

A Survey of Quality Control Practices in the Local Aluminium Scrap Foundries

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Abstract—Quality control reduces rejects and increases production in a foundry. Use of high standard equipment, technics and competitive workforce results in quality products. Industries can be classified on the basis of raw materials, size and ownership. The size refers to the amount of capital invested, number of people employed and the volume of production.

A survey was conducted with an aim of assessing the level of quality control and categorizing the local foundries. A total of forty five foundries located in Nairobi, Mombasa, Nakuru and western Kenya sugar belt were studied. These foundries were using aluminium scrap as a raw material. Data was gathered by use of questionnaires, interviews and site visits to the foundries.

The foundries were categorized into; jua kali, small scale, medium scale and large scale foundries. This classification was based on parameters like aluminium casting practices, capital investments, human resources, volume of scrap consumed, energy consumed, occupational health and safety, and environment conservation.

In this survey it was found that quality control practices such as melt treatment (use of additives, degassers and fluxes), material testing, microstructure analysis and chemical analysis were used occasionally by about 20 percent of the foundries. It was also found that 90 percent of the workforce lacked formal training in foundry practices and the capacity utilization was about 40 percent. As a result most of the products, in general, did not have a competitive edge in the market and could also not find application where high impact and fatigue strength were required.

Keywords—Aluminium scrap, degasser, die casting, grain refiner and modifier.

I. INTRODUCTION

ALUMINIUM is light in weight, resistant to corrosion and has a low melting point. When alloyed with elements like silicon, manganese and copper [1]; its strength increases. During melting controlled additives are added to molten metal to improve castability, fatigue and impact properties [2-3]. As a result the aluminium alloy have a wide application in automobile, house hold utensils, aeronautical industry and general engineering work.

Quality control reduces rejects and increases production in a foundry. Use of high standard equipment, techniques and competitive workforce results in quality products. Industries can be classified on the basis of raw materials, size and ownership [4]. The size refers to the amount of capital invested, number of people employed and the volume of production.

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Recently the Kenyan government banned the export of aluminium scrap [5] and this was reinforced by the East African community member states [6] in order to promote the local foundries. Previous studies [1] on the local foundry situation have touched on useful aspects of foundry like quality control, use of additives and design of castings.

However data on categorization of the local foundries, level of application of quality control, operating capacity and volume of energy consumed is lacking. Further data on workers, their level of training and remuneration is unavailable. This survey was geared at assessing the level of quality control application. To achieve this, a questionnaire was designed and sent to the selected foundries. This was followed by site visits, interviews and the data collected was analyzed.

II. MATERIALS AND METHODS

THE 45 foundries visited during this survey were situated in Nairobi, Mombasa, Nakuru and Western Kenya sugar belt. The distribution of these foundries is shown in fig.1. A questionnaire was designed to collect data in six areas namely capital investment (A), employees (B), the level of technology applied and aluminium scrap melt treatment (C), volume of scrap consumed (D) and energy consumed (E), environmental conservation and safety (F). The questionnaire along with a cover letter from the Jomo Kenyatta University of Agriculture and Technology were posted to all the foundries.

Thereafter site visits and interviews were conducted to give more information. This was aimed at yielding more data, collection of the questionnaire and encouraging those firms who may not have filled the questionnaire.

III. RESULTS AND DISCUSSIONS

OUT of 45 foundries 49 percent responded, 30 percent did not respond and the rest were found to have closed down, relocated to other areas or merged with others as a result of restructuring. The various questions related to parameters A-F were weighted and all response tallied to give a maximum of 80 points. Depending on the total score foundries were categorized into four classes as shown in table I and fig.2.

A. Response to the Parameters A-F

From the data collected the response to the parameters A-F was as follows:

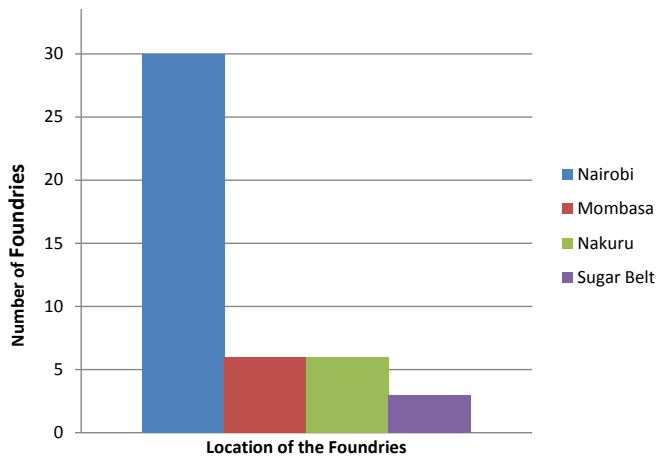


Fig. 1. Distribution of the selected foundries

TABLE I
CLASSES OF FOUNDRIES

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Category of foundry	Jua Kali Foundry	Small Foundry	Medium Foundry	Large Foundry
Total Score Range out of 80	0-20	21-30	31-45	46-80
Average Score out of 80	17	26	33	53
Percentage of foundries in each Category	9.1	36.4	27.3	27.3

1) *Capital Investment*: Equipment used by the foundries were found to include melting furnaces, sand moulding equipment, permanent moulds, pattern making equipment and secondary processing machines. Types of melting furnaces include crucible, induction and cupola furnaces. Capacity of these furnaces ranged between 80 and 500 kg. Most foundries did not have pattern making equipment. The size of land occupied by the foundries was estimated to lie between 0.125 and 2.0 acres and the structures were either permanent or temporary. Most of these institutions lacked material testing equipment and access of the same.

2) *Employees*: Most foundries were found to be dominated by male workers (96 percent) the rest 4 percent being females. Small foundries had less than 6 workers while the big ones had over 60 workers. Majority of the workers had apprenticeship training. Well established foundries were found to have personnel ranging from apprenticeship up to degree level. Small firms had a low wage bill as opposed to big organizations.

3) *Volume of scrap and energy consumed*: Scrap aluminium used was bought locally at an average cost of kshs.100 per kilogram. A kilogram of castings sold at an average range of kshs. 150 - 300 depending on the product. Annual scrap cost

was proportional to the size of foundry and varied between kshs. 100000 and kshs. 8 million. The use of industrial oil has been replaced by use of waste automobile oil which was selling at 20 shillings per litre was available in small quantities. Further it was found that use of electricity was minimal except where induction furnace was used. Coal was being used by only one foundry. Sisal waste and fire wood was being applied to dry sand molds.

4) *Technology and Melt Treatment*: Sand casting was found to favor low production, required a lot of skill and manpower. Other methods like permanent mould casting favored mass production. Many foundries were not applying permanent mould as it had high initial cost and was not versatile. The few foundries that had dies increased their production. Control of chemical composition, melt treatment and proper quality control was ignored in many foundries. Application of fluxes, degassers, eutectic modifiers and grain refiners was partially applied in large scale foundries. Heat treatment, material testing, microstructure, and chemical analysis were carried out infrequently and by a small fraction of only large scale foundries.

5) *Safety and Environmental Conservation*: The level of Safety and environmental awareness was high in big foundries as opposed to small foundries. Both safety awareness and environmental conservation were lacking in small organizations whose workers were exposed to heat, dust and fumes. Small organizations due to financial constraints and lack of strict regulations led to poor work environments. The requirements of legislations, regulations by trade unions, ISO certification and customer specifications have motivated the big foundries to adhere to safety and environmental requirements.

B. Categories of Foundries

1) *Jua Kali Foundry*: Jua kali foundries were found to account for 9.1 percent of the local foundries. These foundries were mostly housed in temporary sheds. They use locally fabricated oil fired furnaces which melted the metal without a crucible thus contaminating the melt. Workers were less than six and not concerned about safety and environmental conservation. The training of workers was through apprenticeship. Molten metal was not treated by application of additives, degassers or fluxes. They depended on sand moulding which was found to be cumbersome during mass production. Neither heat treatment nor mechanical tests were performed on their products. The capacity utilization of the foundry was found to be about 80 percent due to the fact that the owners were aggressive in marketing and the workers were paid by piecework.

The products of these foundries were simple shapes that were not to be subjected to high mechanical forces. Pulleys, decorations, cooking pans and automobile spacers were casted in jua kali foundries.

2) *Small Foundry*: This category was made up of foundries that serviced small engineering workshops that maintain automobile and other machinery. Safety and environmental conservation was observed at about 50 percent level. Foundries serving the engineering workshops were found to be well equipped

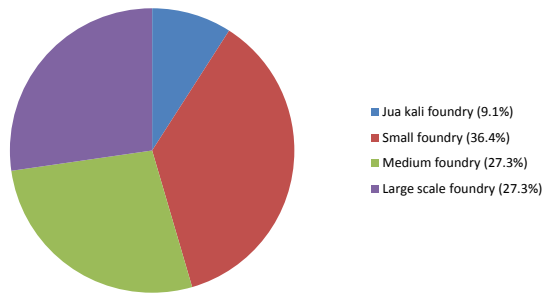


Fig. 2. Classes of Foundries

except that they had about two workers with apprenticeship training. They were casting various types of gears, impellers, machine housings and other machine parts. Since they were maintenance oriented most of the time they were utilized to about 30 percent. They were found to use flux and melt metal in a crucible. The rapidly growing jua kali foundries were also found to graduate into this class. Although they were in temporary sheds they expanded their work force to above six and engaged in mass production by use of permanent molds. Their work force had both certificate and apprentice graduates who were moulding gas stove grills, window latches, cooking pans and decorations. Along the main streets they had opened sales offices and had employed field marketers. Since foundry work was their core business they were utilized up to 90 percent.

3) *Medium Foundry*: These foundries were servicing large engineering firms which were stocked with advanced equipment. Mostly they observed high level of safety and environment conservation. Partial melt treatment was observed whereby a modifier, cover flux or a degasser was used. Their employees were few; about three to four. Their products were single parts like gears and machine components that may have been damaged or worn out. These foundries were utilized up to 30 percent. Besides aluminium, brass and cast iron were also casted.

4) *Large Foundry*: These were found to be foundries involved in aluminium, brass and cast iron moulding. They were engaged in mass production and their products found their way into hardware stores and leading supermarkets. The workers were above 30 and had training up to degree level. Some had branches across east Africa and were able to source materials overseas. They were housed in permanent structures of up to two acres. Their furnaces were oil fired furnaces, induction furnace and tilting furnace. They performed melt treatment thinly; chemical analysis at times, heat treatment and material testing at times. Safety and environmental conservation were taken seriously. Consumption of scrap metal and oil was highest. The capacity utilization was higher about 60 percent.

IV. CONCLUSION

THE following conclusions can be made regarding this work:

- 1) Foundries were classified into jua kali foundry, small foundry, medium foundry and large scale foundry.

- 2) Safety and environmental conservation were not adhered to in jua kali and small foundry.
- 3) Melt treatment (use of additives, degassers and fluxes), material testing and chemical analysis were erratically used by about 20 percent of the foundries indicating a very low level of application of quality control practices.
- 4) 90 percent of the workforce had no formal training.
- 5) There is no professional body to coordinate foundry activities in Kenya.

V. RECOMMENDATIONS

THE following recommendations can be made regarding this work:

- 1) Exploration into ways of creating foundry men society in Kenya.
- 2) Courses should be developed to train workers to upgrade their apprenticeship skills.
- 3) Melt treatment, material testing and chemical analysis should be performed in the foundries.

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