ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 9, September 2017

Investigation on Age Hardening of Aluminium Alloy using Biological Quenchants

[1] M. Maruthi Rao [2] Dr. N.V.V.S. Sudheer
[1]Research Scholar, [2] Associate Professor
[1] ANU, Guntur, [2] RVR&JC College of Engineering, Mech; Dept, Guntur

Abstract: **In this work the suitability of biological quenching medium for age hardening of aluminum alloy has been investigated. An attempt was made to add different percentages of cow and sheep urine in base quenching media(water) separately to study its effect on the micro structural and mechanical properties of cast aluminum alloy. Cow and sheep urine are supposed to contain rich quantities of sodium, nitrogen, sulphur, manganese, silicon etc., homogeneously present. Test samples of aluminum alloy were age hardened at 450^0C, 400^0C, 350^0C by soaking for one hour and then investigated for different strength parameters. The results showed significant increase in ultimate tensile strength, yield strength and hardness possibly due to above elements present in the cow and sheep urine. Sodium present in the cow and sheep urine could be the reason for grain refinement and silicon along other elements could have helped in interlocking of grain boundaries. The values are in coincidence with recommended values of age hardening of aluminum alloy in base quenching media**

***Index terms*— Age hardening, grain refinement, strength parameter, quenching medium.**

I. INTRODUCTION

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 when mixed with base quenching media improves the micro structure and mechanical properties marginally. In fact the sodium present in the cow urine results in grain refinement and silicon 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. LITERATURE 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-TIO2 metal matrix composites. They subjected specimens to heat treatment at temperature 530^0C 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

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 9, September 2017

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

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

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

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

4. Suitable strength measuring equipment's are to be selected.

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

IV. SCOPE AND OBJECTIVES OF PRESENT WORK

The scope of present work is to study the effect of varying quenching parameters with special reference to adding different percentages of cow urine in the base quenching media, on the micro structure and mechanical properties of Al alloy with an objective of obtaining improved mechanical properties of Al alloy used for manufacture of piston heads.

V. 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 manufacture of piston heads. Hence the current problem consists of using different percentages of cow urine in base quenching media and conduct quenching. The micro structure and mechanical properties are investigated.

VI. EXPERIMENTAL WORK

Material chosen for present work is cast Al alloy with IS designation 2585 (Al 2585) with specimen having dimensions of 150mm length and 10mm diameter. The experimental work consists of adding different percentages of cow urine along with base quenching media namely water. The percent of cow urine consists of 0%, 10%, 20%, 30%----------100%. The quenching temperatures considered were 350^0C, 400^0C & 450^0C and quenching time was 90 minutes. Al material test specimen were prepared and quenched as per

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 9, September 2017

the above plan. The UTS, YS and hardness values are noted down and presented in table 1,2,3 and the same was graphically presented in figures 1,2.The specimen micro structures of different percentage quenching media is shown through figures 4 to 14.

Table I. Ultimate tensile strength (UTS in N/mm2), Yield stress (YS in N/mm2) and Hardness number at 450^{0}C temperature in Cow urine & water as quenching medium.

S.No	1	2	3	4	5	6	7	8	9	10	11
% water	100	90	80	70	60	50	40	30	20	10	--
%Cow urine	00	10	20	30	40	50	60	70	80	90	100
U.T.S	69	70	75	76	77	78	74	72	69	67	65
Y.S	46	48	53	58	60	61	59	57	55	53	51
Hardness	34	36	38	40	42	43	45	43	41	38	34

Table II. Ultimate tensile strength (UTS in N/mm2),Yield stress (YS (in N/mm2) and Hardness number at 400^{0}C temperature in cow urine & water as quenching medium.

S.No	1	2	3	4	5	6	7	8	9	10	11
% water	100	90	80	70	60	50	40	30	20	10	--
% Cow urine	00	10	20	30	40	50	60	70	80	90	100
U.T.S	67	68	74	75	73	69	67	65	64	63	62
Y.S	45	46	52	56	53	51	49	47	45	43	42
Hardness	30	32	34	36	38	39	41	40	37	35	32

Table III. Ultimate tensile strength(UTS in N/mm2),Yield YS in stress(YS N/mm2) and Hardness number at 350^{0}C temp; cow cow urine & water as quenching medium.

S.No	1	2	3	4	5	6	7	8	9	10	11
% water	100	90	80	70	60	50	40	30	20	10	--
%Cow Urine	00	10	20	30	40	50	60	70	80	90	100
U.T.S	64	65	70	72	69	66	65	63	62	61	59
Y.S	44	45	51	54	52	50	48	46	42	41	40
Hardness	28	30	32	34	37	38	40	37	35	33	31

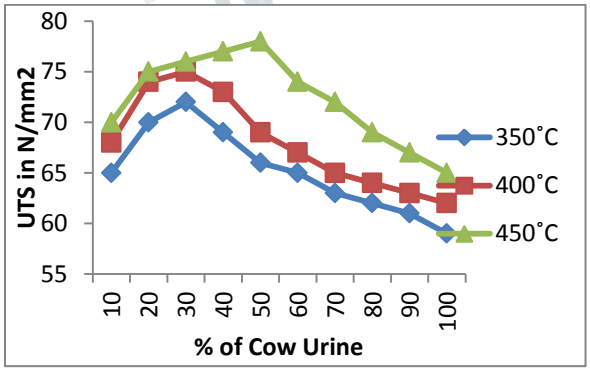

Fig:1 Percentage of Cow urine Vs UTS of Al 2585

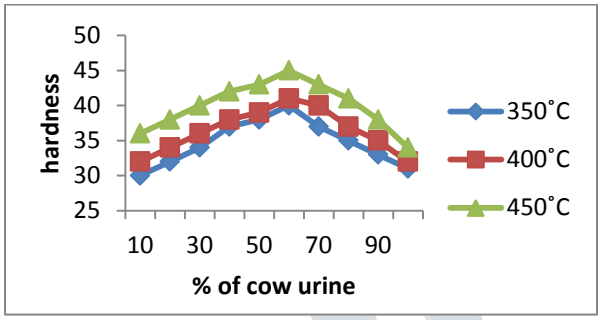

Fig:2. Percentage of Cow urine Vs Hardness of Al 2585

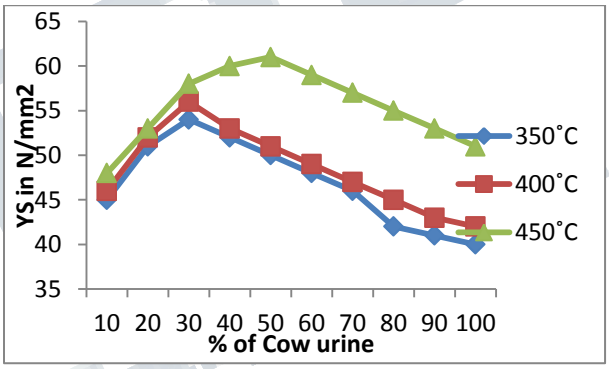

Fig:3. % of Cow urine Vs YS of Al 2585

Microstructure at a quenching temperature of 450^{0}C with different cow urine percentages.

Fig 4: 100%water+%0cow urine

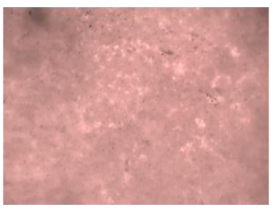

Fig 5: 90%water +10% cow urine

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 9, September 2017

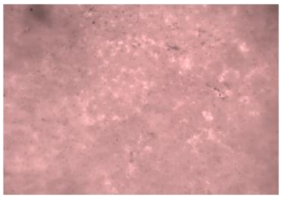

Fig 6: 80%water+20 %cow urine

Fig 7: 70% water +30% cow urine

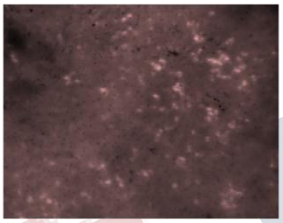

Fig 8: 60%water +40% cow urine

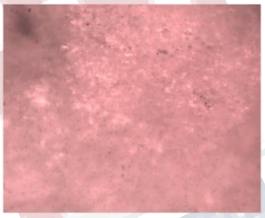

Fig 9: 50% water + 50% cow urine

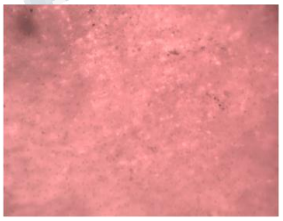

Fig 10 : 40%water+60%cow urine

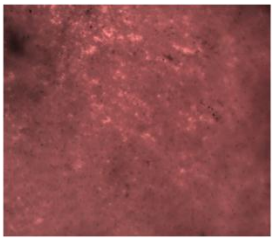

Fig 11: 30%water+ 70%cow urine

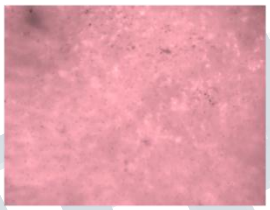

Fig 12: 20%water +80%cow urine

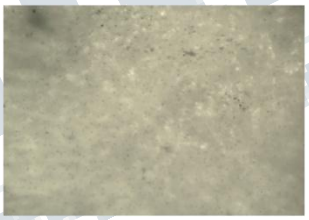

Fig 13: 10%water +90% cow urine

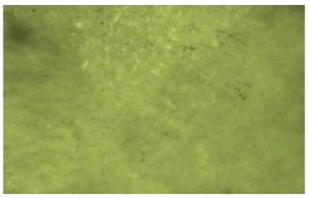

Fig 14: 100% cow urine

VII. RESULTS AND DISCUSSIONS

- It has been found that with pure water, the Ultimate Tensile strength increases along with temperature of quenching thereby at minimum temperature of 350^{0}C the UTS was 64 N/mm2 and at 450^{0}C it was 69 N/mm2. A similar behaviour was observed for Yield stress.
- From the experimental results it is observed that, there is gradual increase in strength values from 65 N/mm2 to 70 N/mm2 for 10% cow urine. This increase is up to 50%

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 2, Issue 9, September 2017

and there after the strength values appear to decrease. This may be because, as the % of cow urine increases beyond a certain value, the sodium present in the cow urine which has a property of refining a grain boundary may show a negative effect and hence a reduction in strength values is observed.

- For 350^0C and 400^0C the reduction in strength starts with 50% cow urine, whereas at 450^0C the reduction starts at 60% of cow urine. This may be because the negative effect of sodium is delayed as the temperature is increased.
- From the experiments it is found that regarding hardness, which is reported in BHN, pure water exhibits the lowest hardness value number namely 28, for 350^0C, 30 for 400^0C and 34 for 450^0C.
- From the experiments it is observed that as the % of cow urine increases, there is a gradual increase in hardness and some where near 60 to 70% cow urine the hardness values appear to slightly reduce. However the reduction is only very marginal.
- The above experimental work is expected to generate huge data base and suitable computer programme can be written to arrive at the optimum strength values and corresponding % cow urine, time of curing etc.
- It is also proposed to study the metallurgical microstructure with special reference to refinement of grain boundaries and interlocking grain boundaries. A few metallurgical microstructure photos are presented.(Fig 3 to 13)

VIII. CONCLUSIONS

- It is observed that in pure water grain refinement is not satisfactory.
- In case of 10% cow urine, grain refinement as seen from microstructure revealed that it is slightly improved compared to water.
- In case of 50% of cow urine, grain refinement slightly decreases (350 to 400^0C), and at 450^0C, grain refinement still continues and this fact is confirmed through the strength values.
- From 60% to 100 % the grain refinement is poorer due to sodium present in cow urine has negative effect on interlocking the grain boundaries.

REFERENCES

[1] Shivaprakash Y.M, Gurumurthy B M, Gowri Shankar M. C, S.S Sharma, Achutha Kini "Comparative studies on mechanical properties of AISI 4340 High-strength alloy steel under time-quenched and austempered conditions", IJRET, volume :04 ISSUE 02 Feb-2015.

[2 M. Dauda, L.S Kuburi, D.O Obada and R.I.Mutapha "Effect of various quenching media on Mechanical properties of annealed 0.509t%C-0.178Wt% Mn Steel", (Nigerian Journal of Technology) NIJOTECH, Vol:34 No.3 July 2015.

[3] O.E Joseph, Asuke Ferdinand "Hardening and characterisation of 0.45%C steel using clay/water media as quenchant", International Journal of Material Science and Applications Feb11, 2015.

[4] M. Maruthi rao "Experimental studies on effect of biological quenching media on micro structural and mechanical properties of al alloy materials used manufacturing IC engine piston heads", GE-IJER, Volume:3, july 2015.

[5] Dr. B.N. Sarada, Dr. P.L.Srinivasa Murthy, Swapnil Ramani " Effect of quenching media on the mechanical properties of AI 6061-TiO2 metal matrix composite", Volume:3, Issue-5 2016.

[6] W Wijanarko, Wajan Berata, Sutikno and Indra Sidharta " Experimental study of the influence of quenching and partitioning temperature variation on retained austenite fraction in AISI 4140 steel", ARPN Journal of Engineering and Applied Sciences Vol:11, January 2016.

[7] Ali Rafaaltaweel, Majid tolouei-Rad, "Effect of quenching media, specimen size and shape on the hardenability of AISI4140 Steel", Emitrates Journal for Engineering Research, Vol:19, 2014.

[8] S.A Takur, M.M. Usman Isyaku Muhamma, N. A sulaiman "Effect of tempering temperature on Mechanical properties of medium carbon steel", IJETT, Volume:9 March 2014.

[9] Saigeeta Priyadarshini, Sandeep K Anand, Omprakash Yadav, "Effect of quenching medium on hardness of three grades of steel – AISI 1040, 1050, and 4340". IJRASET, Volume4 Issue I, January 2016.

[10] Soundhar J, M. Subash "Evaluation of surface Hardness behaviour of heat treated 35Mn6Mo3 and C35MN75 Steel", IJRASET, Volume 3 IssueIV, April 2015.