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EXPLORING LOW DENSITY METAL CASTING WITH LOCALLY SOURCED MATERIALS

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Abstract

Casting in general term is the art of producing a particular item or product either through mass production or selected in number. Metal casting therefore is an art of melting metals and with the use of crucible cast any machine or its spare parts either in a thick or thin manner. It can also be defined as producing things that can be used in the production of other items. The study is to test the authenticating and stamina of clay body in conformity with how to keep the mold at the temperature of the metal that is being melted for the cast. Different stages of the casting would be used which includes the use of two furnaces; one of the furnaces is for the mold to keep it at the temperature that will melt while the other furnace is to help the metal to go a bit further as against what the traditional casters have been doing for ages thereby achieving a little with much effort. This study is to develop a workable hypothesis whereby casting can be done using different casting approaches with regulatory approach in casting both thin and thick metals with the aim of achieving faster output. The result of which will be to use less quantity of metal for multiple and effective casting.

Keywords: Metal, Temperature Casting, Clay body, Mold, Furnace

1. Introduction

In the present reality of our capitalist driven world, it will be wishful thinking to assume or expect that the time will come one day when the West will transfer her technology and knowledge to develop Africa. Even for humanitarian or health reasons, the developed countries that have invested on technological research and development will always expect to profit from their inventions and innovations; they will continue to monopolize their knowledge for as long as it is profitable to do so.

We are enduring technological colonialism by our continued reliance on imported technologies and facilities. Any rightful thinking people will proactively free themselves from any form of technological bondage by working on the art of developing indigenous technology within their tropical or geographical slot.

Nigeria has a renowned history of metal technology; the ancient cultures of Nok, Igbo-Ukwu, Ife and Benin are known world over to have explored mutual technology centuries ago; and instead of consolidating over historic heritage, we find ourselves in a generation that waits for the West to produce them while we buy. Now that government cannot buy equipment for metal casting, we have to look inwards and pick up where we left off. Our fate cannot be continually determined by importation of imported technology or foreign expatriates; the stalled Ajaokuta iron and steel project is an example of how over reliance on foreigners can halt national development, we have the human and natural resources, we have

the history of metallurgical heritage the understanding of metal technology to a large extent, determines the fate of the world. The only fighting chance is to allow basic research and development to go on in our universities, polytechnics and colleges of education, because these were created to explore and develop models to solve pressing problems.

2. Solving Casting Problems

It is logical to deduce that if nations that have mastered metal technological development are rated among the developed nations, then our under developed metal technology as a nation must be related to our status as an under developed nation, although we would prefer to be referred to as a developing nation, but until we develop our attitude towards technological development and become a nation that develops manufacturing technology, we will never develop as a nation. Our over reliance on imported metal casting technology has hindered the development of the indigenous industry.

Metal castings are essential building block of any developed nation as metal casting is of the oldest and ancient manufacturing methods that has been in use since 320BC in Mesopotamia; and till date, there are number of improvement, that have been effected on the technology in other to improve production and efficiency, as well as to reduce product cost (Mohammed et al, 2017).

The role of metal technology in the establishment of world powers has been established even before the Iron Age. John Parrish in his 1956 paper titled “Iron and steel in the balance of world power posit that the East-west conflict goes back to the beginning of the industrial revolution of 1750-1800. Metal casting technology has been consistently synonymous with great civilizations throughout the world history (Usen and Bozimo, 2019.

The potentials of proactively engaging students in universities, Poly- and Mono-technics including colleges of education to continually explore new vistas in metal casting technology, can only do more good than evil hence the justification for this study is a step in the right direction that is long overdue; not only will the problem of relying on imported metal technology facilities be solved but also the problem of high density metal casting objects will be tacked, with the hope of pressing forward towards precision casting. Precision casting is the prerequisite toward automation, mechanization, robotics and industrial technology. Nigeria is endowed with natural and human resources to fully engage in explorations of metal technology; sadly, however, Nigeria tertiary institutions have graduated students in engineering and sculpting without the experience of casting metal into forms, objects or equipment, an abnormally that this study is poised to stop. Emekpe (2019).

The objective of this study is to cast low densities metal object; this study believes the successfully casting low density objects in metal is the precursor to precision casting; which in then is the key to technological development.

The Specific Objectives are:

To test and process locally scraped materials suitable for metal casting

To design, develop and produce efficient equipment for low density metal casting.

To test and determine the most efficient process to achieve low density metal casting.

To test fueling system for low density metal casting.

3. Reconciling Casting Methods

It is common knowledge that government cannot sufficiently fund education at all levels in Nigeria. The several standoffs between the Academic Staff Union of Universities (ASUU) and government are sufficient evidence that government is groaning under the weight of funding education in Nigeria. This is rather grossly unfortunate as other nations of the world are clamoring for developmental process through technological innovations in a competitive manner. Part of ASUU demands that were made public is for government to upgrade all obsolete educational equipments and facilities, the noncompliance by government has

left many generations of graduate from Nigeria tertiary institutions to remain theorists with very minute or no practical experience at all.

Take engineering department in CRUTECH for instance, where students take a course in mechanical called metallurgy and never had the experience to cast anything in metal or a course in Fine Arts sculpture titled “metal technology” also with no experience in metal casting…this is rather unfortunate. Many generations have graduated without casting sculpture in aluminum or bronze. The lack of practice has even made many lecturers forget to practice their skills after two decades owing to lack of demonstrative teaching.

More than 90% of manufactured durable goods and 100% of all manufacturing machinery contain metal casting (American foundry Man’s societies, 1998). Muhammed et al (2017), Lanton (2019).

Helmenstin (2019), defines metal as a substance with high electrical conductivity luster, and malleability which readily loses electrons to form positive (ions).

The flash points of numerous ceramic materials that are locally available informs this study that the flash points of most basic metals that are locally sourced are design interventions that are currently In tune with refractory and insulator materials; which can produce an efficient facility locally to cast low density metal casting and stop the dependency on foreign equipment for teaching and practice of metal technology.

This study is delimited to the use of investment casting method; this is because of its process; also sand casting cannot always make the small and intricate parts possible (Done, 2016).

Foundry variable that determines low density casting include: casting design, heat transfer, gating design, and metal fluidity; because wall thickness and pouring temperature have no greatest effect on casting fill.

Helman (2021) recommends that shell mounding in the casting process enables the manufacturer to create complex parts with thin sections and small proportions, it also imparts high dimensional accuracy and is particularly suited for casting under 75kg.

4. Casting Process

The methodology for this study is experimental and it is hinged on the hypothesis that, “As long as the temperature of the mold is consistently sustained with the temperature of the molten metal, even the thinnest and most intricate sections of the mold will receive molten metal before the metal freezes.”

Figure 1: Stabilizing the Furnace

This hypothesis has informed the action plan to source for retractable bodies that can sustain very high temperature without cracking. To achieve these two furnaces means they would be designed to be used simultaneously; one for keeping the high temperature of the mold, the other to melt the metal.

The area of study is Calabar; the site is Cross River University of Technology, Calabar. The inhabitants have costumes that embrace the use of precious metal objects like bronzes, brasses and copper for marriages and other traditional activities. Items such as basins, bangles bridal staff and others metal objects are in high demand in Calabar is also the home of the biggest carnival party in Africa; so it is a tourism destination and any successful metal technology project here will not be out of place. Emekpe (2019) emphasized on the need to train women in the art of brass making as it is the core of items for the Efik traditional marriages.

Figure 2: Wax Melting Process

Cross River University of Technology has Engineering and Visual art department that also engage in metallurgy and metal technology respectively. It is not an understatement to say that the successful execution of this project will be ideal for this locality and the environment.

Figure 3: Creating the Burner Space

The demographic data of those that would benefit from this project cannot be exhausted because as a tourist destination, this locality is always open to visitors. The existence of locally sourced materials is abundant, clay dump exists in the Tinapa axis, and hardwood charcoal can be produced from the mangrove swamp woods; however, until final analysis, it is too early to recommend this best form of fueling for this project.

Figure 4: Furnace Base Preparation

Figure 5: Furnace Reinforcement

The rationale for this research is to first test the first clay body used to cover whatever is to be used for the cast. The hypothesis arrived at will be the pointer to see if one can keep the mold at the temperature of the metal that is being melted. By implication, no matter thin it is in as much as it is still at the temperature of the melting metal; it will still pass through the tiny spaces in the crucible.

Unfortunately, the traditional casters seem not to know this because of impatience to see if the hypothesis is true and that one can keep the mold in a hot state at the temperature that the metal gets melted at the same time still allows the meta to flow into all the crevices while still in the molting stage. So if it is correct, then no matter how tiny such work to be cast is, once the mold can be kept at the temperature of the metal, the cast will come out successful as the first key to precision metal casting. In essence, one can successfully cast any object in the areas of engine spare parts, medical equipment etc. no matter how thin using this method.

In carrying out this research, two furnaces were used; one for the mold…to keep it at a temperature capable of melting the metal. The other furnace took care of melting the metal; meanwhile the one for the mold is made of clay. This was possible because the best clay body was tested and later used to cover what was cast. This was simply because it was envisaged that some molds would crack because of a drop in temperature. This is why it is good to first ascertain the authenticity of the clay body.

The pictures below show the pouring of the molten brass into a mould embedded in a furnace. Different sizes of objects will now be open for casting having seen the success recorded so far with the conviction that a cast can be successfully done no matter how thin the object is. More samples of smaller works with thinner walls will be produced, this is to validate the element of control to achieve light weight sculptures. With absolute consistency of casting several samples, there is the possibility of shedding more light on new technique for precision casting as far as casting is concerned in Nigeria either in bronze or metal.

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