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Upgrading the Glass Bead Making Furnace for Ease of Operation: A Case Study of the Masaga Glass Guild

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Abstract: The glass bead making furnace of the Masaga Glass Guild in Bida, Niger State Nigeria was evaluated in comparison to those of Ghana (Krobo) and India (Firozabad); it was discovered that the Masaga furnace falls short of an efficient system for sustainable work that should facilitate appreciable productivity. Furthermore, the furnace is not built with refractory bricks, implying that it has a short life span; the furnace is operated by hand-worked traditional cloth bellows requiring sustained and strenuous efforts over a relatively long period of time; Following this assessment, efforts were directed at modifying the furnace by producing design drawings of the modified furnace, design and production of refractory bricks from the design drawing, constructing the modified furnace structure using the refractory bricks, producing suitable furniture for the furnace and subsequently, devising a suitable mechanical blower device as an alternative to the manually worked bellows for the supply of combustion air. Consequently, a furnace was developed which eliminates the strenuous manual working of the bellows as well as the bellow operator and ensures that a single individual can work unassisted at the furnace in the process of glassware production.

Keywords: Upgrading, Masaga Glass Guild, Glass Bead making furnace, Ease of operation

I. Introduction

Glass beads symbolizing power, enabling ornamentation and facilitating trade, are masterpieces that have played significant roles throughout time and across cultures [1]. Glass and metal works have been categorised amongst fourteen on the List of Nigerian Arts and Crafts known to provide a source of livelihood for Nigerians [2]. The Glass bead making craft is a part of the culture of the Nupe indigenes of Masaga in Bida - Bida town, situated in 9° 5'N., 6° E., 25 m. N. by E. of Muraji on the Niger, [3] - Niger State of Nigeria and it occupies a place among the local indigenous industries in Nigeria [4]. However, the glass bead making industry amongst others identified by [5] such as traditional soap making, blacksmithing, fishing, wood carving, traditional medicine, calabash carving, etc., is on the verge of abandonment. One major reason identified by [4] to be responsible for the state of decline in the glass bead craft is that a number of participants, who are most closely linked by family ties are required to make the process work; this means that without the younger members of the family who work the manual bellows, the whole operation becomes impossible. These younger ones may seek tertiary education or alternative vocation, which may draw them away from the craft resulting in a standstill in the craft.

The problem articulated above can be attributed to the way the Masaga bead making furnace is designed. A comparative analysis of the types of furnaces utilized by the glassmakers of Ghana, Firozabad as well as that of Masaga in Bida, Niger state of Nigeria reveals that the furnaces utilized by the Ghanaian and Firozabad glass workers require only one individual to work the entire process, the Masaga furnace requires the input of three individuals consisting of the glassworker, the worker of the bellows and a third hand to

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replenish the supply of wood for fuel as can be seen in Plate 3. This set-up obviously requires more labour input and the effect of this is reflected in the cost of products being relatively high as each of the three participants will have to be considered in pricing the articles that are produced. Furthermore, without the input of the other two workers, the process of bead making will be impossible. This situation provides the impetus for a modification of the furnace.

The Egyptians melted glass in small furnaces shaped like beehives. It is observed that wood was the primary source of energy and the materials used to make the glass was placed in ceramic crucibles [5]. The air needed to fuel the combustion was introduced through portals at the bottom of the furnace and let out through a round exhaust vent at the top. The Ghanaian furnaces or kilns, used for making glass beads are constructed from termite mound clay as can be seen in Plate 1. This type of furnace is employed in making beads using the powdered glass method. The moulds used for making the beads are placed on automotive leaf springs that are supported by recycled car axles [7]. A typical pot furnace used for making glass bangles and other glass articles in Firozabad is shown in Plate 2.

The furnace used by the Masaga glass bead makers is usually made of red clay material with pieces of broken ceramic pots used to reinforce the top opening of furnace particularly in spots where the metal tools will rest while forming the glass articles, and also cover the opening where the bellows are connected to the furnace.

Plate 1: Ghanaian furnace with moulds
Source: [7]

Plate 2: A Pot Furnace in Firozabad
Source: [8 Shafi]

Plate 3: Glass Bead making at the Masaga Wood-fired Furnace
Source: [4]

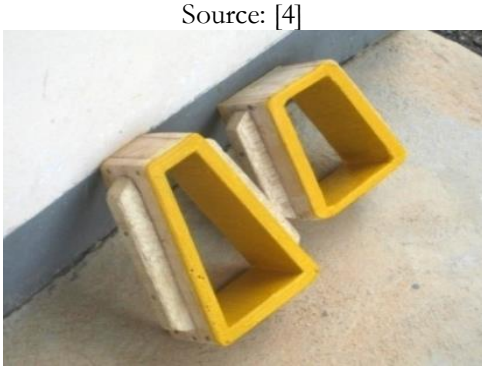

Plate 4: Mould for bricks type 2 and 1

II. Materials and Methods

A. Materials

1. Kaolin
2. Sawdust
3. Water

4. Wooden moulds
5. Metal sheet and circular pipes

The Kaolin used in this work is the Kankara Kaolin sourced from Kankara in Katsina State of Nigeria, while the sawdust was sourced from a woodwork workshop of a roadside carpenter. The wooden moulds were constructed by a carpenter/technician staff of the Department of Fine Arts, Ahmadu Bello University, Zaria, while the metal sheet and pipes were procured from the local scrap market in Zaria.

B. Methods

i. Furnace Design Modification

Furnace modification activities are usually geared towards upgrading technology so as to facilitate energy productivity improvements [9]. With respect to this research work, design modification began first by assessing the current design of the Masaga wood-fired furnace and identifying areas needing modification in terms of materials and method of operation. The modified furnace shape was derived from the "beehive" shape of the current furnace but was made to be circular in such a way that can easily be adapted to contemporary furnace construction methods with refractory bricks and the resultant design can be seen in Figure 1. Preliminary sketches were made followed by Computer-Aided Design drawings of the modified furnace from which brick types were derived (See Figures 2 and 3). Wooden moulds for the brick types (1 and 2) were then constructed according to dimensions calculated from the drawings (See Plate 4).

ii. Insulation Brick Making

The insulation bricks were made by the following procedure: Sawdust and kaolin were mixed in a 1:1 ratio; made to paste by mixing with water; the paste was covered and left to decay for a period of six weeks; the bricks were now extruded using the wooden moulds (See Plate 3).

Plate 5: Extruded Bricks type 2

Plate 6: Extruded Bricks type 1

Plate 7: Metal bench for furnace

The results of the bricks made using the mould for type 2 is displayed in Plate 5, while results of bricks made using a mould for type 1 is displayed in Plate 6. Thereafter, the bricks were left to dry in the open for four weeks (See Plate 6) and finally, the firing of the bricks was then carried out in a kerosene-fired kiln to a temperature of about 1200°C for a period of four hours.

iii. Fabricating the Furnace Stand

The metal stand for the furnace was fabricated by cutting metal pipes which were joined together through welding to form legs for the stand. Steel plates were also cut to size and formed into a circular shape by welding. These were then coupled together and painted (See Plate 7).

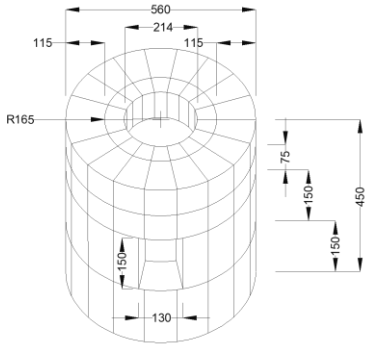

Fig. 1: Isometric of modified furnace with relevant dimensions in mm

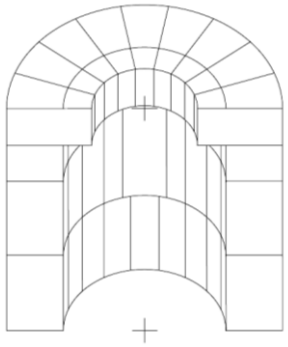

Fig. 2: Section view of modified furnace

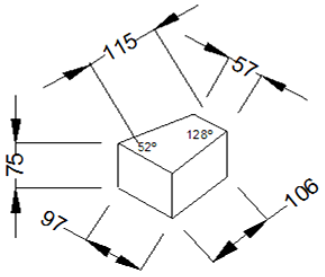

Figure 3: Isometric of Brick type 1

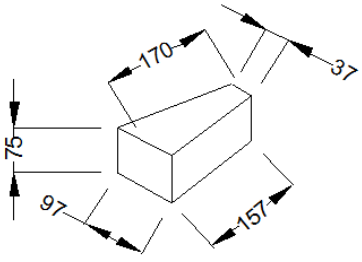

Fig. 4: Isometric Brick type 2

iv. Constructing the Furnace

Construction of the furnace was carried out in accordance with the methods described by [10] and commenced with creating a base for the furnace structure as is shown in Plate 8. Then the first layer of the insulating bricks of type 1 was laid (See Plate 9) with the aid of mortar, composed essentially of a mix of kaolin and sawdust. Using the alternate header and stretcher course method of construction, the same procedure was used to lay the second layer of bricks (See Plate 10); the third and fourth layers of bricks of type 1 were also laid (See Plate 11). Subsequently, the final layers made up of the bricks of type 2 were laid in the final stage of the furnace construction (See Plate 12). The completed modified furnace is presented in Plate 13

III. Results and Discussion

The result of the furnace design modification is presented in Plate 14 showing the furnace constructed with insulating bricks, successfully working and the centrifugal fan designed by [4] to supply combustion air and thereby eliminating the need for an assistant to work the manual bellows.

The modified furnace, which is fueled by charcoal rather than wood, effectively contained the combustion process as well as the heat generated. No heat loss through the furnace walls to the surrounding environment was observed as the outer furnace wall was

Plate 8: Base for the Modified furnace

Plate 9: Laying first row of bricks

Plate 10: Laying second row of bricks

Plate 11: Third &fourth layer of bricks

Plate 12: Final layer of bricks Type 2

Plate 13: Completed modified furnace

Plate 14: Modified furnace in operation

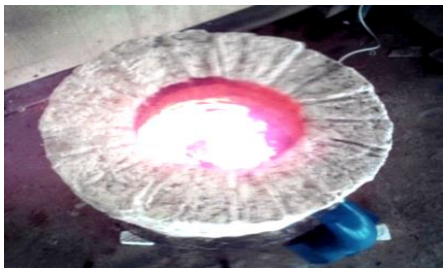

Plate 15: Orange-to-white flame in furnace

observed to remain cool all through and after the firing period. The fan was observed to operate just perfectly, supplying combustion air at an appreciable pressure increasing the rate of combustion of the charcoal and consequently increasing the heat output and invariably the temperature of the furnace. Within twenty minutes of forceful combustion air supply, a deep orange-to-white fire was attained in the furnace, which coincides with the temperature range of about 1,100 to 1,200^{0}C [11] adequate

for any glass-bead working process (See Plate 15)

IV. Conclusion

The Masaga wood-fired furnace design was upgraded and modified in order to eliminate the need for too much manpower input required for glassware production. This was largely achieved through the process of redesigning the furnace to accommodate an electrically powered centrifugal fan which replaced the cloth bellows as well as the operator and in so doing reduced the manpower requirement for the glass bead making process; the glassmaker can by himself replenish the fuel when the need arises since the charcoal content of the furnace will not be exhausted so quickly, thus eliminating the need for extra manpower to sustain the process. The overall effect of the modifications introduced into the bead-making process is that the process of glass bead making can be carried on by a single individual and this is expected to drive down the cost of production and make the products cheaper.

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