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Experimental Investigation on the Mechanical Properties of Al Alloy with Different Quenching Media

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***Abstract:** This paper examines the effect of microstructure and mechanical properties of aluminium alloy. Aluminium and its alloys have been indentified as an important and useful engineering material. It is attracted by its various unique properties, such as appearance, strength-to-weight ratio, excellent thermal properties, workability properties and good mechanical behaviour. In this experiment, there were 2 sets (7 samples each) aluminium alloy prepared. Prepared specimens quenched for one hour by two different media (water & cow urine). Specimens prepared to apply tensile, yield strength and hardness test and show the effect of medias cooling rate on mechanical properties and microstructure of all specimens examined. In water media tensile, yield strength and hardness were improved, cow urine contributed in decrease tensile and yield strength properties because grain size larger, but hardness slightly improved.*
***Keywords:** Hardness, tensile strength, yield strength, quenching media. grain size.*

I. INTRODUCTION

Piston heads form the major components of I.C. engines. Any defect in the piston heads result in abrupt failure of I.C engines lot of literature is available on the failure analysis of I.C engine piston heads and various conclusions were presented. It has been observed that, though the stresses induced on the piston head are less than the design stresses, the piston head failed. The reasons for this type of failure were investigated in depth and it has been observed that the metallurgical and micro structural imperfection and defect were the root cause for this type of failure. Hence at thorough examination of microstructure and possible ways of improving and refining of microstructure through various metallurgical processes has become inevitable. The analysis consists of trying different additives in the base quenching media and study the mechanical and micro structural behaviour of piston heads. Normally different additives are added separately in the quenching media to improve the mechanical properties. However the cow urine which contains many elements mixed homogeneously present. In fact the sodium present in the cow urine results the grain refinement and silion with other elements helps in interlocking the grain boundaries. The above enhances the mechanical properties. An attempt is made in this paper to experimentally verify above statements.

II. LITRATURE REVIEW

Shivaprakash etal [1], did extensive work on the comparative study on mechanical properties of AISI 4340 High-Strength steel alloy under time-quenched and austempered conditions. The hardness, micro structure and impact test were conducted and experimental results were compared with timed quenched specimens. It was found that the grain size of the austempered specimen was higher than the time quenched specimen.

M. Dauda etal [2], worked on effect of various quenching media on mechanical properties of annealed steel. They have used palm kernel oil, cotton seed oil and olive oil as quenching media. They compared the effectiveness of the oils. The samples were quenched to room temperature in the quenching media. They concluded that the hardness of steel when quenched in water was higher than the hardness when quenched in kernel oil. They also concluded that olive oil can be used where the cooling severity is less than that of water.

Joseph etal [3], used clay/water media as quenchant for Hardening and Characterisation of 0.45%C steel. Different weight percentages of clay were added to water to form clay/water quenching media. The steel specimens were heated to austenizing temperature and quenched in above media. The mechanical properties of steel were investigated. They concluded that the addition of 2 to 4% of clay water gave the best mechanical properties.

M. Maruthi rao [4], made Experimental Studies on effect of Biological quenching media on micro structural and mechanical properties of Al alloy materials used for manufacturing IC engine piston heads. The author tried with cow urine along with base quenching media of water and sheep urine along with base quenching media water separately and found that the mechanical and micro structural properties al Al piston head materials improved. The author concluded that there is marginal improvement in the micro structure and mechanical properties of Al piston head material.

Dr. B.N. Sarada etal [5], studied the effect of quenching media on the mechanical properties of Al 6061-TIO_2 metal matrix composites. They subjected specimens to heat treatment at temperature 53C for 1.5 hours followed by quenching in different media like air, water, aqueous polymer solutions. The hardness, tensile strength values were evaluated. They concluded that the quenching has significant effect on the hardness and tensile strength values exhibiting significant improvement as compared to cast composites.

Wijanarko etal [6], made experimental study on the influence of quenching temperature variation on retained austenite fraction in AISI 4140 steel. According to them quenching has three major steps namely austenizing, premier and partitioning . They arrived at an optimum quenching and partitioning temperature and partitioning time so that maximum fraction of austenite is retained.

Ali rafaAltaweel etal [7], did extensive work on Effect of quenching media, specimen size and shape on the harden ability of AISI4140 Steel. The purpose of their study was to investigate the influence of different quenching media on the hardened depth of AISI steel they demonstrated as to how these parameters can effect the hardness from the surface to the core of samples they concluded that the hardness of the quenched samples at certain depths can be estimated on the basis of heat transfer equations.

S.A. Takur etal [8], worked on effect of tempering temperature of mechanical properties of Medium Carbon Steel. Most of the applications require that the quenched part be tempered so as to impact same toughness and further improve ductility. Their work reports and analysis results of mechanical testing on various heat treated medium carbon steel and to arrive at an optimum heat treatment strategy. They concluded that the optimum heat treatment strategy was found to be at a tempering temperature of 250^0C for well balanced mechanical properties. Saigeeta etal [9], did extensive work on effect of quenching medium on hardness of three grades of steel – AISI 1040, 1050 and 4340. They concluded that hardness of medium carbon steel can be improved by quenching through different quenching mediums. Their investigations emphasized on improving the hardness property of three different types of steel as mentioned above.

Soundhar. J etal [10], did extensive work on evaluation of surface hardness behavior of heat treated 35Mn6Mo3 and C35MN75 Steel. They examined samples of medium carbon steel after heating them between 900^0C to 980^0C in a vertical force air circulating furnace and the tempering temperature was 250^0C. They concluded that the hardness values of quenched samples were relatively higher than those of the as cast samples.

III. ISSUES AND CHALLENGES RELATED TO PRESENT WORK]

Extensive literature review is to be made to ascertain the “as on today technology” on quenching methods.

A scientific method is to be developed for studying the metallurgical micro structure of the fractured specimens.

Standard test specimens for estimating various strength properties are to be designed and machined.

Suitable strength measuring equipments are to be selected.

What is being done in the current work is a simulation work. The results are to be transformed for real time piston head Al Alloy.

TABLE I S.No	Quenched in water			
	Temperature ^{0}C	Yield strength(N/mm^2)	UTS (Nmm^2)	Hardness
1.	250	37	55	14
2.	300	40	60	17
3.	350	44	64	19
4.	400	45	67	21
5.	450	46	69	24
6.	500	48	71	26
7.	550	50	73	28

TABLE III

S.No	Quenched in cow urine			
	Temperature ^0C	Yield strength(N/mm^2)	UTS (Nmm^2)	Hardness
1.	250	25	46	20
2.	300	32	52	21
3.	350	40	59	22
4.	400	42	62	25
5.	450	51	65	28
6.	500	52	65	32
7.	550	55	67	35

IV. FORMULATION OF PROBLEM

Since piston heads form the critical components of IC engines and are subjected to extreme stress conditions, any research on improved micro structure goes a long way in the life of piston heads. The methods of casting, heat treatment and quenching play a major role in deciding the strength of the Al alloys used for manfacture of piston heads. Hence the current problem consists of using different quenching media. The micro structure and mechanical properties are investigated

V. EXPERIMENTAL WORK

TABLE IIIII Chemical Composition of Al 2585 (wt%)

%Cu	%Mg	%Si	%Fe	%Mn	%Ni	%Zn	%Pb	%Sn	%Al
10	0.3	2	0.7	0.5	0.5	0.1	.01	.01	Remaining

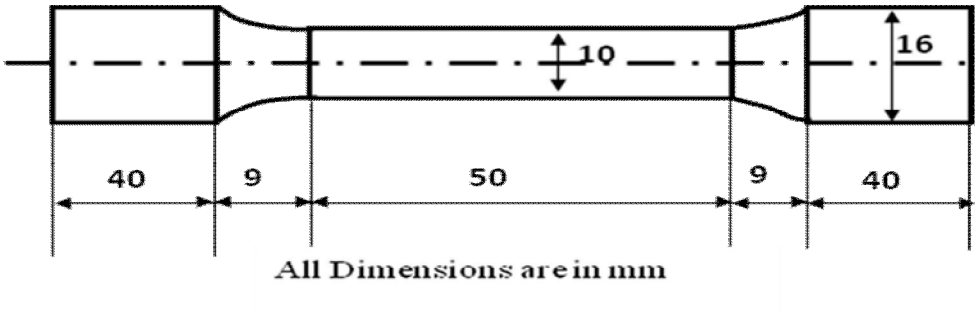

Fig 1. Tensile test specimen from Al 2585

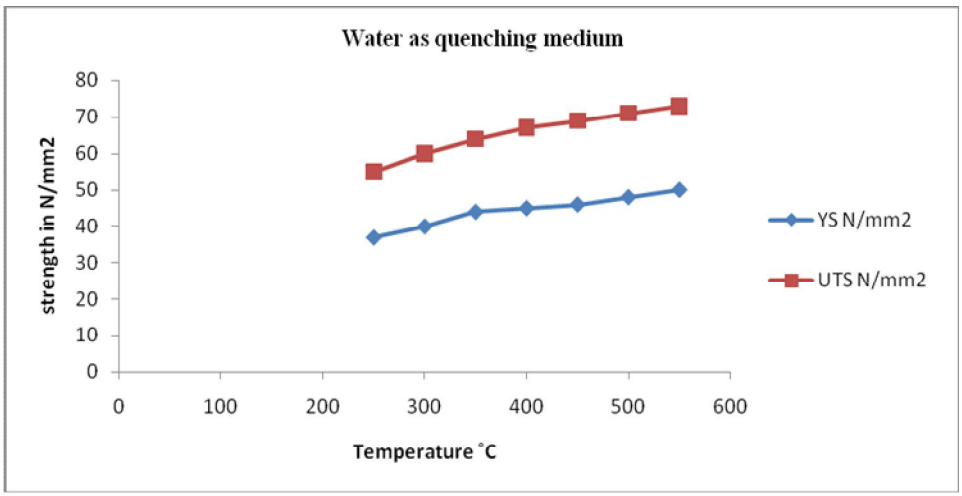

Fig 2. Change in strength properties at different temperature (water as quenching)

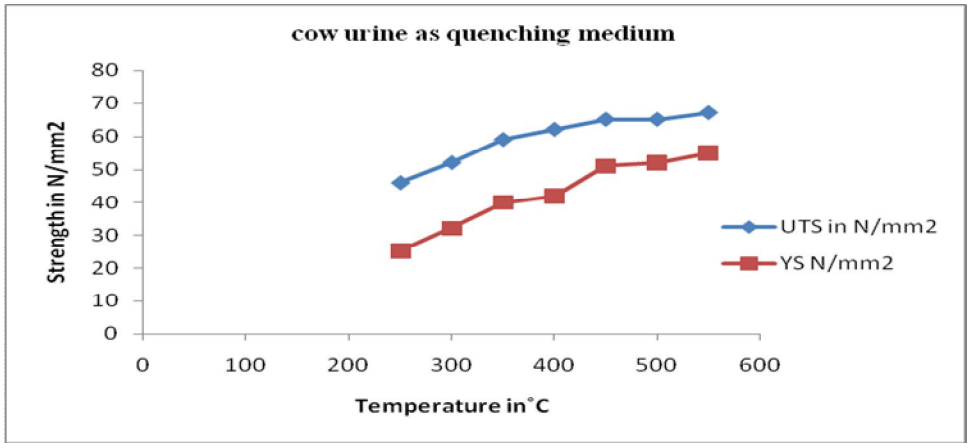

Fig 3. Change in strength properties at different temperature (cow urine as quenching)

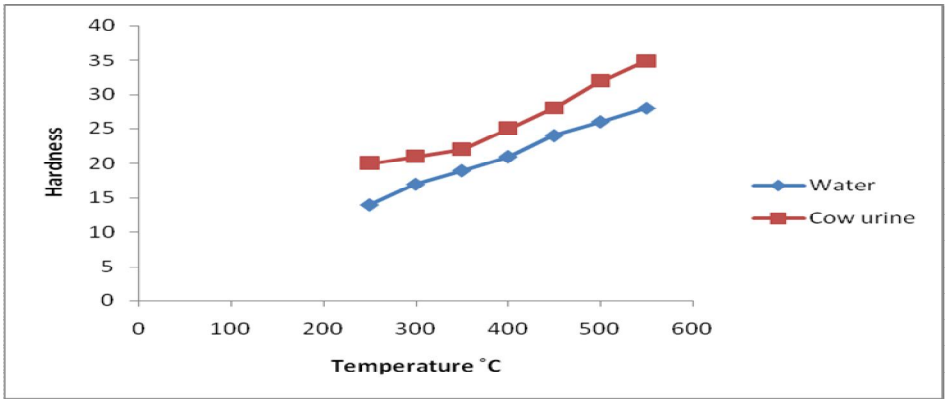

Fig 4. Hardness at different temperature (water& cow urine as quenched)

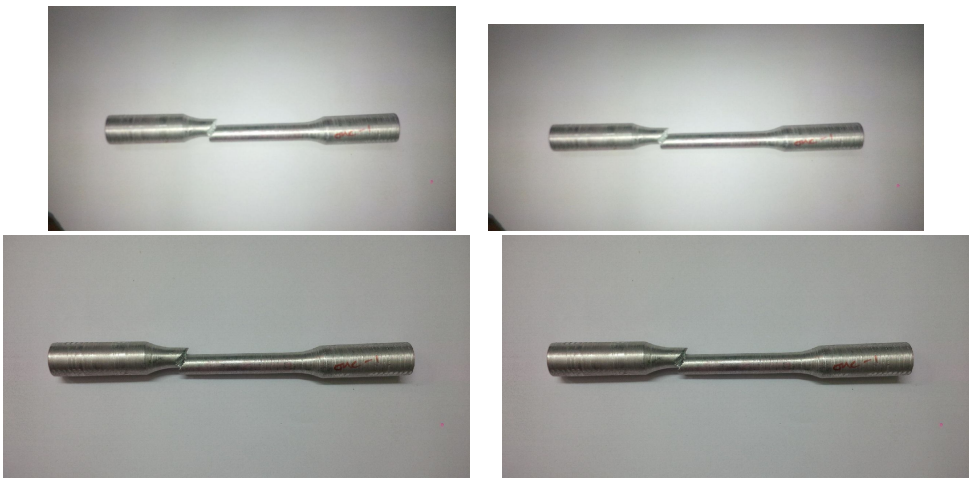

Fig 5. The photos show fracture shape experienced Specimens

VI. CONCLUSIONS

A. It has been found that with pure water, the Ultimate Tensile strength increases along with temperature of quenching thereby at minimum temperature of 450^0C the UTS was 69 N/mm^2 and at 550^0C it was 73 N/mm^2. A similar behaviour was observed for Yield stress.

B. From the experiments it is found that regarding hardness, which is reported in BHN, pure water exhibits the lowest hardness value number namely 24, for 450^{0}C, 26 for 500^{0}C and 28 for 550^{0}C.

C. For 450^{0}C and 500^{0}C the increase in strength starts cow urine, the Ultimate Tensile strength increases along with temperature of quenching thereby at minimum temperature of 450^{0}C the UTS was 65 N/mm^2 and at 550^{0}C it was 67 N/mm^2. A similar behaviour was observed for Yield stress. This may be because the negative effect of sodium is delayed as the temperature is increased.

D. From the experiments it is observed that the cow urine, there is a gradual increase in hardness. It is also proposed to study the metallurgical microstructure with special reference to refinement of grain boundaries and interlocking grain boundaries.

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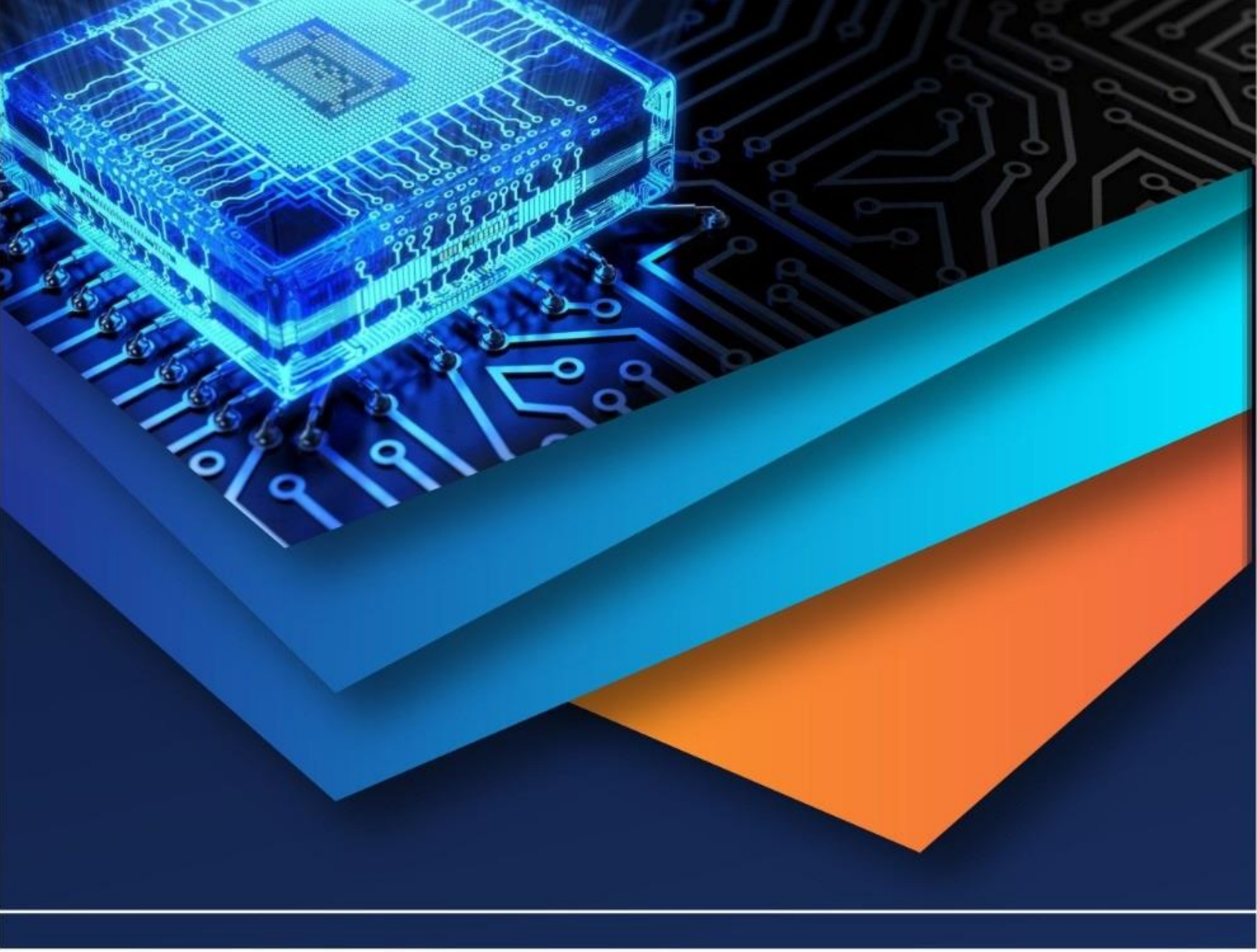

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