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Experimental Study of Liquid Quench Media Cooling Performance by the Effect of Heat Transfer characteristics

M. Maruthi Rao*, N. Santhi Sree**, S. Praveena[1], S. Nishanthi[2], S. Lakshmi[3]
*(Research Scholar, Dept.; of Mechanical Engineering, ANU, Guntur, AP, India.
(Email: raom06838@gmail.com)
** (Dept. of Mechanical Engineering, Associate Professor, Osmania University, Matrusri Engineering College, Hyd, AP, India.
1. Assistant Professor, Dept. of Mechanical Engineering, JNTUA AITS, Tirupati, AP, India.
2. Assistant Professor, Dept. of Mechanical Engineering, JNTUA AITS, Tirupati, AP, India
3. Assistant Professor, Dept. of Mechanical Engineering, JNTUA AITS, Tirupati, AP, India

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Abstract:

Heat transfer characteristics of quench media decide the mechanical properties of metals, alloy and micro structure. As the hot metal is immersed in the cooling medium, the liquid vaporizes instantly and the thin film produced decreases the heat transfer rate of the metal. Novel quench media cow urine as quench ant for heat treatment process, in these media different additives and enzymes are present homogeneously and destabilize the thin film and effective heat transfer rate occurred. In addition time and temperature have improved the mechanical properties of the Al2585 alloy. In this experimental work was observed that quench media, time and temperature play vital role increase properties of the Al 2585 alloy. Based on heat transfer characteristics of different media (Tap water, Distilled water, Soap nut solution, Shikakai nut solution, Engine oil) gives maximum mechanical properties cow urine and minimum is Engine oil.

Keywords — **Al alloy, Heat transfer characteristics, Mechanical properties, Quench media.**

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I. INTRODUCTION

Heat transfer characteristics like (Thermal conductivity, heat transfer coefficient, specific heat, thermal diffusivity etc.,) play vital role decide the mechanical properties of the metal and alloy. If the micro structure is strong mechanical properties are also strong. In literature survey different cooling medium used for heat treatment process, for improving the micro structure and properties. Sound micro structure sound mechanical properties defects in micro structure, mechanical properties not significant level. Addition of Nacl [1] not a significant effect of thermal conductivity and viscosity of water, the addition of PVP polymer effect on the viscosity of water. Mineral oils decrease conductivity and increase viscosity compared with water. In this experimental study showed that kinematic viscosity main factor affects the quench severity. Vegetable oils [2] rate of heat transfer hardness and severity of quench both edibles and non-edible oils. Based on heat transfer characteristics decide the best cooling media. Phase transformation [3] of Cu-Al-Mn alloy was performed using optimized thermodynamic parameters from literature. Precipitation behaviours in [4] Al-Cu-Mg and 2024 aluminium alloy in this study by means of conductivity and hardness measured calorimetry and TEM. Heat transfer characteristics [5] of each boiling regimes can be approximately by LFP, MHF and CHF plus properties of quench ant, finally CFD software, to simulate the quenching process compare the results with thermocouple readings. When hot metal [6] quenched in cooling media, boiling of quench ant goes through different stages each stage has

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different Heat transfer characteristics. Gross man number [6] indicates the quench severity for different quenching process is not sufficient to describe details of the quenching process. By alter composition [7] of quench oils, base oils and additives, Heat transfer characteristics are also changed in this study investigated physical chemical properties and cooling properties of new quench oils with different compositions according to ISO9950 standard. Different factors including [8] the cooling media is condition, thickness of the specimen. Quench factor analysis can be used to predict the strength of aluminium alloy quench ant Heat transfer coefficient. Air and water as cooling media [9] fast cooling rate fine grain and higher strength and slow cooling rate coarse grain and lower strength. Evaluation [10] khaya seed oil, water, SAE 40 engine oil. Khaya seed oil improved toughness of plain carbon steel than water and hardness less than water but higher in SAE 40 engine oil, quench severity khaya seed oil less than water.

II. Experimental and Analytical analysis

A. Material and Method

The key material used for this research work the composition of alloys Al2585 shown in Table 1. The machining of the Al2585 alloy samples was carried out using the lathe machine to the standard tensile and hardness check sample as shown in fig.6. The prepared test specimens were loaded in the heat treatment furnace and heated to a temperature of 500^0C, soaked at this temperature for different quenching media, to achieve a uniform temperature for 30min. The chemical composition of Al 258 alloy shown in table 1.

B. Tensile test

The test specimens, 2585 Aluminium Alloy, were used to determine the tensile strength of the materials on the Universal Testing Machine (UTM). The mechanical behaviour of each specimen was calculated from the tensile test and data were produced during the test such as applied load, elongation, stress were tabulated in the table1.

C Hardness test

The hardness test was conducted using a Brinell hardness test machine with a precision ball indenter of 10 mm on a material with a load of 500 kg for 15 sec and two or three indentations were carried out at various material locations and the Brinell hardness number was registered and the hardness value of 2585 Aluminium alloy was tabulated.

Table 1 Composition Al 2585 alloy % weight

Cu	Mg	Si	Fe	Mn	Ni	Zn	Pb	Sn	Al
10	0.3	2	0.7	0.5	0.5	0.1	0.01	0.01	Rest

Table 2 Mechanical Properties of the metal after quenched different media

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QM	UTS (N/mm^2)	YS (N/mm^2)	HBN	Elongation in mm
CU	125.62	99.05	47	7.5
TW	111.45	85.52	41	8.8
DW	102.42	70.89	40	9
SN	90.1	64.94	38	9.4
Shi N	86	62.72	36	9.7
EO	77.05	57.6	32	10

Fig.1 Specimens Quenched in media

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Fig.2 Specimens ready for testing

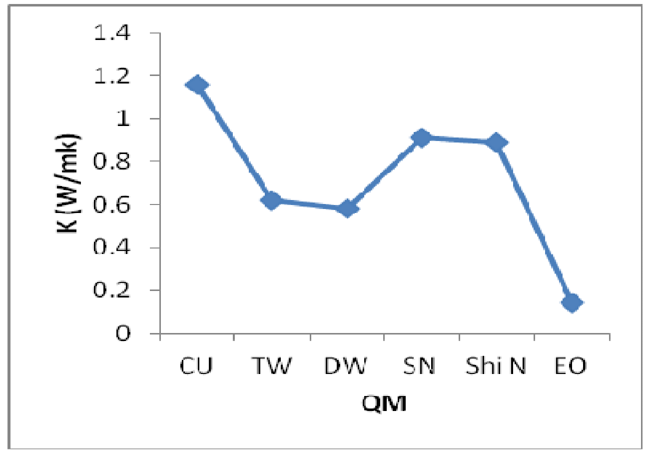

Fig. 5 Thermal conductivity Vs QM

Fig.3 Fractured specimens

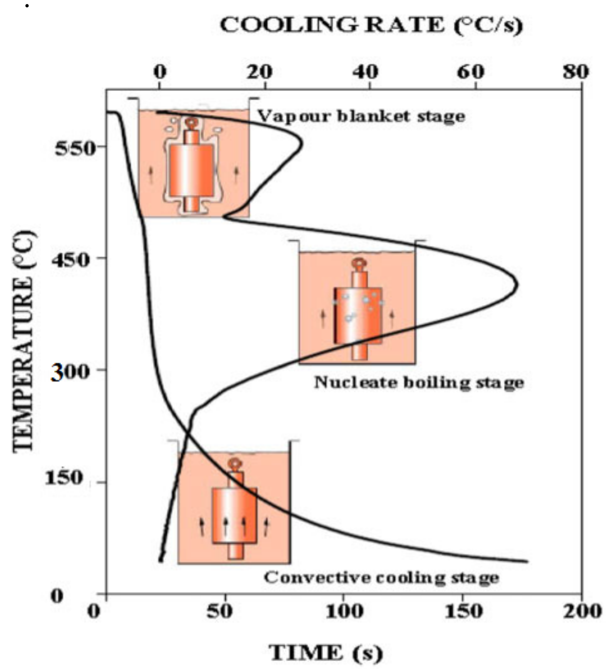

Fig.6 Different stages of cooling

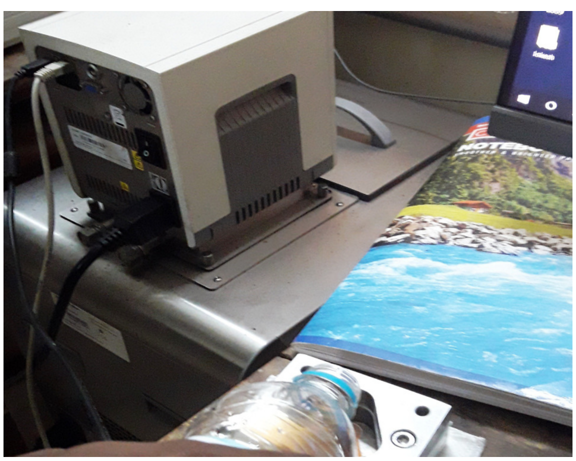

Fig.4 Thermal conductivity analyser

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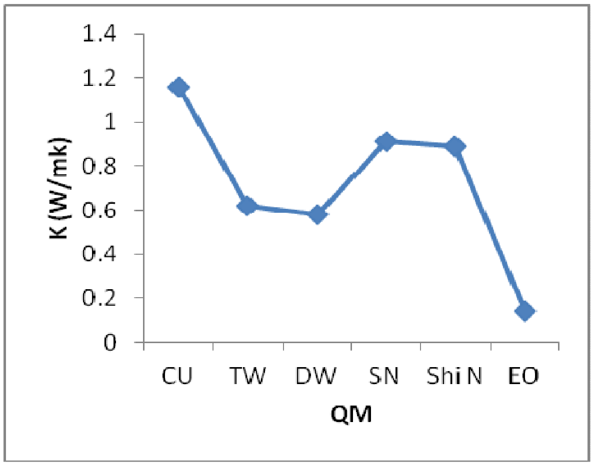

Fig. 7. Thermal conductivity Vs QM

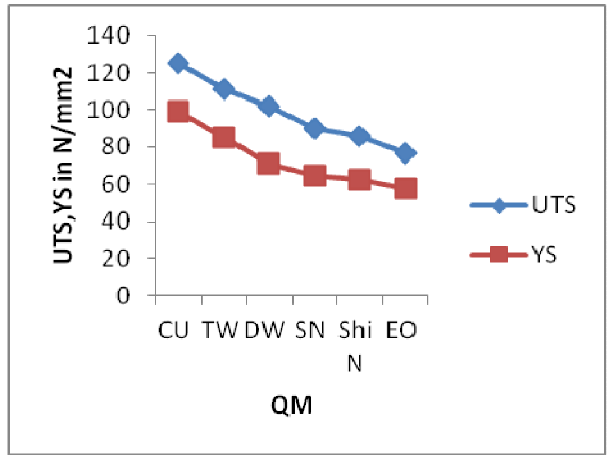

Fig.10 UTS&YS Vs QM

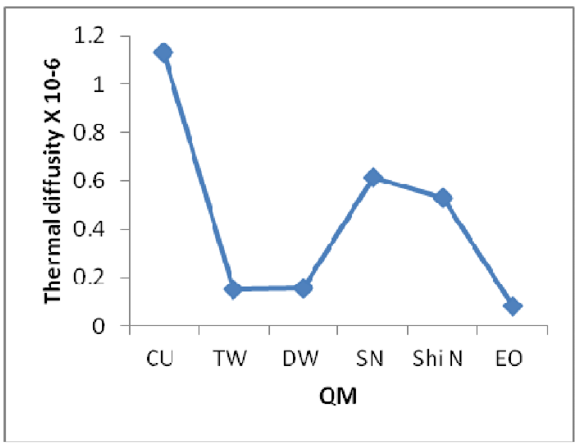

Fig. 8 Thermal diffusivity Vs QM

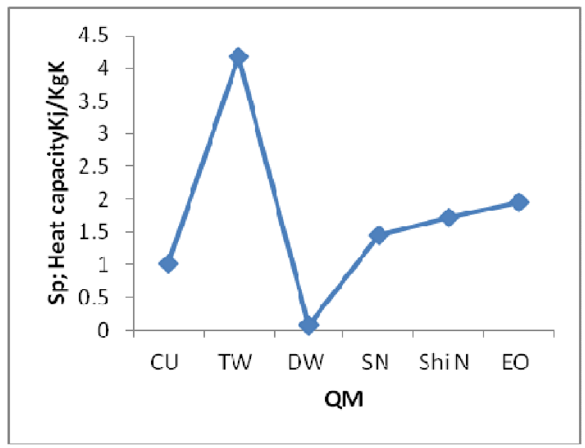

Fig. 11 Sp; heat capacity Vs QM

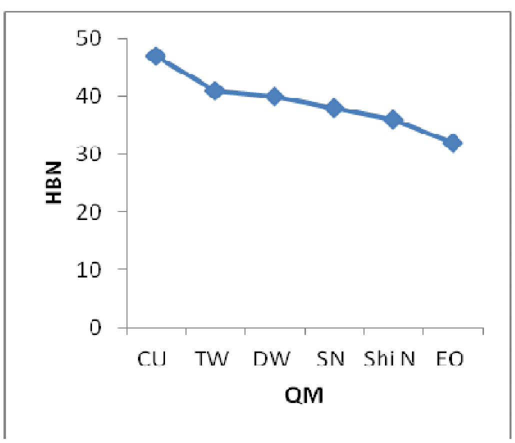

Fig.9 Hardness Vs QM

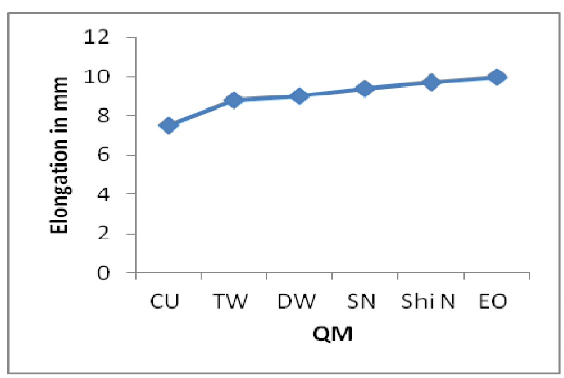

Fig.12 Elongation Vs QM

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RESULTS AND DISCUSSION

Vapour blanket Stage: The cooling rate at this stage is slow because the vapour envelope acts as an insulator, with cooling occurring primarily through the vapour film. Depends on surface roughness, medium temperature, cooling medium type and oxidation. Nucleate boiling Stage: At this point, the vapour envelope melts, with rapid heat removal as the liquid comes into contact with the metal surface and is vaporized. Convention cooling stage: This starts when the temperature of the metal surface is lower than the boiling point of the quench ant. Boiling and cooling stops by conduction and convection into the quench ant. The convective flow may be either turbulent or laminar.

From the investigation (Fig.7, Fig.8 & Fig.10) cooling characteristics like thermal conductivity, thermal diffusivity and specific heat are dependent on the ingredients present the cow urine. (Minerals, vitamins and enzymes) which helps fast cooling rate and quench severity are increased.

CONCLUSIONS

The additional elements present in cow urine quench media (fluid) properties changed drastically like thermal conductivity, specific heat and thermal diffusivity. Mechanical properties like Tensile strength, yield strength and hardness improved as compared with rest of fluids. Tap and distilled water similar heat transfer properties slightly effect of mechanical properties. Soap and Shikakai Nut solution naturally acid base thermal properties is very low and mechanical properties are very normal. Engine oil (SAE 40 Unused) thermal conductivity low and viscosity is high so cooling performance lower during quenching. The investigation clearly showed that thermal properties of the quench media is the principal parameter that effects the quench severity. Selection of quenching media plays vital role to improve the properties of metal and alloy. The cooling rate of the samples depends for the most part on the form of quenching medium and the shape and size of the specimen.

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Nomenclature

UTS	Ultimate Tensile Strength [N/mm^2]
YS	Yield Strength [N/mm^2]
HBN	Brinell Hardness Number
K	Thermal conductivity[W/mk]
EO	Engine Oil SAE 40
QM	Quenching Media
CU	Cow Urine
TW	Tap water
SN,Shi	Soap & Shikakai nut solution
DW	Distilled water

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