual energy consumption (toe)	Share (%)
NG	277368	90
Others (diesel, kerosene, LPG, etc.)	32632	10
Total	310000	100

Potential options for energy saving

The following measures can bring significant energy savings and other benefits to glass units in the Firozabad cluster.

Reheating furnace - energy efficient

Tank furnace units

Improved tank furnaces

Most of the tank furnaces are poorly designed and use relatively inferior insulating materials for furnace and regenerator construction, resulting in increased structural heat losses and low thermal efficiency of the furnaces. The efficiency of the tank furnaces is further reduced through the use of inefficient burners, absence of monitoring & control systems, and manual control of regenerators. Significant energy savings can be obtained by improving tank furnace design, through the use of high quality refractories and compatible insulating materials to reduce structural losses. Other features of improved design include: (1) compatible burners, (2) optimum heat recovery from regenerator, (3) improved instrumentation for monitoring & control, and (4) automatic damper system to control furnace draft. The envisaged energy saving is 30–35%, equivalent to 48 million Sm^3 of NG per year at cluster level. The estimated investment required is 40 million rupees (4 crores) per tank furnace.

Improved annealing lehrs

The existing annealing lehrs may be replaced with energy efficient annealing lehrs, with an energy saving potential ranging from 40–50%.

Pot furnace units

Almost all the pot furnace units in Firozabad have adopted the energy efficient 'recuperative furnace' design, developed and promoted in the cluster under the TERI-SDC partnership project. However, there is significant potential for energy saving through re-design of the auxiliary furnaces: particularly, the reheating furnaces (sekai bhatti), which do not have any monitoring & control systems, waste heat recovery or chimney arrangements. An energy efficient reheating furnace will have (1) waste heat recovery system (recuperator); (2) compatible burners; and (3) appropriate instrumentation and draft system. The envisaged energy saving is about 25% of NG consumption, equivalent to 4.9 million Sm3 of NG per year at cluster level.

Utilities

Potential energy saving options in utilities include (1) energy efficient compressed air systems, (2) proper sizing of blowers used in pot furnace units, (3) replacement of old motors with energy efficient (EE) motors, (4) replacing inefficient pumps with EE pumps, and (5) EE lighting systems.

Compiled by TERI based on interactions with various stakeholders and on the 'Cluster Profile – Firozabad glass industries', 2015, prepared under the TERI–SDC EESE project

THANGADH CERAMIC CLUSTER

Background

Thangadh is a ceramic cluster known for the production of sanitary ware. The cluster is located near Rajkot, in Gujarat. Morbi, a well-known cluster for production of ceramic wall and floor tiles, is located in close proximity to Thangadh. There are about 225 ceramic units in Thangadh, of which about 180 units are engaged in production of sanitary ware. Some of the other units are engaged in the manufacture of refractories, wall tiles and art tiles.

There are two major industry associations in the cluster: (1) Panchal Ceramic Association Vikas Trust, and (2) Federation of Ceramic Industries.

Technology status and energy use

The basic raw material for production of sanitary ware is fire clay. Suitable quality of clay is available locally. The manufacture of sanitary ware involves wet grinding of the raw material in ball mill to prepare the slip (slurry); pouring of the slip into moulds; natural drying of the cast ware with the help of ceiling fans; glazing of the dried ware; and firing of the glazed wares in kilns at temperatures up to 1250° C where natural gas is used as a fuel. The finished products from the kiln are inspected before packaging and dispatch.

Energy consumption

The specific energy consumption (SEC) of sanitary ware units varies between 0.74–1.06 million kcal/tonne. The major energy consuming areas in sanitary ware units are raw material preparation (ball mill), mould, finishing and drying, and kiln. Natural gas (NG) is the major fuel used in the kiln. The other major energy source is electricity, which is used in electric motors, air compressors, ceiling fans and for lighting applications. The total energy consumption of the Thangadh ceramic cluster is estimated to be about 33,644 tonnes of oil equivalent (toe), as shown in Table 1.

Table 1. Cluster-level energy consumption

Energy source	Annual energy consumption (toe)	%
NG	28050	83
Charcoal	3740	11
Electricity	1548	5
Diesel	306	1
Total	33644	100

Options for energy saving

Thangadh cluster offers good potential for energy savings. The major energy conservation options in the ceramic units in the cluster are the following:

Improvements in kiln

The energy saving options in kiln include waste heat recovery through modifications in flue gas path, improvements in furnace insulation, and replacement of inefficient (on–off) burners with energy efficient (modulating) burners.

Energy conservation measures in electrical systems

Raw material preparation is the main area which uses electrical energy. Some of the measures for energy conservation in electrical systems include adoption of new and energy efficient equipment like IE3 electric motors, super energy efficient ceiling fans, invertor based screw air compressors, energy efficient pumps, improved glazing systems, and use of on–off controllers in agitators.

Use of renewable energy

There is good potential for the adoption of grid-connected solar rooftop power systems among the ceramic units in Thangadh. Typical capacities of these rooftop solar systems range between 50 kW–100 kW.

Compiled by TERI based on interactions with various stakeholders, and on the 'Cluster Profile – Thangadh ceramic industries' report prepared under the GEF–UNIDO–BEE Project for Energy Efficiency in MSMEs

MSME UNIT IN KHURJA CERAMIC CLUSTER SLASHES FUEL CONSUMPTION BY REDESIGNING KILN CAR WITH BETTER INSULATING MATERIALS

Background

The Khurja ceramic industry cluster is one of 11 energy intensive MSME clusters in which UNIDO, in collaboration with BEE, implemented the project titled 'Promoting energy efficiency and renewable energy in select MSME clusters in India' with funding by GEF and co-financing by the Ministry of MSME and Ministry of New and Renewable Energy. Under the project, an Energy Management Cell (EMC) equipped with energy audit instruments was set up in Khurja; unit-level energy audits were conducted by trained personnel to identify potential energy conservation measures (ECMs) that could be adopted by the concerned units as well as disseminated to other units; awareness and training workshops were organized for operators, factory-floor personnel and other cluster-level stakeholders; and technical support provided for units that undertook the adoption of the identified ECMs.

Intervention

Under the project, an energy audit was conducted in Patna Ceramic, a leading manufacturer of HT and LT insulators in the Khurja ceramic cluster. The study revealed that there was scope to improve the energy efficiency of the unit's tunnel kiln by reducing the dead weight of the kiln car—which weighed about 1186 kg—through the use of low-mass kiln furniture.

The existing insulating bricks at the bottom of the kiln car were removed, and the resultant hollow space was filled with 'ultralite' (an improved insulating material with the lowest specific heat compared to the insulating bricks). A supporting block was installed to improve the strength of the kiln car base.

Redesigning the kiln car: L - old structure; R - new structure

The refractory brick base of the car was replaced by ceramic fibre blankets. Also, the refractory bricks at the supporting pillars were replaced with hollow ceramic-coated pipes for holding the racks. With these design changes, the weight of the kiln car was reduced by 17% to 983 kg.

Investments, energy savings, and other benefits

The reduction in weight of the kiln car is yielding significant savings in energy, and also improves the material-to-car weight ratio. Implementation of this ECM entailed a total investment of 55,000 rupees by the unit. Against this investment, the redesigned kiln car is saving around 10,800 litres of furnace oil each year, equivalent to a monetary saving of 302,000 rupees and a reduction in carbon emissions of about 30 tonnes annually. The simple payback on investment works out to barely 2–3 months.

The newly designed kiln car is easy to maintain. This ECM can be replicated in all units having tunnel or shuttle kilns.

Contributed by UNIDO

ABOUT SAMEEEKSHA

SAMEEEKSHA is a collaborative platform aimed at pooling the knowledge and synergizing the efforts of various organizations and institutions—Indian and international, public and private—that are working towards the common goal of facilitating the development of the Small and Medium Enterprise (SME) sector in India, through the promotion and adoption of clean, energy-efficient technologies and practices.

SAMEEEKSHA provides a unique forum where industry may interface with funding agencies, research and development (R&D) institutions, technology development specialists, government bodies, training institutes, and academia to facilitate this process.

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