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Chemical Characterization of Cow Urine For Cooling Media Application In Metallurgical Operations

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Abstract - *In this research work alkali nature of cow urine as cooling media for metallurgical operations were examined. The alkaline nature of cow urine acts as a good electrolyte liquid. One of the most common processes in quenching is the vaporization of liquids. During this process, due to Leiden, the frost phenomenon leads to generating uneven residual stress, crack distortions and thus avoid homogeneous quenching. In this work, the chemical characterization of cow urine has been tested by means of Differential Scanning Calorimeter/Thermogravimetric analysis (DSC/TGA), Fourier Transform Infrared Spectroscopy (FTIR), Particle size analyzer (PSA), and Conductivity meter, through these tests the points of interest are (i) how ingredients activated, (ii) mass measurement while the temperature of a sample is changed over the time, (iii) evaluate the thermal stability, and (iv)specific heat of cooling medium. Cow urine specific heat 4.517J/gm^{0}c at room temperature is high compared with water, and the boiling point is slightly higher than water, C-H, C=O, OH groups present, particles are monodisperse 7091.5nm spherical size present. Due to ingredients present in the cow urine, it exhibits superior properties with respect to thermal and heat transfer characteristics than other cooling media. Moreover, it provides uniform quenching, better thermal and cooling properties, so cow urine is one more option for cooling media.*

Keywords — *Alkaline nature, Cow urine, DSC/TGA, FTIR, Leiden frost point.*

I. INTRODUCTION

In ancient Indians, especially in Hinduism cow was considered a sacred animal. It is observed that cow milk, urine, and dung have been used as food supplements, medicinal, spiritual, and agriculture purposes. Traditionally [1], cow urine is being sprayed in-home and courtyards for its holy purposes based on the belief that it gives purity, happiness, prosperity, wealth, and health. A laboratory study on cow urine reveals that it consists of copper, iron, nitrogen, manganese, sulfur, carbolic acid, silicon, ammonia, chlorine, citric, magnesium, calcium salts, mineral salts, enzymes, vitamins like A, B, C, D, E, uric acid, creatinine, gold acids, hormones, etc. [1]. Most of the rural areas in developing countries like India are suffering from frequent electricity power cuts. The applications of cow urine have been examined in a 14 W capacity power generation plant as a part of green energy technology in Dhaka, Bangladesh [2]. The cow urine as prime catalyst was successfully demonstrated in the plant with respect to the pace of chemical reactions and electrode conditions within a time interval frame [3]. From these results, it can expect to generate large electrical power by using more quantity of cow urine to fulfill the future demand. Hence, the need arose to build cow urine-based power generation systems to overcome the electricity power shortage problems. For sustainable economic growth and a healthy environment and electricity generation systems, mankind has access to a variety of natural renewable energy resources are tidal, solar, wind, biomass, and biogas, *etc.* [4]. Energy from cow urine can be used as a new renewable source of energy; that produces electricity by electrolytic conductions. By the research, a small cow urine-based power generation system was demonstrated. The efficiency of the system is satisfactory. Hence, for better understanding and the feasibility of the system, it needs to test for a longer period of time and build a larger scale of the system. A 5 liters quantity of urine is taken for the work, and electrodes taken are very old and got the power of approximately 1.5 W. All over the world, the majority of the population faces regular power cuts [5]. Consequently, taken shot at dairy animals' urine to control the produced framework for tomorrow's future generations. During this investigation, 10 straightforward cells were constructed by considering the usage of plastic containers with 2 cathodes (copper and Zinc). They are dunked in dairy animals' urine which goes about as arrangement of electrolytic. Dairy animals' urine contains corrosive Uric. Copper responded with water nearly corrosive Uric. Whenever copper and zinc plates interacted with corrosive uric and began to move with electrons to generated power. One liter of urine is needed to run an

electric generator with enough hydrogen. Around 7 liters of the fuel is required by a gas-fuelled generator to continue running for a comparative time frame. The ionic liquid increases the cooling rate predominantly by adding a few % of water [6]. Even at higher bubble boiling, convection and water contents are significant, and almost no Leiden frost-effect will rises. This gives a huge potential to homogenize immersion quenching and accelerate. To sum up, ionic liquids seem to have a bulk potential to homogenize immersion quenching and accelerate. Hence it minimizes avoidable distortion and asymmetrical residual stresses in the quenched components. Several health advantages, the cows were adopted, commence with dung, urine, manure, yogurt, ghee, and milk products., hence they are more popular; that is why cow urine has always been divine and superior [7]. Cow's urine has improved as in combination or single in combination with other treatments for spiritual uses and medicine in the past. Currently, photocatalytic degradation is the popular alarming technique to make water waste impact inorganic and harmful organic hazards [8]. Photo-catalysis for a semi-conductor is a favorable method that provides a number of benefits, including water and air cleaning, remediation, and toxic wastewater sterilization in the surroundings. Silver oxide (SiO_2) enabled photocatalytic is an excellent and ideal method for biodegradation in wastewater and organic pollutants [9]. Experimental investigation accomplished for the first time the quick synthesis in a single pot of Ag_2O (cylindrical form) nanoparticles (NPs) using cow urine [10]. The *X*-ray diffraction studies confirm Ag_2O NPs. The Transmission electron microscopy analysis showed 20 nm particle sizes with spherical shapes. They have shown excellent photocatalytic degradation because of the delicate nature of methylene blue to absorb energy broader power of its bandgap. The results obtained are confirmed that they produced Ag_2O NPs shows an effective anti-bacterial activity against pathogens from foodborne. This is environmentally and a rapid benign method, which is added advantage of better control shape and oversize and reduced reaction time. Through literature survey, it is observed that different cooling medium was used for heat treatment processes, for improving the microstructure and mechanical properties of materials. Good refinement of microstructure leads to better mechanical properties. Otherwise, defects present in microstructure wouldn't improve mechanical properties at a significant level. The addition of NaCl does not have a massive impact on the thermal conductivity and viscosity of water; however, the addition of PVP polymer influences the viscosity of water [11]. Usage of mineral oils as cooling media decreases conductivity and increases viscosity as compared to water. From the experimental study, it is found that kinematic viscosity significantly affects the quench severity. In both edible and non-edible oils rate of heat transfer, hardness, and severity of quench were decreased [12]. In the following paragraphs, the studies related to heat transfer characteristics of Al alloys using different techniques are presented. This helps in deciding the best cooling media.

A study was conducted on Al-Cu-Mg 2024 alloy by adding precipitation to know the thermal conductivity behavior using Differential Scanning Calorimeter (DSC) and Trasmission Electron Microscopy (TEM). Through this study it was observed that due to changes in morphologies, hardness was improved, and defects are decreased [13]. Phase transformation of Cu-Al-Mn alloy was performed using optimized thermodynamic parameters such as enthalpy change and thermal stability of liquid and found refined microstructure [14]. In a study on heated piston the behaviour of thermal properties such as Leidenfrost point, Mininium heat flux and Critical heat flux were experimentally analysed and the results were validated with CFD software simulation [15]. The variations of heat transfer characteristics of a hot metal in different stages like vapour blanket stage, nucleate boiling and liquid boiling were experimentally studied when water is used as cooling media [16]. As Gross man number indicates the quench severity of a quenching process. A study on Aluminium alloy series is conducted with different cooling media such as base quench media (water) to compare quench severity in terms of Gross man number [17]. It was found that polyvinyl chloride (PVC) media is having highest quench severity. The study on Aluminium alloy for alter compositions, addition of additives with different quench media revealed that the temperature profile of water is better as compared with oils [18]. A study was conducted to examine the variations of physical, chemical and cooling properties of new quench oils such as polyalkylene glycol with various compositions by maintaining ISO 9950 standards [19]. From the study, controlled distortion and low residual stresses were observed. A study was conducted to predict the strength of aluminium alloy quenchant and heat transfer coefficient using a novel approach called Quench factor analysis with air and water as cooling media [20]. In the same study it was aimed to evaluate the durability, hardness and quench severity properties of Khaya seed oil, water, and SAE 40 engine oil on plain carbon steel. The test results revealed that (i) Khaya seed oil enhances durability than water (ii) hardness is higher in SAE 40 oil, and (iii) quench severity of water is high. Furthermore, the potential of cow urine in electrical power generation has been examined by extracting hydrogen. [21].

II. MATERIALS AND METHODS

Water and oil are most oftenly used cooling media for metallurgical operations. Water gives fast cooling rate and low temperature range where as oil gives slow rate of quenching and high temperature range. However a ideal quenching media will have same cooling rate at both low and high temperature ranges. In this regard, cow urine has been investigated for its unprecedented thermal properties to establish as a ideal cooling media for metallurgical applications. Accordingly the tests conducted are presented in the following Section.

A. FOURIER TRANSFORM INFRARED (FTIR) SPECTROSCOPY

Fourier Transform Infrared (FTIR) spectroscopy is a technique for determining the qualitative and quantitative characteristics of IR-active compounds in organic and inorganic solid, liquid, and gas samples. From the figure 1 observed that C-H, OH and C=O groups are present in above media. These. are destabilize the vapour blanket formed around the hot specimen when quenched the cow urine, that is rapid cooling the specimen grain refinement and mechanical properties are improved. In water as quenching media vapour blanket formed around the specimen cooling rate is very slow and distortion of work piece had occurred. C-H stretching vibrations usually appear between 2500 and 2700 cm^{-1}. C=O stretching vibrations usually appear between 1600 cm^{-1} and 1750 cm^{-1}. The reappearance of strong peak that appeared at 3200 - 3600-1is along with the bending vibration of OH. Based on IR so we expected vapour blanket break when hot specimen quenched in medium(faster cooling rate than the other media)

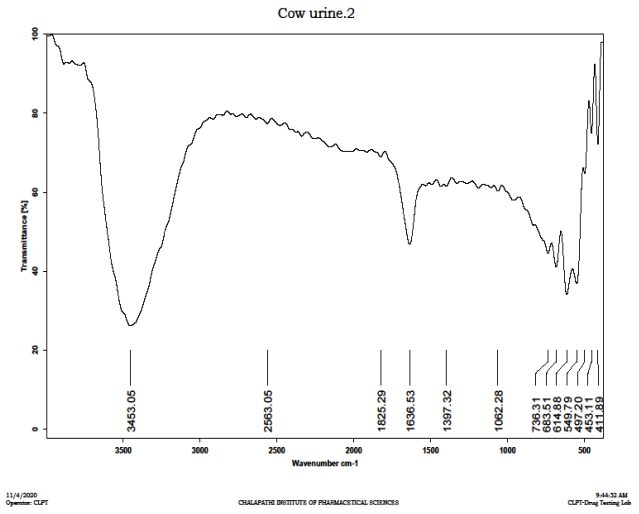


Fig.1 FTIR Spectrum

B. PARTICLE SIZE ANALYZER (PSA)

In order to investigate the particles in the sample (Cow urine) particle size analyzer experiments have been performed to know the size distribution of particle present in solution. The experiment revealed that the sample is having spherical particle of size 7091.5nm indicates that the particles are mono disperse. From the figure 2, Diameter and Frequency (indicated particle size in nanometers) The charge on a particle surface in a certain liquid media is measured by the zeta potential. This surface charge value is useful for understanding and predicting particle suspension interactions. Zeta potential is measured on the SZ-100 using the technique of electrophoresis light scattering. In this case, particle motion is observed in the presence of an applied electric field.

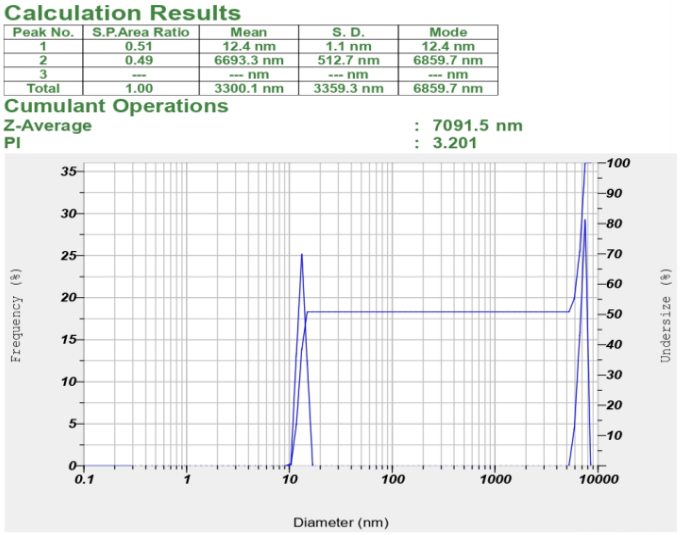
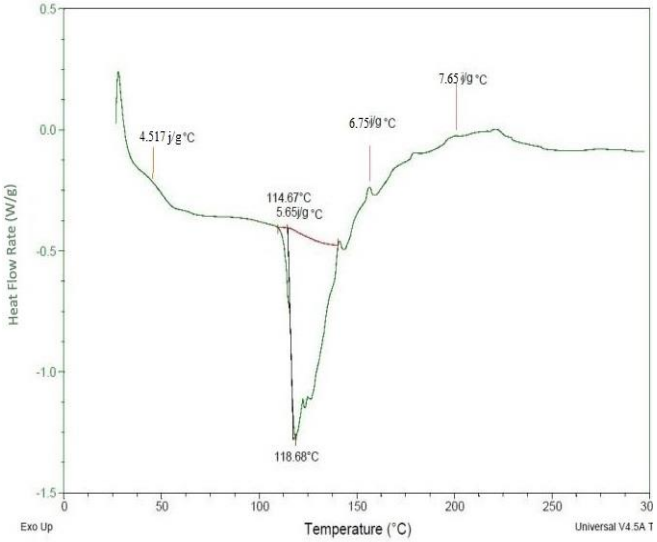


Fig.2 PSA- Particle size distribution

C. DSC (DIFFERENTIAL SCANNING CALORIMETER)

DSC is used to study the behavior of materials as a function of temperature or time. Differential Scanning is a method of tracking. Thermo chemistry is a thermal analysis technique that analyzes how temperature can affect a material's heat capacity (Cp). By heat or cool a known mass sample, and variations in heat capacity are measured as changes in heat flow. It was observed that specific heat of cow urine is high at 100^0C (5.65J/Kg K) (Figure 3 specific heat with respect to temperature) as compared with water. Specific heat vital role any quenching media. Differential Scanning Calorimetry is an effective analytical tool find the thermal properties of the medium. We absorbed the graph specific heat capacity of cow urine is higher than that of water respective temperatures. Exothermic(enthalpy change is negative) and endothermic reaction(absorb heat).



D. TGA (THERMO GRAVIMETRIC ANALYSIS)

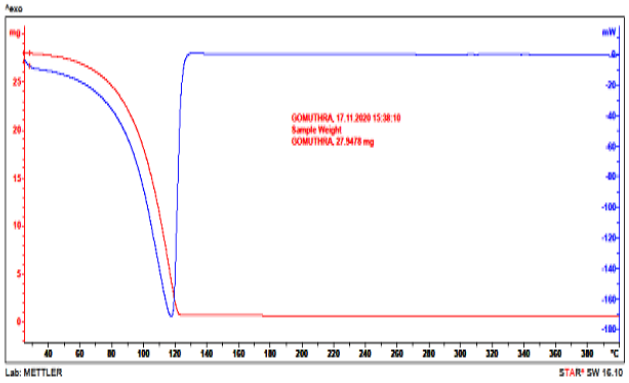


Fig.4 TGA & DSC (Combined)

TGA curve revealed that cow urine is having up to 80^0C stability from 80^0C to 124^0C cow urine is sharply degraded from 124^0C to 400^0C the cow urine is completely stable. The DSC curve shows (Figure 4) is exactly matching to the TGA curve, the boiling point of cow urine is sharply 120^0C is shows that it clearly indicates the degradation of cow urine is 80^0C to 120^0C. TGA analysis is a type of thermal analysis that looks at how a sample's mass changes as a function of temperature or time. Thermal stability of cow urine higher than the water i.e. latent heat of vaporization is low. Normally water is boiled at 100^0C but cow urine(Fig.5) takes slightly higher than the water. So thermal stability and latent heat of vaporization is important property of any quenching media. Due to higher temperature of specimen will be having higher surface energy which is very much greater than surface tension of the liquid will be having super hydrophilic wettability condition.

III. CONCLUSION

In the present investigation, cow urine one more option for cooling media (alkaline nature) for metallurgical operation that is fast quench, uniform quench and easy quench. Water, air and oils have been the major quenching media for changing the properties of any engineering material. Oils are complex mixtures that are made up of different molecules that should not be changed so as to maintain the synergy to produce their effects. Mineral oils have been in use as the traditional source of quenching media for metals and alloys because excellent cooling capacity. However, the growing environmental concerns such as renewability, biodegradability, safety and health of workers demand serious attention; thereby looking for an alternative quenching media that is cow urine is one more option (free of cost) metallurgical application having unprecedented thermal and heat transfer properties. In this research profound of cow urine excellent thermal and electrical properties various tests conducted in laboratoty. So far cow urine used for imporve the medicinal properties of the medicine. It was medicine for some diseases like cancer, skin diseases, asthama etc., Junagadh Agricultural University (The Economics Times Epaper, June 28, 2016) foud gold nano particles (Gir type-cow). Gnnerally alkaline nature of cow urine high coductance compared with water. Nearly twenty five existing media so far used for metallurgical operations to improve the micro structure and mechanical properties of the metals. Normally water as base quenching mediafor all metallugical operations. It is novel quenching media vraious ingrediants homogeneously present, so rapid cooling heated specimen without internal craks of specimen. And these ingrediants refine the grain structure (interlocking the grain boundaries) and improved the mechanical properties of the metals.

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CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest

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