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Foundry Industry of Zimbabwe - The Present and Future

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Abstract

Metal casting is the mother of Zimbabwean industries since their performance is mainly hinged upon cast components. An overview of the Zimbabwean foundry industry showing its state of the art including annual production, number of employees, technology, material, quality and diversity of castings, and common markets is presented. The Zimbabwean foundries were then compared with global leading countries in performance. Challenges faced by the Zimbabwean foundries were identified and potential development strategies were suggested.

Keywords: Economic; Solidification; Agriculture; Manufacturing

Introduction

The metal casting industry is key to the basic economic development and security of any nation. The production foundries melt ferrous and non-ferrous alloys and pour them into molds to shape them into finished products through solidification [1]. These molds maybe metallic or mineral and maybe permanent or expendable. In Zimbabwe, the casting industry supply components mainly to the mining, agriculture, construction and manufacturing industries. The future of the metal casting industry in Zimbabwe holds great promise. Although there are economic constraints, but the demand of castings is appreciably high. The casting industry is grappling with aging machinery of low productivity, limited cast products, poor management, unsupportive government policies, unskilled workforce and depressed market activity [2]. These challenges result in inability to supply products at the right time, in the right quantities, at the right level of quality and at a competitive price to consumers. These factors make Zimbabwean products expensive and at the same time of inferior quality compared to those found on the global market such that most consumers prefer importing.

The foundry industry in Zimbabwe mainly manufactures castings from steel, cast iron, brass and aluminum alloys. The foundries are very few in number, more are operating below capacity and a lot are closed. However, there are many raw materials to satisfy the diverse markets needs of the country. Meanwhile, on the global level, markets for metal castings are increasingly becoming competitive and manufacturers are placing greater emphasis on the rapid production of high quality and competitively priced castings delivered in time. Advanced manufacturing using automation and robots for quality and high volume castings is now being used and specialized casting/melting technologies like investment casting, lost foam casting, suction casting, squeeze casting, rapid solidification, casting of metal matrix composites and levitation melting are now well used [3,4]. The foundry manufacturing technology in Zimbabwe is lagging and casting technology is mainly restricted to sand, permanent, die and pressure casting and the manufacturing steps are manual thereby compromising product quality and productivity. For the Zimbabwean foundry industry to become competitive and maintain a viable industry, these challenges must be overcome.

This article makes a survey of the foundry industry in Zimbabwe since a little attention has been paid to its development for too long. This is the reason the country is depending on imported spare parts for key industries like agriculture, mining, construction and cement manufacturing thereby spending a lot of foreign currency. The annual production, plant productivity, processing technologies and markets for foundries in Zimbabwe were compiled, analyzed and compared with global leading nations. The challenges being faced by Zimbabwean foundries were highlighted and potential solutions for growth were proposed.

The Zimbabwe Foundry Industry

The foundry industry in Zimbabwe is composed of both ferrous and non-ferrous metal casting. The manufacturing generally consists of melting in furnaces, designing and making of patterns and cores, casting in sand, die and permanent molds, finishing and inspection as shown in the flowchart in Figure 1. Planning is done after receiving orders by balancing the product requirements, machine and furnace capacity and start with computer aided drawing (CAD) and computer aided manufacturing (CAE) design. In situations of die casting, dies can be produced in house or sourced from other companies.

Table 1 shows the results of the survey of ten (10) leading foundries in Zimbabwe. The foundries are in this article named by city and number to protect identities of the foundries. The total number of foundries operating in Zimbabwe are very few (less than 20) since a lot were closed down due to economic constraints. The number of foundries, employment and overall production in the industry has shrunk over the last years. Table 1 show the summary of the survey results which do not include suppliers of ingots to other casting foundries.

Process technology

The table show that ferrous metals processed in Zimbabwe foundries are cast iron and steels and these are found mainly from scrap. Melting of these alloys is mainly practiced in the cupola, induction and electric arc furnaces. The table shows that sand casting is more popular in Zimbabwean foundries. This is because it is the least expensive way of making a component and its inherent cost advantage over other methods continues to make it an attractive molding method. The foundry operations are mainly manual and skilled persons work in

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molding, core making, pouring, fettling, machining heat treatment and quality checking. Advanced techniques like additive manufacturing, use of artificial intelligence, rapid prototyping, melting cleaning techniques, simulation to reduce casting defects and quality control using software's are not yet practiced.

The non-ferrous foundries are very few in Zimbabwe as shown in Table 1 and manufacture components from aluminum, brass, copper and bronze alloys. Alumin metal industries is one of the few non-ferrous industry committed to secondary aluminum and copper products. The products are mainly used for light purposes like domestic, irrigation parts, general engineering, etc. and the annual tonnage is very low. These alloys are mainly melted using coke fired crucibles, induction furnaces and reveberatory furnaces.

The ferrous foundries in Zimbabwe produce more that 95% of the total metal tonnage per annum. The total castings production in Zimbabwean foundries is about 10000t and this figure is very small. This affects the profitability of foundries in Zimbabwe due to low yield, high rejection ratio, high cost of production and low market activity.

Employment

The survey showed that there is shortage of skilled employees especially engineers in Zimbabwean foundries. The staffs with degrees are scarce especially in technical areas and foundries cannot afford employing them due to low profitability of their business. The industry is generally considered hard, dirty, low paying, and dangerous to attract talented workers.

Market

The Zimbabwean foundries mainly supply mining, agriculture, construction and agriculture industries both locally and in the region. The ability of the foundry industry to penetrate the global world is slim due to competition from leading nations in quality castings production. Figure 2 show the market shares of the foundry industries in Zimbabwe and it is observed that the major supply of foundry products is the mining followed by the agriculture industry.

Environment

The Zimbabwean government have policies to be complied with by foundries on environmental issues. The biggest problems in foundries are the reclamation and re-usage of foundry sand. As shown in Table 1, sand casting route accounts for about 98% of the volume of annual total castings in tonnage. In addition, other issues like poor working environment, noise, high emissions, toxic effluents, lack of safety clothing, waste management (e.g. water and heat reclamation), recycling and green house are challenges in Zimbabwean foundries.

Energy

The biggest challenge is shortage of electricity such that load shedding is common in Zimbabwe. This affect productivity and interrupt melting processes. The melting process have the largest energy requirements in the foundry and because of the power challenges, companies are now preferring energy efficient electric furnaces to cupola furnaces.

Comparison with Global Foundry Industry

The total annual production of castings for the year 2016 was 104.1million metric tonnes. Top ten (10) leading producers of castings in the world are China, India, USA, Japan, Germany, Russia, Korea, Brazil, Italy and France [5,6]. The castings annual production for 2016 for each of these countries is shown in Figure 3 and the annual production per plant are shown in Figure 4. Table 2 show the total number of foundries for the leading countries in casting production, and show that China is leading. However, as shown in Figure 4, Germany leads in terms of average production per plant. This maybe due to more advanced technologies including automation, use of artificial intelligence and strong management practices. Comparing the average production per plant and the total production per each country statistics show that the Zimbabwe foundry industry is still far away from reaching these figures. High annual production figures in leading nations are attributed to advanced process technology and strong market demands including automobile, aerospace and ship industries [7]. The main recipient of foundry production in these

Foundry City and number	Metals	Market	Casting Method	Total Number of Employees	Annual Tonnage	Tonnes/worker
Bulawayo 1	Cast Iron and Steel	Mining	Sand Casting	65	1080	16.62
Harare 1	Cast Iron and Steel	Agricultural, Mining and Industry	Sand and sand Casting	40	720	18
Harare 2	Ferrous and aluminium, brass and bronze	Mining, Construction, Agriculture and Industry	Sand Casting	45	330 Ferrous +30 Non-Ferrous	8
Norton 1	Ferrous	Mining	Sand Casting	30	2400	80
Harare 3	Cast Iron and Steel	Mining, General Engineering	Sand Casting	34	600	17.65
Gweru 1	Cast Iron and Steel	Mining, Agriculture	Sand Casting	17	100	5.88
Bulawayo 2	Ferrous and Non-Ferrous	Mining, Agriculture and General spares	Sand Casting	36	320 Ferrous +40 Non-Ferrous	10
Bulawayo 3	Ferrous and Non-Ferrous	Industrial, Mining and General Spares	Sand Casting	100	1800 Ferrous +120 Non-Ferrous	19.2
Harare 4	Aluminum, Copper	Agriculture, Domestic, Electrical	Gravity Die Casting	25	120	4.8
Ferrous Total					7350	
Non-Ferrous Total					310	
Other Foundries	Ferrous and Non-Ferrous	-	-	-	1600	-
Total	-	-	-	392	9260	-

Table 1: Summary of performance of leading foundries in Zimbabwe 2016.

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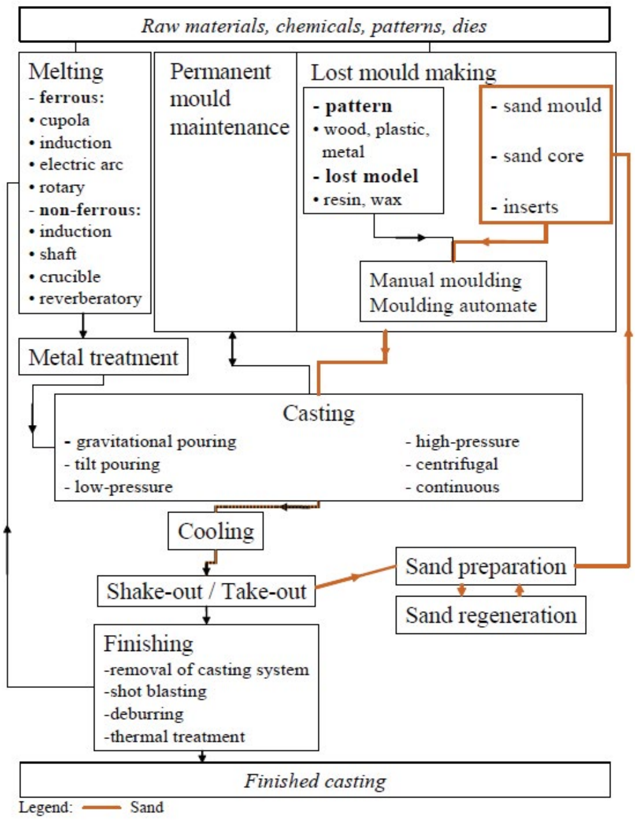

Figure 1: The Foundry Process.

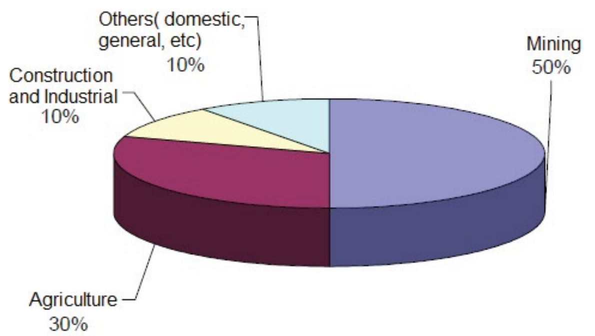

Figure 2: Relative sectoral market shares.

nations is the automotive industry for example the industry consumes approximately 80% of Japanese casting output.

In these leading countries, the foundry has become highly mechanized, enlarged, and with high speed molding, melting, casting and finishing forming a highly automated production line. The processes are monitored by a computer information system that reports both inventory control and manufacturing process data. Figure 5a and 5b show an example of the comparison of the automated casting process from a leading nation with that of a local Zimbabwean foundry which is manual. Thus, in these leading countries, computer based technologies with robust and reliable sensors, cellular concepts and automation control the process and critical parameters in real time thereby improving casting control and production [8,9]. For example infrared temperature sensing devices are used to monitor die temperatures and computed tomography (CT) scanners are used for measuring interior casting dimensions enabling mass production of quality components at low cost. Many operations manually done in Zimbabwe like degassing, filtering, skimming, poring, fettling, fettling are carried out by automation and robots in the global leading foundries. However, there is still strong research and development ongoing in these leading countries to produce new materials like light-weight, high-strength, and thin-wall components essential for competing in new and emerging markets. The foundry technologies in global leading foundries are energy efficient and the governments are strict about environment such that pollution is minimum. In addition, the collaborations between the industry, academia and government is strong in these nations. The government and industry mostly fund these state key researches aimed at providing solutions to the industry and steer projects of national importance.

Challenges and Potential Growth

The foundry problems in Zimbabwe are associated with changes in market demand, product design, product life cycles and changes in production and manufacturing technologies [10]. The foundries need to focus on quality and cost of products, timely delivery of products and the flexibility of the foundry to adapt to rapid global changes [11,12]. The Zimbabwean foundry industry is like a sleeping elephant with a lot of potential due to the availability of local market in need of cast components.

The major challenges can be summarised as:

1) Outdated equipment- poor product quality with variations, low productivity, high manufacturing costs, limited product variety

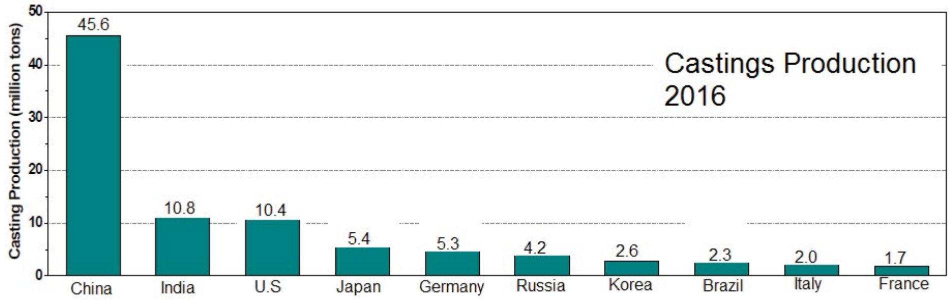

Figure 3: Castings production in the leading world countries [6].

Country	Total Number of Foundries
China	26000
India	4500
US	2060
Japan	1612
Germany	614
Russia	1350
Korea	881
Brazil	1354
Italy	1100
France	454

Table 2: Total number of foundries for each country [6].

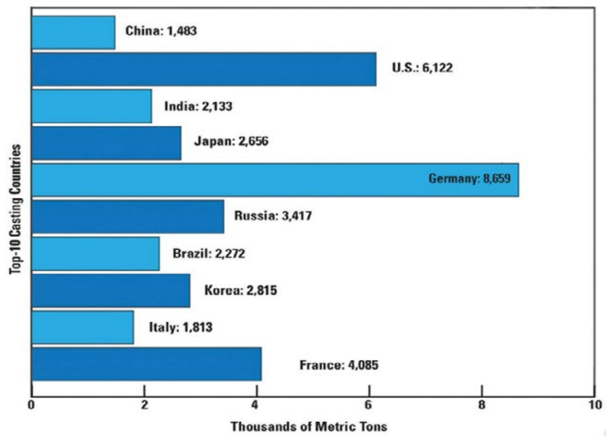

Figure 4: Production per plant for different countries [6].

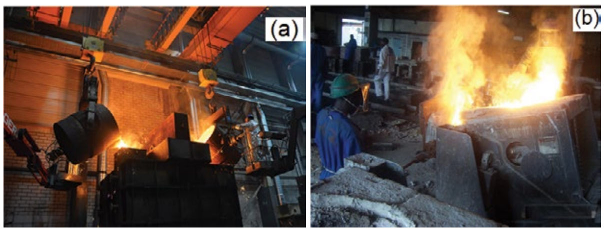

Figure 5: Typical foundry casting in leading (a) global foundry and (b) local foundry.

2) Shortage of skilled workforce specifically trained in foundry-poor foundry practices like poor management, maintenance, poor use of advanced technologies and lack of research and development.

3) Less collaborations with other foundries, academia and government

4) Lack of government support to protect foundries.

5) High energy costs and environmental pollution.

6) Depressed market activity

Potential Growth Strategies should focus on:

1) Investment in advanced foundry equipment and softwares.

2) Training and attraction of skilled personnel especially engineers.

3) Adoption of advanced technologies like computer integration in manufacturing, additive manufacturing, rapid prototyping, melt degassing, filtration, electromagnetic separation, and thermal analysis, simulation, etc.

4) Support of the foundry industry by the government [13].

5) Minimization of emissions through enforcement of green manufacturing principles like sand reclamation, scrubbers, bag houses, fume and dust collection systems, ventilation, heat and waste management [14].

6) Collaboration of foundry industry, academia and industry to solve problems.

7) Look at new casting applications replacing forgings, stamping, and conversion of ferrous to nonferrous castings.

8) Find new regional and global markets

Conclusions

An overview of the state of the art for the foundry industry of Zimbabwe was presented. The Zimbabwe foundry industry has a big potential for growth and will be the key driver of other industries. The industry is producing ferrous and non-ferrous components with an average total of 10000t per annum which is much small when compared to those for other global leading nations. These products are in demand mainly in the mining, agriculture and construction industries. The foundry industry is faced by many challenges including backdated and aging machinery of low productivity, limited cast products, depressed market activity, poor management, unsuportive government policies and unskilled staff. These factors make the Zimbabwean products expensive and at the same time of inferior quality compared to those found on the global market. Solutions to these challenges should include training of foundry personnel, establishment of technical foundry research and training centers, improvements in waste management, use of cleaner production, active use of software for management and solving of problems, research and development, investment in advanced technology, collaboration of industry, academia and government.

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References

1. Jain PL (2003) Principles of foundry technology. Tata McGraw-Hill Education.
2. Madanhire I, Kagande L, Chidziva C (2013) Application of Just In Time (JIT) Manufacturing Concept in Aluminium Foundry Industry in Zimbabwe. International Journal of Science and Research (IJSR) 2(2).
3. Holtzer M, Dańko R, Żymankowska-Kumon S (2014) The state of art and foresight of world's casting production. Metalurgija 53: 697-700.
4. Nakatani K (2008) The present and future status of Japanese foundry industry. China Foundry 5: 205-208.
5. 50th Census of World Casting Production. Modest Growth in Worldwide Casting Market. Modern Casting. December 2015 pp: 26-31
6. Soiński MS, Kordas P, Skurka K (2016) Trends in the Production of Castings in the World and in Poland in the XXI Century. Archives of Foundry Engineering 16: 5-10.
7. Dańko J, Holtzer M (2006) The state of art and foresight of world's casting production. Metalurgija 45: 333-340.
8. Ohnaka I (2015) How to solve complex problems in foundry plants-future of casting simulation. In IOP Conference Series: Materials Science and Engineering 84: 012034. IOP Publishing.

9. Patil SV, Patil DD, Malgave SS (2017) A Review on Foundry Automation by using PLC. International Journal of Engineering Development and Research 5: 3.
10. Schonberger R (2003) World Class Manufacturing Casebook: Implementing JIT and TQC. New York. The Free Press.
11. Karkahnis S (2010) Steps in implementing JIT manufacturing. Harvard Business Review (Mrc): 12-16.
12. Dhilon B (2002) Engineering Maintenance A Modern Approach (1stedn), Boca Raton: CRC Press.
13. Jimoh SO, Iraboh PS, Abhulimen IU, Amiebenormon SO (2013) Casting technology and developments: Nigeria as a case study. International Journal of Scientific and Technology Research 2: 1-5.
14. Masike R, Chimbadzwa M (2013) Cleaner Production Options In Sand Casting Foundries.