Experimental Evaluation in the Properties of Various Tin Bronzes

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Abstract: - **Bronze is an alloy of copper and tin. These bronzes has high tensile strength, wear resistance and hardness that can be improved by adding and varying the percentage of tin, zinc to base metal. It is also possible improve hardness by heat treatment followed by different cooling mediums. This paper deals with preparation and the comparative study of tensile strength, hardness behavior of Tin bronzes which consist of copper metal reinforced with zinc, tin and in different weight ratio combinations.**

Keywords: Various bronzes, Gunmetal, Tensile strength, Hardness. Microstructure

I. INTRODUCTION

Copper and its alloys are widely used in variety of products that enable and enhance our everyday lives. They have excellent electrical and thermal conductivities, exhibit good strength and formability, have outstanding resistance to corrosion. They are readily soldered and brazed, and many can be welded by various gas, arc and resistance methods. Tin bronzes are easily cast, possess high strength, toughness and resistance to sea water corrosion. It can be applicable for casting gun barrels, boiler fittings, bolts, nuts Bearings, bushings, piston rings, steam fittings, gears and for many parts in naval constructions.

Tin Bronze is an alloy of copper tin and zinc. These bronzes has high tensile strength, wear resistance and hardness that can be improved by adding and varying the percentage of tin, zinc and phosphorus to base metal. It is also possible improve hardness by heat treatment followed by different cooling mediums.

This paper deals with preparation and the comparative study of tensile strength, hardness behaviour of Tin bronzes which consist of copper metal reinforced with zinc, tin in different weight ratio combinations. Tensile testing is conducted on universal testing machine for all specimens, hardness can be tested on Rockwell's hardness testing machine.

II. LITERATURE REVIEW

Copper's malleability, machinability, and conductivity have made it long time favourite metal of manufactures and engineers, but its antimicrobial property that will extend that popularity into the feature. For example, the ancient Egyptians, Greeks, Romans and Aztecs used copper compounds for the treatment of disease and good hygiene and much later the hulls of British naval ship were encased in copper to protect against befouling. In support of historical anecdotal evidence, recent laboratory testing has shown that copper and copper alloys are effective antimicrobial materials. Copper, brass and bronze work effectively against the most troublesome antibiotic resistant bacteria including mathicillinresistant staphylococcus auras and vancomycinresistant surface material registered by U.S environmental protection agency to continuously kill bacteria that pose threat to human health. No other tough surface material hag this kind of registration.

D.M. Zhao et al. reported in their paper when Cu-3.2Ni-0.75Si alloy is aged at 723^{o}K after solution treatment, the super saturated solid solution is appeared following three stages of decomposition. In the first stage, the modulated structure with Si rich and Si poor regions forms as a result of spinodal decomposition. In the second stage the ordering 3Si with DO22 type structure nucleate from the modulated structure. The final stage of transformation is the appearing of a disc structure.

Copper-zinc-lead alloy with duplex alpha-plus-beta phase structure containing a depression of lead particles. This alloy is the standard European cutting brass generally supplied as a rod. It is widely used where extensive machining is required, especially on automatic machines.

Phosphor tin bronze CuSn10P is characterized by good tensile strength (350-430MPa), proper hardness, and corrosion and abrasion resistance. As well as resistance to high mechanical load. This material has also good castability and machinability. Due to the its advantageous properties the phosphor tin bronze is widely for high -load, high speed, poorly lubricated and exposed to corrosion bearings, and in casting of machine engines components as well as chemical armature. The structure and proprieties of alloy depend on melting and casting conditions, which influences the alloy crystallization. Improvement of alloy structure is crucial for alloy properties. In this paper studies on the influence of modification of bronze CuSn10P on its structure are described. The results of investigations on modification of copper alloys have shown the advantageous effect of zirconium on modification of bronzes. Moreover, the micro-additives of magnesium and iron enhanced significantly the positive effect of zirconium in the modification of bronzes. Iron stimulates the processes of heterogeneous nucleation. Magnesium prevents the oxidation of zirconium in liquid metal. Phosphor Bronzes, or tin bronzes, are alloys containing copper, tin and phosphorous. The phosphor bronzes contain between 0.5 and 11% tin and 0.01 to 0.35 % phosphorous. The addition of tin increases the corrosion resistance and strength of the alloy. The phosphorous increases the wear resistance and stiffness of the alloy. The phosphor bronzes have super spring qualities, high fatigue resistance, excellent formability and solderability, and high corrosion resistance. They are primarily used for electrical products;

other uses include corrosion resistant bellows, diaphragms, and spring washers. The phosphor bronzes are designated as UNS C50100 through C54200. Leaded phosphor bronzes combine good strength and fatigue resistance with good machinability, high wear resistance and corrosion resistance. They are used in applications such as sleeve bearings, thrust washers, and cam followers. They are designated as UNS C53400 through C54400.

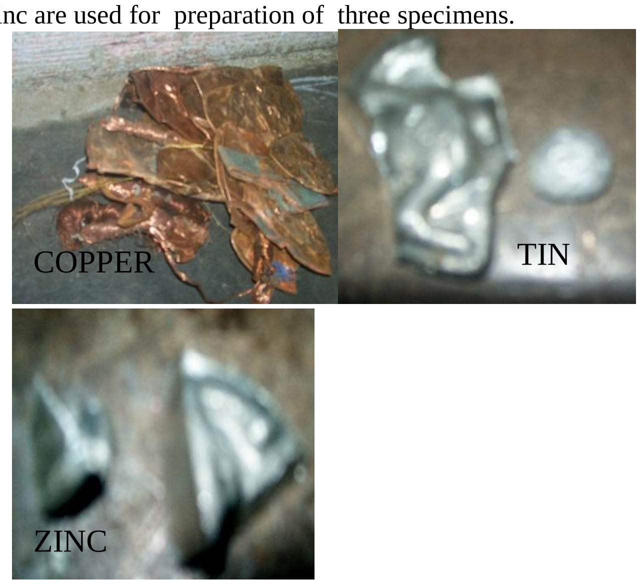
Microstructure of wrought phosphor bronzes contains the twinned grains typical of copper alloys. The tin remains in the alpha copper solid solution. The phosphorus forms a copper-phosphide phase. The phosphor bronzes have a wide freezing range and extensive segregation of the alloying occurs on cooling. The material that cools first is dendrites of the copper rich alpha phase. The dendrites are heavily cored, or contain a range of compositions over their thickness. The second phase to form is tin rich, initially transforming to beta, and finally to a mix of alpha and delta. The alpha and delta phases form in between the dendrites. The phosphor rich phase solidifies last as the eutectic composition of copper phosphide. The dendrites are broken up during working and annealing, the resulting structure consists of grains of alpha copper and are of the alpha and tin rich delta phases, and copper phosphide.

Bronze, an alloy of copper and tin, has been known since 2500 BC. The first inclusion of tin (Sn) in bronze was probably an accidental result of tin ore being found in copper ore; pure tin was most likely obtained at a later date (7). For the first time a workable metal with a low-melting point was available to fabricate durable weapons, ornaments, coins, cooking utensils, bells and statuary. Mining and melting became established industries, adjacent cities grew wealthy, the science of navigation advanced, trade flourished. Tin was mined in Spain, Britain and Central Europe. This thousand-year-old multifaceted civilization declined with the advent of iron mongering.

III. EXPERMENTAL ANALYSIS

A. MATERIAL COLLECTION

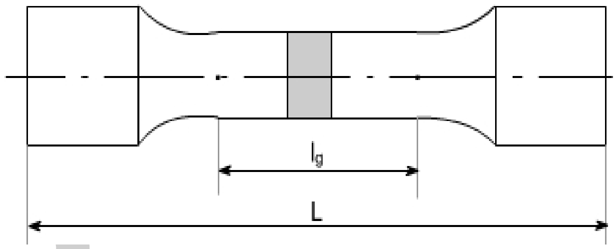
In material collection, Three metals namely copper,tin and zinc are used for preparation of three specimens.



The three specimens mainly consist of copper, tin, zinc in various combinations. The percentage of the compositions of each specimen are selected by weight basis.

B. PREPARATION OF SPECIMEN:

The Specimens are prepared by varying tin percentage by weight up to its solubility and keeping Zn percentage constant using casting process. The compositions have good casting characteristics. Sand casting also known as sand molded casting, is a metal casting process characterized by sand as the mold material. It is relatively cheap and sufficiently refractory even for steel fondly used. A suitable bonding agent (usually clay) is mixed or occurs with the sand. The mixture is moistened with water to develop strength and plasticity of the clay and to make the aggregate suitable for molding. The pattern is prepared as per ASTM standard.



C. EQUIPMENT AND METHODOLOGY:

(i) Tensile Strength:

Tensile strengths are obtained for the composition of alloy specimens prepared through casting process. The yield strength, tensile strength and breaking strength are calculated with the help of Universal strength testing machine (UTM).

(ii) Hardness Test:

The hardness values are measured by using Rockwell hardness tester before and after the heat treatment.

The compositions of the alloys based on their weight basis given in below table.

TABLE:

I
SPECIMEN:1

MATERIAL	COPPER	TIN	ZINC
PERCENTAGE	93%	5%	2%
WEIGHT	744	40	16

SPECIMEN:2

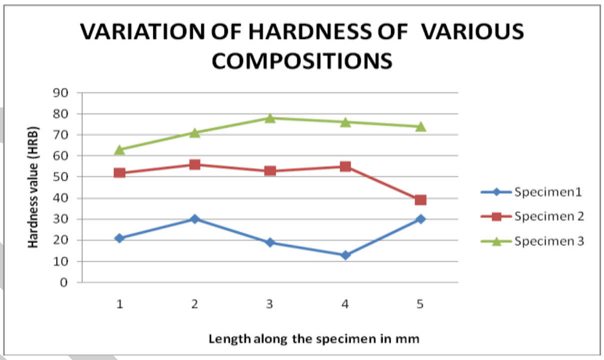
MATERIAL	COPPER	TIN	ZINC
PERCENTAGE	88%	10%	2%
WEIGHT	704	80	16

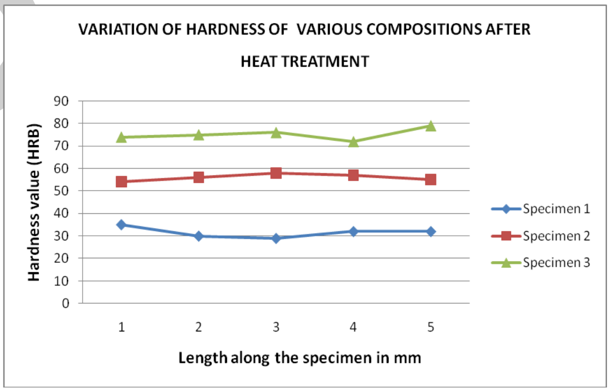
SPECIMEN:3

MATERIAL	COPPER	TIN	ZINC
PERCENTAGE	86%	12%	2%
WEIGHT	688	96	16

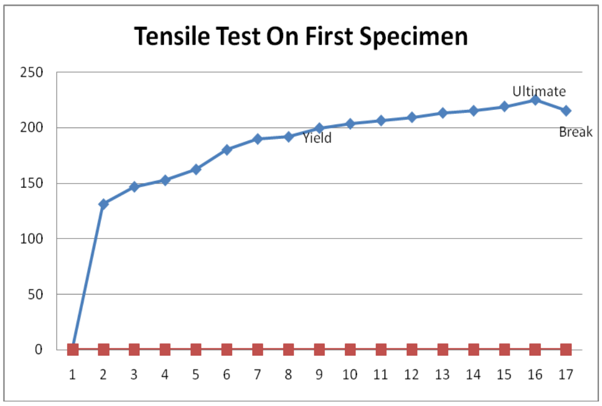
IV. RESULTS AND DISCUSSION

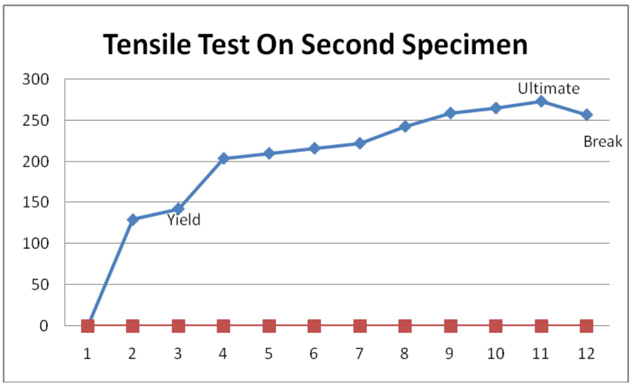
(i) HARDNESS TEST

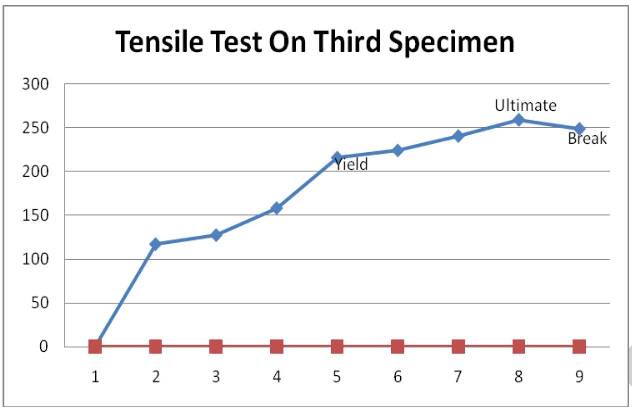




(ii)TENSILE TEST:







V. CONCLUSION

(i)From the above experimental data It has been concluded that the Tensile strength will be highest for the specimen 2 of composition 88%Cu 10%Sn 2%Zn known as gunmetal.
(ii)Hardness is highest for the specimen 3 of the composition 86%Cu 12%Sn 2%Zn.

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