

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
(KNUST)

KUMASI, GHANA.



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INDIGENOUS PROCESSING

TOPIC: THE TRADITIONAL EXPLORATION OF CASTING

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3. 1965522
4. 1965622

LECTURER: PROF EMMANUEL KWESI ARTHUR .

ABSTRACT

Casting is a centuries-old time-honored craft that has been producing exquisite machine parts and objects. This report provides an in-depth analysis of the art of casting, evaluating its significance, traditional techniques, contemporary practices, and working tools. The report delves into the creative and artistic aspects of casting, highlighting the craftsmanship involved in designing and crafting unique and personalized metal pieces. It also sheds light on the challenges and advantages in the casting industry, including the cost of materials, time-intensive production processes, specialized equipment requirements.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

According to Biblical records casting technology can be traced back to 5000 BC. It is possible that metal casting technology, using molds originated in the Middle East. However, there are suggestions that this process may have been developed in India and China. It is said that the first steel products were made in India in 500 B. C., but the process was lost. The earliest records of casting methodology are the writings of monk Theophilus Presbyter in his book *Schedula Diversarum Atrium*. He has described in detail the casting of the famous Perseus and Head of Medusa.

The Casting is a crucial factor that lead to the progress of each civilization. The important ages of the prehistoric times is named after the metal that was prevalent used in that age.



Fig 1.1. The casting ladle in use.

Casting is a manufacturing process in which molten material, like metal, is poured into a mold and allowed to harden. Once solidified, the mold is broken or ejected to retrieve the casting. This method enables the production of intricate and complex components with specific properties. A person involved in this type of field is called a metal caster. Casting is most often used for making complex shapes that would be otherwise difficult or uneconomical to make by other methods. Heavy equipment like machine tool beds, ships' propellers, etc. can be cast easily in the required size, rather than fabricating by joining several small pieces. Casting is a 7,000-year-old process. The oldest surviving casting is a copper frog from 3200 BC.

CHAPTER TWO

MATERIALS NEEDED

Casting involve a variety of materials which are used to produce a objects . Most popular among these materials include:

1. Magnesium

Magnesium alloys are commonly used in casting due to their lightweight properties and good strength-to-weight ratio. They are often utilized in applications for which weight reduction is crucial, such as aerospace components and automotive parts.

2. Aluminium

Aluminium is a versatile casting material known for its excellent corrosion resistance, high thermal conductivity, and good mechanical properties. It is widely used in various casting methods, including sand casting, die casting and investment casting.

3. Iron

Iron is a widely used casting material that comes in different forms, including grey iron and ductile iron. Grey iron is known for its good casting properties, high thermal conductivity, and damping capacity, making it suitable for applications such as engine blocks, pipes, and automotive components. Ductile iron, also known as nodular or spheroidal graphite iron, offers higher strength, toughness, and ductility, making it ideal for applications requiring greater load-bearing capabilities.

4. Zinc

Zinc is commonly used in die casting due to its low melting point, excellent flow characteristics, and dimensional stability. It is often chosen for casting intricate shapes and thin-walled components.

5. Steel

Steel is a strong and durable casting material used for applications that require high strength, wear resistance, and impact resistance. It is suitable for heavy-duty components subjected to harsh conditions, such as machinery parts, construction equipment, and tools.

6. Copper Alloys

Copper alloys, such as bronze and brass, are popular casting materials known for their excellent electrical conductivity, corrosion resistance, and thermal conductivity. They are commonly used in electrical and plumbing components, decorative items, and musical instruments.

7. Lead Alloys

Lead alloys are utilized in certain casting applications, primarily due to their low melting point and malleability. They are used in specialized industries, including radiation shielding, battery manufacturing, and certain industrial applications.

Material	Density ρ (kg/m ³)	Thermal Conductivity k (W/mK)	Specific heat C_p (J/kgK)	Thermal Diffusivity $\alpha = k/(\rho \cdot C_p)$ (m ² /s)
<i>Casting</i>				
Aluminium	2707	204	896	8.418×10^{-5}
Zinc	7144	112.2	384.3	4.106×10^{-5}
Lead	11373	35	130	2.343×10^{-5}
<i>Mould</i>				
Steel	7700	42	611	0.892×10^{-5}
Graphite	1890	174.5	670	13.8×10^{-5}
Graphite-lined Steel (Composite)	3321*	67.24*	663*	3.053×10^{-5}

* Calculated using equation (1)

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Int. J. Cast Metals Res., 2002, 15,

Fig 2.1. Thermo-physical properties of casting materials

Some tools used in casting include the following:

- Hand riddle
- Shovel
- Rammer
- Sprue pin
- Strike of bar
- Mallet
- Draw spike
- Vent rod
- Lifter
- Ladles
- Smoother
- Spirit level
- Gate cutter
- Daggers
- Bellows
- Clamps, cutters, and wedges



Fig 2.2. A set of sand casting tools.

CHAPTER THREE

PROCESSES INVOLVED IN CASTING

The casting process, specifically sand casting, involves the following:

- Coremaking

Many part designs require the inclusion of cores in the casting mold. Cores are solid materials placed inside the mold cavity to create interior surfaces of a casting. For example, a metal pipefitting will require a cylindrical core inside the mold cavity to create the hollow construction of the component's interior.

- Molding

At this point, the manufacturer can create the casting mold. A material such as sand, plaster or wax is used in expendable mold casting, whereas metal and other durable materials are used in non-expendable mold casting techniques. The material fills the casting mold model and is allowed to harden, at which point the manufacturer removes it from the cavity and the casting of the component can now begin.

- Melting and Pouring

Metal must be properly melted prior to being placed in the mold. Typically, this is done by using what is known as a crucible. Crucibles are containers made of porcelain or another melt-resistance substance in which a manufacturer can heat a metal beyond its melting point. Once properly melted, the molten metal is poured into the casting mold to cool and harden.

- Finishing

Because metal can sometimes fill in cracks in a casting mold or sprues, the pouring channel for the mold, manufacturers must often finish the metal following casting. This can be accomplished through a variety of finishing techniques, including sanding, grinding and buffing. Once proper appearance and surface texture has been achieved, further post-treatment processes such as painting or electroplating may be necessary for some applications.

CHAPTER FOUR

SCIENTIFIC CONCEPTS INVOLVED IN CASTING

The whole process of casting is backed by science which includes these basic concepts:

The scientific concept behind molten metal and casting involves understanding the physical properties of metals and how they change with temperature. When a solid metal is heated to its melting point, the thermal energy overcomes the forces holding the metal atoms in a fixed position, causing them to break free and move more freely. This results in the metal transitioning from a solid state to a liquid state, forming molten metal.

Casting is a manufacturing process that involves pouring molten metal into a mold cavity and allowing it to cool and solidify, taking the shape of the mold. The key scientific principles involved in casting include:

1. **Melting Point:** Each metal has a specific melting point at which it transitions from a solid to a liquid. By heating the metal above this temperature, it becomes molten and can be poured into a mold.
2. **Solidification:** When molten metal is poured into a mold, it begins to cool and solidify. As it cools, the metal atoms lose energy and arrange themselves in a more ordered structure, forming a solid metal part.
3. **Shrinkage:** During solidification, metals undergo shrinkage as they cool and change from a liquid to a solid. This shrinkage can result in dimensional changes in the final cast part, which must be accounted for in the design of the mold.
4. **Grain Structure:** The cooling rate of molten metal influences the grain structure that forms in the solidified metal. A slower cooling rate typically results in larger grains, while a faster cooling rate leads to finer grains. The grain structure can affect the mechanical properties of the cast part.

By understanding these scientific principles, engineers and manufacturers can optimize the casting process to produce high-quality metal parts with desired properties and characteristics.

CHAPTER FIVE

ADVANTAGES AND LIMITATIONS IN CASTING

5.1. ADVANTAGES

- Metal castings provide a more cost-effective option when it comes to low-volume manufacturing because of speed, low tooling costs, and ease of complex geometries.
- It also provides a simple process to produce parts that can be done without machining.
- Metal castings are a great choice for complex parts as they offer design flexibility as castings can be offered in a variety of sizes and shapes.
- Another advantage of metal casting is you can achieve hollow sections or internal cavities with ease
- Metal castings offer high compressive strength and can produce thin walls without losing structural integrity.
- Many metal casting companies work with local recycling companies to help reduce waste. Also, most metal casting companies use less power consumption than other manufacturing options.

5.2. LIMITATIONS

- Health risks
- Exposure to metals and chemicals can pose serious health risks. Metal casting can produce harmful emissions.
- Environmental impact
Metal ore extraction operations are responsible for the depletion of massive amount of surface vegetation, resulting in destruction of natural habitat and biodiversity of the natural setting.
- Time-Intensive
Casting can be time-consuming, particularly for intricate designs or custom pieces, which may result in longer production times.

CHAPTER SIX

IMPROVEMENT METHODS

Casting can be improved in several ways, including:

1. Skill development: Metal casters can improve their craft by continuously develop their skills through practice and learning new techniques. This can involve attending workshops, classes, or seeking mentorship from experienced goldsmiths.
2. Use of technology: Incorporating modern tools and technology into the casting process can improve efficiency and precision.
3. Quality of materials: Using high-quality raw materials such as metal alloys with specific properties can improve the overall quality and durability of the finished products.
4. Design innovation: Metal casters can improve their craft by staying updated with current trends and developing innovative designs that appeal to contemporary tastes.
5. Sustainability: Implementing sustainable practices in casting, such as using recycled metals, can improve the environmental impact of the industry.
6. Customer feedback: Listening to customer feedback and incorporating their suggestions can help metal casters improve their products and services to better meet the needs of their customers.

CHAPTER SEVEN

CONCLUSION

In conclusion, casting is an ancient craftwork that continue to thrive in the modern world. The art of working with these precious metals requires skill, creativity, and a deep understanding of materials and techniques. As with any craft, there are always opportunities for improvement and innovation. By focusing on skill development, incorporating modern technology, using high-quality materials, embracing design innovation, promoting sustainability, and listening to customer feedback, metal casters can continue to elevate their craft and meet the evolving demands of the market. With dedication to these principles, the art of casting will continue to flourish for generations to come.

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