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Influence of Zinc Composition on Mechanical Properties of Brass Alloys.

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ABSTRACT
Cu-Zn alloy is widely used as industrial materials because of their excellent characteristics such as balance of strength, ductility and high corrosion resistance. The resesrch investigate the effect of zinc content on the mechanical properties of brass alloys. The Zinc(Zn) material was added on concentration of (0,2,4,6,8)kg respectively. The samples produced using die casting process and machined to the specification in accordance to the mechanical test involved. The mechanical properties such as percentage elongation, compression strength and impact strength of the alloys were studied using Mensanto Hounsfield Machine and Monsanto Universal Testing Machine. The result of the mechanical testing indicated that addition of zinc to the brass alloys improved the percentage elongation, compression strength and impact strength alloys. The compression strength reduced with increased in zinc content. Further increase in zinc content resulted to increase in impact strength.

KEYWORD: Brass alloy, Furnace, Strength, Yield load, Zinc (Zn).

I. INTRODUCTION

Brass is a metal alloy made of copper and zinc (Brass Overview 2015), whose proportions can be varied to create a range of brasses with varying properties (Khurmi and Gupter, 2020).Copper alloys have been widely utilized in various applications, such as in wires, water pipes, and roof systems, due to their high thermal and electrical conductivities. Pure copper is mechanically soft and unsuitable for numerous applications. However, copper can be hardened when used as an alloy, which greatly enhances its applicability. Consequently, various copper alloys have been developed and classified according to the principal alloying element.

The formation of brass makes it a substitutional alloy i.e. atoms of the two constituents may re- place each other within the same crystal structure. Brass has higher malleability compared to its counterpart bronze. However, both may also include small proportions of a range of other elements including arsenic, phosphorus, aluminum, manganese and silicon (Brass Overview, 2015).

Copper/Zinc (Cu-Zn) alloy is widely used as industrial materials because of their excellent characteristics such as balance of strength, ductility, high corrosion resistance, non-magnetism and good formability (Hisashi, Shufeng, et-al., 2019). Due to the excellent mechanical properties and machinability, it finds good applications in plumbing fixtures and fittings, low pressure valves, gears, bearings, decorative hardware and architectural frames (Ashby and Johnson, 2021).Refinement is also known to improve casting characteristics such as fluidity and hot tearing.

These investigation, involves in evaluation of zinc on mechanical properties of brass alloy. When a new experiment is performed by usingfive different compositions or quantities of the α-brass alloys, which brasswere produced from scraps of copper wire and zinc batteries casing, respectively by method of sand casting(Hamizah 2010).Brass is still commonly used in applications where corrosion resistance and low friction are require suchas locks, hinges, gears, bearings, ammunition c asings, zippers, plumbing, hose couplings, valveshorns and bells, fashion jewelry, and other imitation jewelry.Today, almost 90% of all brass alloys are recycled, because brass is not ferromagneticbillets., 2010).The aim of this study is to determine the effect of zinc on mechanical properties of brass alloys.To determine the impact strength and compression strength of the brass alloy.

II. MATERIALS AND METHOD

2.1 Materials

Brass scrap was collected and transported to the foundry where it was melted and recast into billet. Billet was reheated and extrude into the desire form and size which was then taken to the laboratories for proper analysis to determine the mechanical properties. This investigation, involves in evaluation of zinc on mechanical properties of brass alloy(Khurmi and Gupter.2020) .The experiment is performed by usingfive different compositions or quantities of the α-brass alloys.

2.2 Experimental Procedure

Five different compositions of the alloys were prepared to give brass of 10kg and 8kg (compression and impact strength) with 2kg Zinc, Brass of 10kg and 8kg(compression and impact strength) with 4kg of Zinc, Brass of 10kg and 8kg(compression and impact strength) with 6kg of Zn, Brass of 10kg and 8kg(compression and impact strength) with 8kg of Zinc respectively.The total mass for each brass was weighed to 10 kg and 8kg for both compression and impact strength and this serve as control sample.

2.3 Sand Casting Method

The alloys was prepared by method of sand casting, pattern making, mould and core making, casting, demoulding, removal of runner/riser cast cleaning(Roger, 2019).

The furnace charge will be calculated using Equation:x (% of brass in the melt) m R = X T (1)
Where X = constituent (Cu or Zn);
Rx = required mass of the constituent in the melt;
Tm = total mass of melt.
Parts of the cast rods were machined on a lathe to obtain the impact test specimens.
The rods were machine down to test specifications of 60 mm × 100 mm × 300 mm .

The cast samples were subjected to homogenization annealing in order to homogenize the composition. They were heated in an MELLEN modelelectrical furnace which was set to a temperature of 1500 ℃.The samples were soaked at this temperature for 3hrs and then allow to cool slowly in the furnace.

The grinding of each test sample was carried out under running water to avoid over heating of the samples with grinding machine

Casting process begins by creating a mould (cavity), which is the ‘reverse’ shape of the part needed, before the molten metal is poured and the liquid takes the shape of the cavity. The mould is made from a refractory material, that is, sand. The melting was carried out in an electric furnace (Mellen model TC series). 500g of ingot needed to cast each specimen was cut and weighed using electronic weighing balance shown, re- melted and the molten alloy was treated with strontium. All the samples were prepared in clay mould. The mixture was gently stirred for 3 – 5 minutes and the dross or impurities were removed prior to casting. The patterns of the cast rods were produced using wood (Hisashi et al,2019).

2.4. Compression Measurement

The samples that werereceived and cast alloys were subjected to the compression test using brinellcompression test accessory of the MensantoHounsfieldTensometer in the central laboratory of the Federal University of Technology, Akure, Nigeria.
Before the Tensometer was used, the compression attachments were mounted on the machine. After the whole setup, the corresponding compression number was then calculated.

2.5. Impact Measurement

Samples that were received and cast brass alloys were machined into impact test pieces which was subjected to impact tests with the aid of a Monsanto universal testing machine in the department of Metallurgical Engineering of the University of Ibadan, Nigeria.

The test was carried out to determine the response of samples under the application of increasing stresses. Some properties of the alloys that were studied are as follows;
Effect of zinc on brass (%) initial test, Effect of zinc on brass (%) post-test, yield load, Tensile load and Yield strength.

III. RESULTS AND DISCUSSION

3.1 Compression Strength.

Zinc is a heavy element, and when alloyed with other metals it provides better corrosion resistance, stability, dimensional strength and impact strength. Because of a lower casting temperature, zinc provides a much longer die life which further adds to reducing production costs.

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Brass is a mixture of copper and zinc that can contain as little as 10%, or as much as 45%, zinc. Distortions of the crystal lattice often occur when impurities are added to a solid. The results of the test carried out for the effect of difference percentages of zinc on brass. The mass in kg of brass, zinc were noted and the initial test of effect of zinc on brass and post-test of effect of zinc on brass for compression shown on Table 1. Also the effect of zinc on brass at initial test and post test for impact strength were noted in this chapter, yield load, tensile load and yield strength of both compression and impact strength were observed.

Table 1: EFFECT OF ZINC ON BRASS IN INITIAL TEST AND POST TEST WITH 10KG OF BRASS FOR COMPRESSION STRENGHT

S/N	Cu-Zn (kg)	Zn (kg)	Total (kg)	Effect of Zn on Cu-Zn Initial Test %	Effect of Zn on Cu-Zn Post-test %	Yield Load (KN)	Tensile Load (KN)	Yield Strength (MPa)
1	10	0	10	0.000	0.0000	9.9000	0.0000	0.0000
2	10	2	12	2.5647	2.4999	9.4353	0.0648	-1.9100
3	10	4	14	5.1294	4.9998	8.8706	0.1296	-3.8900
4	10	6	16	7.6941	7.4997	8.3059	0.1944	-5.7980
5	10	8	18	10.2588	9.9996	5.7412	0.2592	-7.9000

Table 2: EFFECT OF ZINC ON BRASS IN INITIAL TEST AND POST TEST WITH 8KG OF BRASS FOR IMPACT STRENGTH

S/N	Cu-Zn (kg)	Zn (kg)	Total (kg)	Impact strength Initial Test %	Post-test %	Yield Load (KN)	Tensile Load (KN)	Yield Strength (MPa)
1	8	0	8	0.0000	0.0000	0.0000	0.0000	0.0000
2	8	2	10	1.9116	1.7894	19.1160	15.9116	3.7010
3	8	4	12	3.8232	3.5788	42.9456	30.5856	7.4020
4	8	6	14	5.7348	5.3682	75.1548	45.8784	10.7348
5	8	8	16	7.6464	7.1576	114.5216	61.1712	14.8040

3.2 Discussion.

3.2.1 Compression Strength – The effect of Zinc on brass studied initial and post test with 10Kg of brass for compression strength which is represented graphically fig. 1.

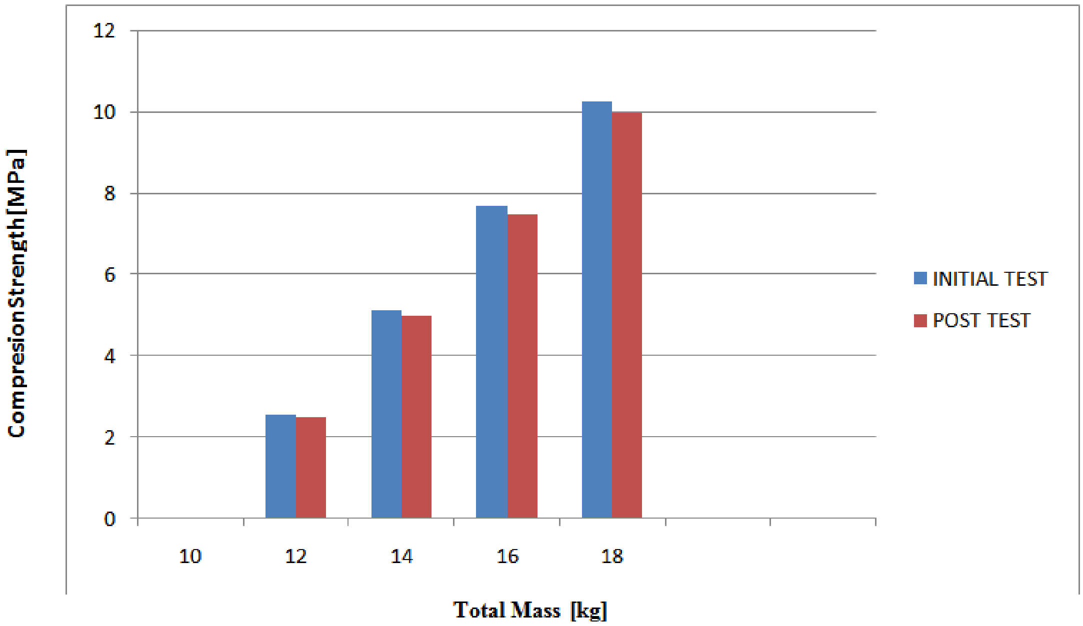

Fig.1: Compression Graph for both Initial and Post Test

The observation through the figure and the table 1 above proved that both initial and post test of the compression data shows that there were increase as the quantity of brass and zinc increase, this also indicate that the hardness value of the alloys increases as the zinc content increases in the test.

It was observed that the effect of zinc on brass for compression strength gave significant difference. On table 1, the yield load decrease accordingly as the quantity of brass and zinc were increasing and the same thing applicable to yield strength which was decreasing as the both brass and the zinc were increasing, meanwhile the tensile load was increasing as the brass and zinc were increasing.

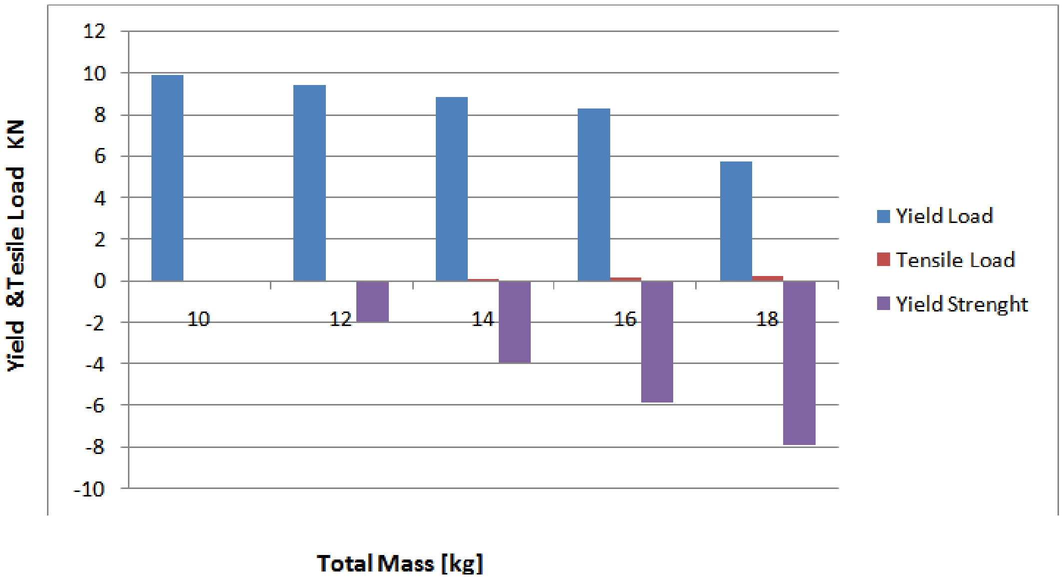

Fig 2: Compression Graph for Yield Load, Tensile Load and Yield Strength

3.2.2 Impact Strength.

Also the effect of zinc on brass at initial test and post test for impact strength were noted in this section, yield load, tensile load and yield strength of both compression and impact strength were observed.

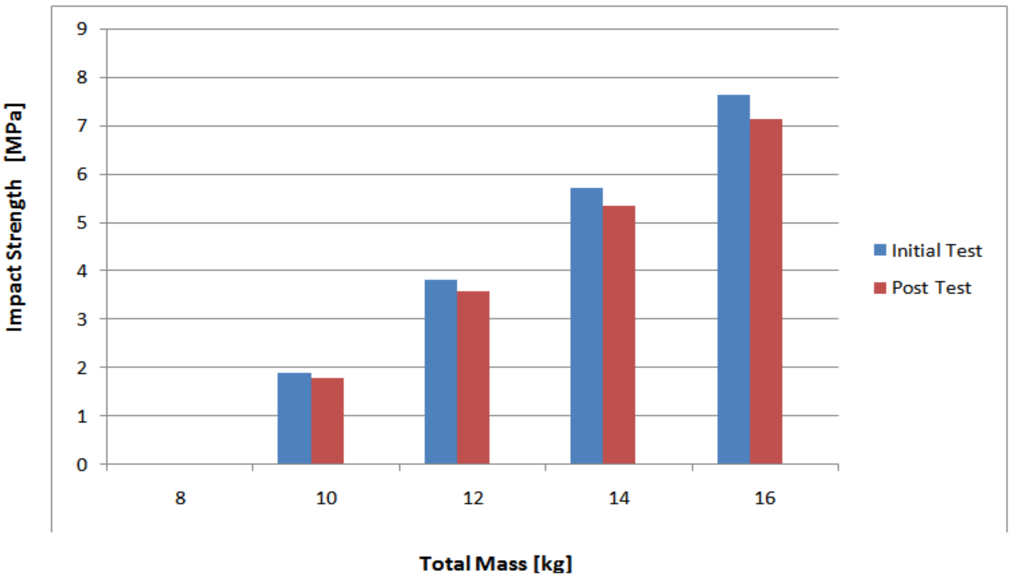

Fig 3: Impact Strength for Initial and Post Test.

Figure 3 above showed the impact of Zinc on Brass alloys. The materials were affected in the process, the data in the initial results were increasing than the data in post test, the increase the data the more the impact strength increase on the materials.

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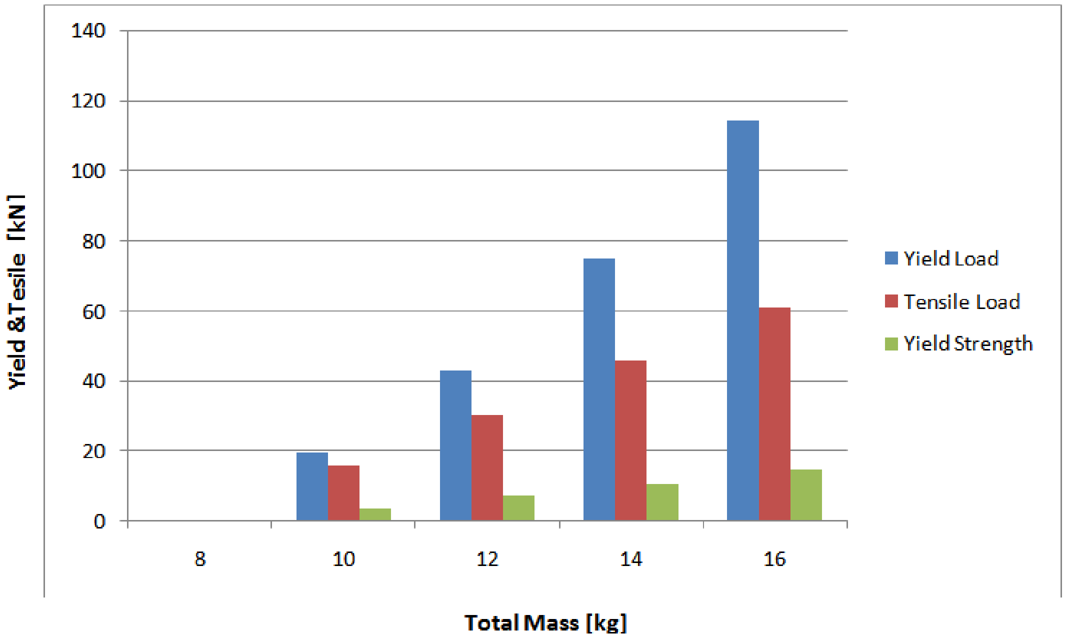

Fig. 4: Impact Strength in the Graph for Yield Load, Tensile Load and Yield Strength.

According to the result gotten from the table 2 and figure 3 and 4 above it was observed that the brass product made from recycled copper and zinc metals increased with increase in zinc content which shows that, the higher the percentages of zinc used in casting brass alloys, the harder the brass obtained. Brass alloys were observed to achieve slowly increase yield strength in impact strength and ductility with increase in yield load and tensile load as the zinc content increased which proved right the initial and post data of the effects of the zinc on brass.

IV. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion.

Brass product made from recycled copper and zinc metals increased hardness with increase in zinc content which shows that, the higher the percentages of zinc used in casting brass alloys, the harder the brass obtained. Brass alloys were observed to achieve low yield strength in impact strength and ductility with increase in yield load as the zinc content increased while in compression it was observed that yield load and yield strength decrease while tensile load increase.

4.2 Recommendations

It can be recommended that based on the results obtained in this work, the yield load and yield strength on compression strength can be improved by continue working on the hardness of the brass. The addition of Zinc beyond 8kg could have a negative effect on the brass alloys.
However, further research work is required to determine other mechanical properties of the alloys (such as tensile strength and fatigue strength).

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