

IDENTIFICATION OF INEFFICIENT PROCESSES AND RECOMMENDATIONS FOR IMPROVEMENT IN GLASS BANGLE INDUSTRY OF HYDERABAD (PAKISTAN)

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Abstract

Bangle industry is mostly developed from home/cottage industry into small scale industry in Pakistan and still has the inefficiencies in the system which needs improvement. Present global energy crises and particularly price hike up in petroleum and natural gas prices in Pakistan have hit the industry very badly. Flaws of inefficient processes have magnified during energy crises and price hike up reduced their profit margin to a point where industrialists have been forced to improve their processes to become more energy efficient. The present study was conducted as a result of initiative taken by local industrialists facing energy crises which was in dire need of technical assistance to improve upon their energy consumption/efficiency. The present study highlights the inefficiencies/shortcomings of the present system and recommends the way forward for glass bangle industry in Hyderabad.

Keywords: Glass Bangle, Cottage Industry, Glass Melting, Energy Efficiency

1. Introduction

The glass bangles manufacturing is believed to be started as cottage industry which gradually grown over the period of time [1]. In Pakistan and its neighbouring countries different types of glass bangles are well-liked fashion accessories. The industry caters for the need of mainly domestic market and the product demand increases during the festive periods [2].

In Hyderabad (Pakistan), the glass bangle industry is located around three distinct areas; The Sindh Industrial & Trading Estate (SITE) Area, The Old City, and Latifabad. The SITE area is a proper industrial estate, where a number of glass bangles manufacturing factories are housed. Latifabad and The Old City match up rather closely to the "cottage industry", where bulk of the production takes place in tiny workshops operated by families in their houses[3,4]. SITE area has been an industrial estate even before 1947, when Pakistan came into being. Industries present at that time of independence included a glass factory which

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acted as a source for the glass bangle industry to develop in Hyderabad. Presently there are approximately 35 glass factories which are operating in the region for exclusively making glass-bangles.

The immigrant Siddiqui community is the major population group form the hub of the glass bangles industry in Hyderabad. At the time of partition in 1947, these people migrated from Firozabad in western UP (India) and relocated in Hyderabad (Pakistan). Firozabad was, and still it is, a key place for producing glass bangles in this region [6].

2. Introduction to Bangle Manufacturing

There are three main steps involved in the making of glass bangles. These steps are recognized by the output of each step of these manufacturing processes [7]. Firstly, molten glass is formed into spiral shaped open-ended bangles onto a rotating and linearly moving roller. Second stage is to shape it into closed bangle in which the open-ended bangles are straightened and joined to make closed bangles. Finally chemicals are applied to clean, stain and polish the bangles.

2.1. Stage-I: Manufacturing of Spiral Shaped Open Bangles

The molten glass pores down from the orifice in the furnace forehearth in the form of continuous thread (Figure 1), which is rolled while hot, into spiral shapes over a roller (Figure 2). This process requires a great deal of expertise and concentration. As soon as the glass spirals cover the whole length of roller, it is taken out of the roller. The spiral is then snapped to form into an open-ended bangle. These open-ended bangles are collected together into bundle called tora containing about 300 bangles. When these open-ended bangles are in a tora then these are taken out of the factory for further processing.

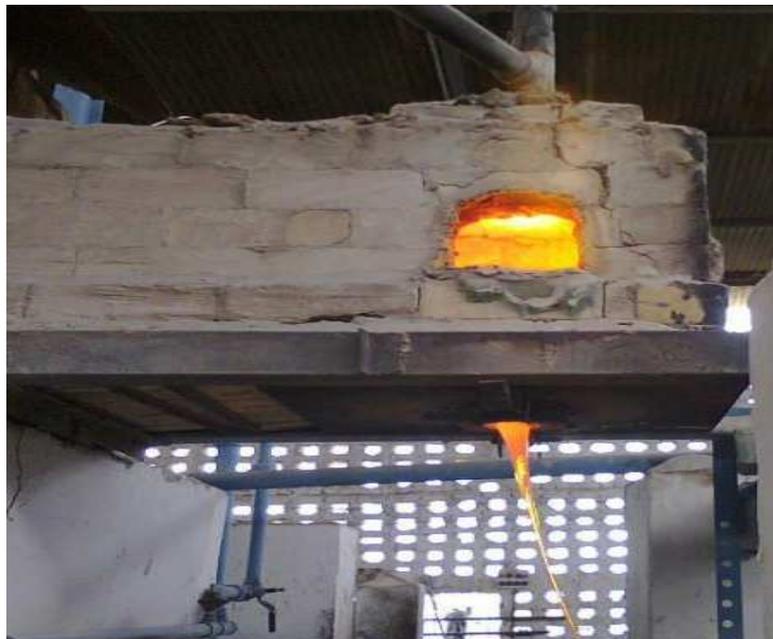


Figure 1: Molten glass coming out of the single gob orifice ring in the form of continuous thread.



Figure 2: Continuous thread of hot glass rotating onto a roller forming into spiral shaped bangle.

2.2. Stage-II: Straightening and Joining of Open Bangles

The toras containing open-ended bangles are taken to mini workshops or to the workers working in their homes in Latifabad or in The Old City. Now the open-ended bangles are straightened by workers called as sadhayyas and joined by workers called as jorayyas. Heat is applied to glass bangles in these two steps which constitutes the second stage. The sadhayyas place open-ended bangle on trays and heat in purposely built small ovens in workshop/homes. The glass bangles are then joined by jorayyas with the help of an open flame over a stove built in small workshops/homes.

2.3. Stage-III: Finishing and Decorating Glass Bangles

The closed bangles are then transported next to series of small workshops or to the workers in their homes where a chain of finishing processes are performed to achieve finished product. Cleaning and reshaping processes need further usage of severe heat which is provided by small stoves/ ovens. However, processes like polishing and staining involve use of different chemicals.

3. Hyderabad Glass Bangle Industry: Brief Introduction to Some of the Facilities Visited

Four industries and SMEDA (Small and Medium Enterprise Development Authority), office in Hyderabad were visited and discussions were made with the factory owners and people working in the production facility. Three of the factories visited were semi-automatic and one was manual. The observations made for each of the industries visited are separately mentioned below.

3.1. SMEDA, Hyderabad

In SMEDA there is provision of glass etching, staining, cutting, sand blasting and bead making. This organization also provides training for glass fusing and decorating the finished products. Moreover, there is an established chemical laboratory for analyses of raw material and/or chemicals and finished product [8].

3.2. Tariq Glass

It is a semi-automatic bangle manufacturing factory which produces flint (colourless) glass bangles. The furnace is end fired which is 18 feet long, 7 feet wide and 3 feet tall. The depth of the molten glass in the melting tank was 26 inches. Pressure gauge showed 4.7 psi pressure of natural gas and opening of the burner nozzle was 5.5mm. The cullet was charged manually through the dog house. The molten glass holding capacity of the furnace is approximately 14 tons. The furnace is attached to a forehearth. The molten glass from a single gob orifice ring comes out in the form of continuous thread and is supported by a steel channel onto the rotating roller to form into spiral shape.

3.3. Shadman Glass Industries

It is a manual bangle manufacturing factory having production capacity of four tons per day. It produces bangles in wide range of colours. They have facility for not only making coloured glasses but also can do colour spray coatings on flint glass. They manually gather gobs of different coloured glasses and make multi-colour bangles (Figure 3 & 4). It was told that their furnace life varies from six months to two years. Local fireclay bricks are used to construct glass melting furnaces where 100 kg of cullet is used along with 20 kg of batch. Selenium metal powder is used for making red colour glass which is not only expensive but also creates health hazards.



Figure 3: Gob prepared by manually gathering different coloured molten glasses on gathering rod is ready to be drawn into spiral form bangles.

Wastage of bangles is high because the bangles go out of factory for straightening and joining. Other source of glass wastage is through gob gathering rods since the operation is manual. This is minimized by the skilfulness of the operator to offer maximum glass to form into bangle and minimum to stick to the rod. Almost 50 percent of the glass is wasted in this manual process [9].



Figure 4: Manually gathered gob on gathering rod is being formed into bangle at Shadman Glass Works, Hyderabad.

3.4. Karam Glass Factory

This is also a semi-automatic bangle manufacturing factory which produces purple colour glass bangles. The furnace is end fired which is 20 feet long, 7 feet wide and 3.5 feet tall. Colouring agents are mixed in the batch along with the cullet to charge manually into the furnace.

3.5. Golden Glass Tube Factory

It is a semi-automatic bangle manufacturing factory that produces flint (colourless) glass bangles. Golden colour is sprayed onto the bangles soon after they are formed and still in red hot condition. It was learnt that cullet is mainly used to melt flint glass as it costs less i.e., only Rs.450 (US\$ 5) per 40 kg and therefore requires lesser energy to melt glass as is required to melt batch. The furnace life is from 6 to 8 months. Wastage is only 2% in the factory [10].

4. Recommendations

Keeping in view the working facilities of the glass bangle industry in Hyderabad, and after having detailed discussion with the management and workers from the industry and fellow expert in PCSIR Hyderabad office, the following recommendations are made [11];

4.1. Heating System for Glass Melting Furnaces

In the visit to bangle industries it was found that un-economical gas burners are being used for melting glasses (Figure 5). Instrumentation is almost non-existent as no temperature indicating devices like thermocouples or optical pyrometers were being used. Decisions are made by the judgement of skilful workers by looking at the hotness of furnace or the approximate adjustment of glass viscosity to shape into spiral on forming machine. As a result a great deal of heat is lost resulting in process being uneconomical and inefficient.

It is suggested that existing burner shall be replaced with more economical gas fired burners which can automatically control burner firing to maintain required temperature with most efficient fuel consumption.



Figure 5: Gas fired burner being used in glass melting furnace.

4.2. Use of Recuperator for Melting Furnaces

Recuperators shall be used to re-use out-going flue gases from the furnace [12]. Waste heat recovery in gas fired glass melting furnaces can be made by the use of waste heat to preheat the combustion air in a ceramic or metallic heat exchanger [13]. Recuperators are continuously operating heat exchangers in which the media for giving up heat and its absorption are separated from one another by a gas-tight heat conducting wall [14]. Depending on the respective flow directions of waste gases and combustion air, recuperators are described as parallel flow or counter flow. Recuperators find application with small to medium size glass melting furnaces as they provide the advantage of more stable furnace operation, free from reversal changes, as is in case of regenerators. Use of recuperators will recycle the energy which is otherwise wasted through fly gasses and hence will make the process more energy efficient.

4.3. Thermal Insulation

Presently there is no proper insulation in place in the industries visited which results in heat loss making the whole process inefficient and uneconomical. The consumption of thermal energy can also be reduced by providing the glass furnace with good insulation [15]. However, more insulation also creates more risks. The ability to observe refractory operating under critical conditions is more limited and rapidly deteriorating situation may not be recognized in time; defects in the glass or, in extreme cases, a breakout of glass or collapse of the crown may result. Insulation should not be applied without a full consideration of the consequences [16]. Not all parts of the furnace can be insulated. The flux line and throat of a tank must be left un-insulated and after a period of operation, or even from the beginning, they will have to be cooled to extend furnace life.

4.4. Refractories for Glass Melting Furnaces

In all present glass melting methods, the molten glass comes into direct contact with refractory lining which has been the subject of increasingly demanding qualitative requirements as melting temperatures rise in the furnace. The production economy depends to a large extent on the life of the refractory lining and thus on the entire furnace [17, 18].

It has been specified that in the manufacture of soda-lime-silica glass, 5 to 15 kg of furnace refractories are consumed per 1 ton of glass [19, 20]. The local bangle industry is using low grade fireclay bricks for the construction of furnaces. The furnace should last minimum for 3-4 years in continuous operation and this can reach up to 7 years but in our case it is 6 - 24months. This is because of intensive flux line corrosion of the fireclay bricks. The use of better quality refractories is suggested at least for the zone of flux level and other high-wear areas can reduce this problem. The selection of refractories for the different parts of a furnace should aim at achieving uniform wear so that the furnace as a whole achieves an adequate life [21].

4.5. Glass Batch Formulation using Trona

Mineral Trona is available in Sindh province (in the surroundings of the area under consideration) and it mainly contains alkali as sodium carbonate and bicarbonate and minor amount of clay [22]. Trona sample were collected for chemical analysis and making batches for glass melting. This will be a cheap source for replacing soda ash in the batch compositions.

4.6. Red Colour Generation in Glass

At present cadmium sulphide and selenium metal powder is being used for producing red colour. It is not only health hazardous but selenium is very expensive too [23-25]. R&D activities need to be carried out to find more economical substitutes to serve the purpose. One such in-house research project of the kind has already been started in PCSIR Labs, Lahore to produce ruby glass [26]. In this project ruby glass is being developed without using selenium which is showing promising results. This will help to manufacture comparatively low cost red glass decorative products and table ware.

4.7. Automatic Bangle Straightening and Joining Machine

One of the industrialists made a demand for automatic machine for straightening (flattening) and joining bangle (fusing the open ends of bangle) as the wastage of bangles is very high as the bangles go out of factory for straightening and joining. A joint effort with the assistance of Department of Mechatronics Engineering, University of Engineering and Technology, Taxila is underway to come up with design to address the problem.

5. Conclusions

A detail visit to the glass bangle industry Hyderabad provided us with the in-depth information about the present status of the industry. There is a great room for improvement in processes being practised right now. Operating conditions and life of glass melting furnaces can be improved by the use of quality refractories and temperature measuring devices. Also, fuel economy can be achieved by the use of efficient gas burners, recuperators, insulation bricks and proper instrumentation (temperature control devices). Low cost glass batch composition by replacing soda ash with local trona and making ruby glass will be of some economic benefit. An attempt will be made to develop an automatic bangle straightening and joining machine with the help of UET Taxila to help in reducing wastage in glass bangle industry.

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