

# Tribological Analysis on Aluminium Metal Matrix Composite Reinforced With Aloevera

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**Abstract-** The growing concern of producing diligence is to use price effective bolstered Al essence matrix mixes for meeting their product rates with least price enterprises while not immolating the precise parcels. during this design Aloevera is employed as underpinning material for Al essence matrix compound because it's a lower quantum thick and ecofriendly at low price and it can be the choice to ash, rice cocoon, etc., in respect of advanced physical and mechanical parcels. The stir casting fashion is employed for getting ready the casting of the Al essence matrix compound. Also the castings area unit machined to asked form and size. associate experimental study has been carried on mechanical characterization of Al essence matrix mixes victimization aloevera as underpinning accoutrements and thus the following tests area unit done, Tensile check, Hardness check, Impact strength check and Wear check.

**Keywords-** Aluminium, AMMCs, Aloevera, Stir casting, Hardness, Impact, tensile, wear.

## I. INTRODUCTION

These days metal matrix composites (MMCs) area unit additional enticing for producing industries as they're the replacement for standard materials in several engineering applications. normally MMCs comprises a minimum of 2 elements, one is that the metal matrix (pure metal or alloy) and also the alternative is that the reinforcement material. The addition of reinforcement material into the metal matrix improves the precise strength, stiffness, wear, creep and fatigue compared to the traditional engineering materials. expressly the particulate metallic element matrix composites (PAMCs) are with success used as elements in automotive, aerospace, optomechanical assemblies, braking systems of trains and cars, turbine engines, helicopters, military aircrafts, etc. On the idea of reinforcing materials the PAMCs area unit classified into 3 broad classes specifically artificial ceramic particulates, industrial wastes and agro waste derivatives. the event of AMCs strengthened with agro and industrial waste derivatives have loads of focus within the gift day producing state of affairs to attain the advantages of serious process price reduction, satisfactory physical and mechanical properties.

additional recently the main target of researchers turns towards the utilization of agro derivatives as reinforcement materials in Al metal matrix composites with a read to complementing reinforcement to either carbide or corundom. a {number of|some|many} number of agro derivatives like breadfruit seed hull, rice husk, bamboo leaf, coconut shell, sugarcane pulp etc. are processed into ashes and their quality to be used as reinforcing material are studied. Aloe vera could be a perennial, drought-resisting, succulent plant happiness to the Asphodelaceae family. Aloe vera (*Aloe barbadensis miller*) could be a tropical or sub-tropical plant that has lance-shaped leaves with jagged edges and sharp points. This plant is getting used extensively in healthful functions and cosmetic business. it absolutely was originated in tropical continent and it's currently cultivated in heat climatical areas of Asia, Europe and America. In India, Rajasthan, state, Chhattisgarh, Gujarat, Tamil Nadu and Kerala are the main producers of this crop. The cultivation of Aloevera plants is economically terribly enticing. The plantation of Aloevera doesn't need a lot of water and it needs one 50ml of water monthly for yield of fine quality leaf deliberation more or less 1 kilo. In India, the common yield for organically big succulent is concerning twelve tonnes per area unit. The Aloevera has higher water holding capability and primarily contains metal (3.58%), metallic element (1.22%), sodium (3.66%), metal (4.06%), phosphoric (0.02%), iron (0.1%), copper (0.06%) and metallic element (0.02%). it's a stem less or terribly short stemmed succulent plant growing to eighty to one hundred cm tall, spreading by offsets and root sprouts. The contact angle for Aloevera leaves is ninety six.89° and thus it possesses important wet ability. it's a succulent like plant with inexperienced, dagger- formed leaves that area unit fleshy, tapering, spiny, marginated and crammed with a transparent viscous gel. As Aloevera is essentially offered, simply tillable, less dense ecofriendly material with extended wettability, it's appropriate for reinforcement of AMCs. On the idea of reinforcement materials, there area unit four types of MMCs specifically particle - strengthened MMCs (particulate MMCs), short fibre (or whisker) - strengthened MMCs, continuous fibre (or sheet)-reinforced MMCs and laminated (layered) MMCs

## II. METAL MATRIX COMPOSITE

Metal matrix composite (MMC) is stuff with a minimum of 2 constituent components, one being a metal. The opposite material could also be a unique metal or another material, like a ceramic or chemical compound. MMCs square measure nearly continuously costlier than the additional typical materials they're commutation. As a result, they're found wherever improved properties and performance will justify the superimposed value. these days these applications square measure found most frequently in craft parts, house of applications will definitely increase as producing prices square measure reduced. as compared with typical chemical compound matrix composites, MMCs square measure immune to fireplace, will operate in wider vary of temperatures, don't absorb wet, have higher electrical and thermal physical phenomenon, square measure immune to radiation, and don't show out gassing. On the idea of reinforcement materials, there square measure four types of MMCs specifically particle - bolstered MMCs (particulate MMCs), short fibre (or whisker) - bolstered MMCs, continuous fibre (or sheet)-reinforced MMCs and laminated (layered) MMCs. Earlier studies reveal that the appliance of continuous fibre bolstered MMCs are hindered by high producing prices related to the high prices of the reinforcement fibers and extremely labour intensive producing processes. Consequently, utilization of those materials has been restricted to military and different extremely specialised applications. although whisker bolstered MMCs are shown to own smart mixtures of strength and thermal stability relative to those of particulate bolstered materials, the commercialisation of whisker bolstered MMCs has been slow as a results of high prices related to presently obtainable whiskers, faulted internal structure of whiskers etc. MMCs square measure created by dispersing a reinforcing material into a metal matrix. The reinforcement surface may be coated to forestall a chemical process with the matrix. for instance, carbon fibers square measure usually utilized in aluminum matrix to synthesize composites showing density and high strength. However, carbon reacts with aluminum to come up with a brittle and watersoluble compound on the surface of the fiber. to forestall this reaction, the carbon fiber is coated with nickel or metallic element boride. Over recent decades several new composites are developed, some with terribly valuable properties. By fastidiously selecting the reinforcement, the matrix, and also the producing method that bring them along, engineers will tailor the properties to satisfy specific necessities. They can, for instance, build the composite sheet terribly sturdy in one direction by orientating the fibres that manner, however choose properties like resistance to heat, chemicals, Associate in Nursingingd weathering by selecting an acceptable matrix material.

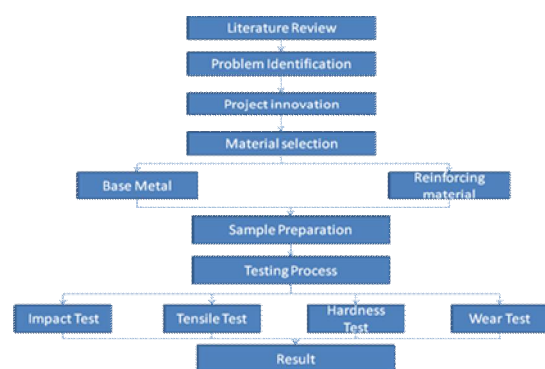
## III. LITERATURE REVIEW

Atuanya et al[1] fictional Al matrix composites (AMCs) bolstered with absolutely utterly completely different volume fractions of breadfruit seed hull ash particles by observe double stir casting methodology. The microstructures and properties of Al-Si- iron alloy matrix composites bolstered with absolutely utterly completely different weight fractions of breadfruit seed hull (husk) ash particles of size five hundred nm were investigated. Six (6) absolutely utterly completely different weight fractions of breadfruit seed hull ash particles were superimposed to Al alloy matrix employing a double stir-casting methodology. Microstructural analysis shows that with the rise of the reinforcement weight fraction, the matrix grain size decreases. The mechanical properties of the composites unit improved over the matrix materials, apart from the marginally decrease of the impact energy. Fracture surface examination indicates that there's associate degree honest surface bonding between the Al alloy matrix and therefore the breadfruit seed hull ash particles that fracture initiation doesn't occur at the particle-matrix interface. Hence, incorporation of breadfruit seed hull ash particles in Al matrix will cause the assembly of low value Al composites with improved hardness and strength. These composites will notice applications in automotive components wherever light-weight materials unit needed with wise stiffness and strength. Usman et al .[2] examined the mechanical properties of sugarcane pulp ash (SBA) strengthened atomic number 13 composites and that they over that the mechanical properties square measure inside the vary of properties of materials employed in the assembly of automobile parts. The study was meted out to work out the density and mechanical properties of Al-7%Si alloy - pulp Ash (BA) composite created at 800oC. BA obtained at 700oC and having high silicon dioxide and corandom contents of up to seventy seven.29% and 10.95%, severally was used as reinforcement and varied from 0vol% to 30vol%. The density and a few mechanical properties of the created composites were determined. The results showed that the density decreases with share increase in reinforcement from 2840.242kgm-3 to 2292.208kgm-3 with the minimum worth at 30vol% BA. The results of the mechanical properties tests showed that, the last word enduringness (UTS) varies from 139.677MNm-2 to 176.683MNm-2 with most worth at 10vol% BA, Young modulus varies from 1429.890MNm-2 to 1725.425MNm-2 with most worth at 10vol% BA, impact strength varies from seventy five.401kJm-2 to 128.262kJm-2 with most worth at 10vol% BA and hardness varies from seventy.467RHV to ninety.767HRV with most worth at 20vol% BA and with all the hardness values higher than that of the management sample. The results conjointly showed that, the fatigue strength varies from zero.066x10<sup>6</sup> cycles to one.797x10<sup>6</sup> cycles with most worth at 15vol% BA and also

the share elongation having around constant worth. The results of the applied math analysis showed that there square measure vital variations among the suggests that of every property of the composites at varied levels of BA replacement. It was over that pulp ash may be used as reinforcement in metal composites and also the created composites may be employed in industry for the assembly of engine blocks, pistons, among others. . Alanemeet al. ( 3) developed Al mongrel mixes strengthened with bamboo splint ash (BLA) exploitation 2 step stir casting fashion. The viability of developing low value – high performance Al matrix mongrel mixes with the application of bamboo splint ash (an agro waste ash) and carbide as completing mounts was delved. carbide (SiC) particulates side with zero, 2, 3, and four binary halls bamboo splint ash (BLA) were used to organize ten binary halls of the buttressing part with Al Mg Si amalgamation as matrix exploitation 2 step stir casting fashion. Microstructural characterization, mechanical parcels analysis and erosion geste were habituated assess the performance of the mixes. The results show that the hardness, final continuity, and extension of the mongrel mixes drop with increase in BLA content. The fracture durability of the mongrel mixes were but superior to it of the only strengthened Al ten binary halls set on compound. solely the two binary halls BLA containing mongrel compound had specific strength price akin to that of the only strengthened compound. In 5wt NaCl resolution, it had been determined that the two and three wt nothing BLA containing mongrel mixes had advanced erosion resistance as compared to the only strengthened Al ten binary halls set on compound still the rear trend was determined in zero.3 M H<sub>2</sub>SO<sub>4</sub> resolution wherever the only strengthened had superior erosion resistance. Pradeepet.al. [4] conducted a study of mechanical properties of aluminium red mud and carbide metal matrix composite of A7075 with the addition of varied percentages of red mud and carbide particles by stir casting technique. metal metal matrix composites ar gaining widespread acceptance for automobile, aerospace, agriculture farm machinery and lots of different industrial applications owing to their essential properties like high strength, density, sensible wear resistance compared to the other metal. the current study deals with the addition of reinforcements like carbon, fly ash, carbide, red mud, organic material etc. to the metal matrix in varied proportions. every bolstered material has a personal property that once value-added improves the properties of the bottom alloy. a trial has been created to review the various combos of the composites and the way they have an effect on the properties of the various alloys of metal. A comprehensive data of the properties is provided so as to possess AN overall study of the composites and also the best results will be used for the more development of the metal bolstered composed. Gurvishal Singh et al. [5] administrated experimental study to look at the small hardness of red mud

strengthened metal alloy A6061. during this paper we have a tendency to describe the behavior of Metal matrix composites. As we all know that these metal matrix composites square measure used largely in liberty ships, aerospace, automotive, and nuclear. within the gift paper the study on sharp brag activities of Al metal matrix composite strengthened with Red Mud, set and Al<sub>2</sub> O<sub>3</sub> has been administrated. There square measure numerous production technique offered wherever the worth fraction of reinforcements might be inflamed and square measure doubtless to vary the damage performances of the composite. Composites posses wonderful Strength and Stiffness and this describes that these square measure Very light Materials. therefore this paper describes that these possess high resistance to reaction, chemicals and different weather agents. Our paper additionally describes the benefits of MMC's because it provides Dimensional stability, Wear and Corrosion resistance, Reduced Weight. As we all know that Red mud emerges because the major waste matter throughout production of corundum from mineral by the Bayer's method. huge efforts are directed worldwide towards red mud management problems, i.e., of utilization, storage and disposal. totally different avenues of red mud utilization square measure a lot of or less famed however none of them have to date tried to be economically viable or commercially possible. it's studied that small onerousness and resistance to wear of MMCs is made by reinforcement and additionally the damage properties square measure improved remarkably by introducing hard intermetallic compound into the Al matrix.

#### IV. METHODOLOGY



#### V. FABRICATION

Aluminium 6063 is employed as a base that incorporates a chemical composition of metal zero.9%, silicon 0.6% , iron 0.35%, and copper, manganese, metal atomic number 30, metallic element square measure 1 Chronicles. Aluminium incorporates a density of two.70g/cc. It conjointly has sensible strength, corrosion resistance , weldability & brazability, good workability and machinability

The reinforcement material used for atomic number 13 is Aloe vera. The density of the aloe vera is one.22g/cc. Adding it as a reinforcement can increase the strength of the fabric. Before casting, the aloe vera leaves were shredded to a length of five metric linear unit and that were washed with plight at eight0°C to get rid of unwanted dirt and so dried in an exceedingly hot air kitchen appliance for 8 hours at 100°C to get rid of excess wetness content. Then the shredded leaves were ground into a powder kind concerning 2mm size. As for atomic number 13, Al6063 is already purchased in an exceedingly style of fine powder. Stir casting methodology has been used for making ready the 2 completely different sets of AMCs with reinforcement materials Av powder on an individual basis. At first four hundred grams of pure atomic number 13 is thawed in an exceedingly resistance heated muffle chamber. The pure atomic number 13 was charged into plumbago vessel and also the temperature of the melted metal is raised to 720°C that is quite the freezing point of atomic number 13. At an equivalent time the Aloe vera powder is preheated to get rid of the wetness content in it. The preheated Av powder of fifty wt of base metal was introduced slowly in to the melted atomic number 13 that is at concerning 720°C. to enhance the wet ability of Av powder, metal (3 wt%) was additional and so the melted metal was stirred at a continuing speed of three hundred revolutions per minute for five minutes to achieve homogeneity of the mixture of matrix material and Av powder. The soften was poured into the steel die when the mixture was unbroken within the vessel concerning 0.5 a moment in static condition and so it absolutely was poured and solid in an exceedingly steel die. an equivalent method was continual for one more proportion V-day Of Aloe vera.



Figure 1: Image of specimen

#### A. Stir casting



Figure 2: Stir casting machine assembly

Stir casting setup in the main contains a chamber and stirring assembly as shown in fig. generally the activity of metal matrix composite involves a soften of selected matrix

materials followed by introduction of a reinforcement material into soften, getting an appropriate dispersion. subsequent step is that the material to get the specified distribution of the phase within the forged matrix. In making ready metal matrix composites by the stir casting technique, there are many factors that require extended attention together with.

- i. the problem in achieving an even distribution of the reinforcement material.
- ii. Weld ability between the 2 main substances.
- iii. consistence within the forged metal matrix composite
- iv. chemical process between the reinforcement material and matrix alloy.

#### B. IMPACT TEST SETUP

Impact check we have got an inclination to taken is that the ASTM Charpy impact check. Charpy impact check is nothing that determines the volume of energy absorbed by a instance throughout surprising impact that makes the fracture among the 'V' notch gift among the instance. The instance length was regarding 55 mm length and so the depth of V notch was 2 mm. The machinery consists of a setup of known mass and length that's born from a known height to impact a notched instance of material. The energy transferred to the material are inferred by examination the excellence among the peak of the hammer before and once the fracture (energy absorbed by the fracture event). The notch among the sample affects the results of the impact check, so it's a necessity for the notch to be of normal confines and calculi. the scale of the sample could have an impact on results, since the confines corroborate whether or not the material is in aeroplane strain. This distinction can greatly have an impact on the conclusions created. The qualitative results of the impact check are used to corroborate the malleability of a cloth. However, the fracture was brittle, and if the material breaks with jagged edges or shear lips, If the material breaks on a flat aeroplane. generally a cloth doesn't break in exactly some way or the volition, associated so examination the jagged to flat face areas of the fracture offers associate degree estimate of the proportion of ductile and brittle fracture. The impact energy of low-strength essence that don't show revision of fracture mode with temperature is generally high and asleep to temperature. For these reasons, impact tests aren't wide used for assessing the fracture resistance of low-strength accouterments whose fracture modes keep unchanged with temperature. Impact tests generally show a ductile-brittle transition for low strength accouterments that do exhibition revision in fracture mode with temperature like body-centered boxy (BCC) transition essence. generally high-strength accouterments have low impact powers that attest to the

particular certain fact that fractures simply initiate and propagate in high-strength accouterments. The impact powers of high-strength accouterments away from brands or BCC transition essence unit of dimension generally asleep to temperature. High-strength BCC brands show a wider variation of impact energy than high-strength essence that don't have a BCC structure as a results of brands bear bitsy ductile-brittle transition. Anyhow, the foremost impact energy of high-strength brands remains low thanks to their terseness



**Figure 3: Pendulum impact test machine**

### C. TENSILE TEST SETUP

Tests square measure performed as per the ASTM Standards. A tensile check measures the resistance of a fabric to a static or slowly applied force. A machined specimen is placed within the testing machine and cargo is applied. A strain guage or extensometer is employed to live elongation. the strain obtained at the very best applied force is that the strength. The Yield Strength is that the stress at that a prescribed quantity of plastic deformation (commonly zero.2%) is made. Elongation describes the extent to that the specimen stretched before fracture. info regarding the strength, stiffness, and plasticity of a fabric is obtained from a tensile check. The machine used was a operated by hand UTM machine the most load of machine is 400KN.



**Figure 4: Universal tensile machine**

### D. HARDNESS TEST SETUP

Hardness could be a characteristic of a fabric, not a elementary property. it's outlined because the resistance to indentation, and it's determined by measure the permanent depth of the indentation. additional merely place, once employing a mounted force (load) and a given indenter, the smaller the indentation, the tougher the fabric. Indentation hardness price is obtained by measure the depth or the realm of the indentation mistreatment one amongst over twelve

completely different check ways. The illustrator scale is a hardness scale based mostly on indentation hardness of a fabric. The illustrator check determines the hardness by measure the depth of penetration of AN indenter beneath an outsized load compared to the penetration created by a preload. There square measure completely different scales, denoted by one letter, that use completely different masses or indenters. The result's a dimensionless variety noted as HRA, HRB, HRC, etc., wherever the last letter is that the various illustrator scale. once testing metals, indentation hardness correlates linearly with tensile strength. This vital relation permits economically vital nondestructive testing of bulk metal deliveries with light-weight, even moveable instrumentality, like hand-held illustrator hardness testers. The determination of the illustrator hardness of a fabric involves the appliance of a minor load followed by a serious load. The minor load establishes the zero position. the most important load is applied, and so removed whereas still maintaining the minor load. The depth of penetration from the zero knowledge is measured from a dial, on that a tougher material provides the next variety. That is, the penetration depth and hardness square measure reciprocally proportional. The chief advantage of illustrator hardness is its ability to show hardness values directly, so preventive tedious calculations concerned in different hardness measuring techniques.



**Figure 5: Rockwell hardness test machine**

### E. WEAR TEST SETUP

A pin-on-disc is employed to perform the damage experiment. the damage track, alloy and composite specimens ar cleansed completely with ketone before check. every specimen is then weighed employing a digital balance having AN accuracy of  $\pm 0.001$  gm. subsequently the specimen is mounted on the pin holder of the tribometer prepared for wear check. Specimens of size twelve millimeter diameters and 15mm length were cut from the forged samples, machined, and so polished. throughout the check, the sample is command ironed against a rotating EN32 steel disc (hardness of 65HRC) by applying load (4Kg) that acts as counter weight and balances the pin. The track diameter was chosen as 100mm and therefore the parameters like the load, slippery speed and slippery distance were varied within the vary given. Once the surface connected wears out, the load pushes the arm to stay connected with the disc. This movement of the arm generates



a proof that is employed to work out the utmost wear. Weight loss of every specimen was obtained by deliberation the specimen before ANd when the experiment by one pan electronic balance with an accuracy of .001g when thorough cleansing with ketone answer. Dry slippery wear rate check was performed with 3 parameters: applied load, slippery speed, and slippery distance and ranging them for 3 levels.



Figure 6: Pin and disc wear testing machine

VI. RESULT

A. IMPACT TEST



Figure 7: Test piece after impact test

the energy absorbed by the specimen AMC-AV 15% is higher than AMC-AV 5%. So the specimen AMC AV 15% has higher impact strength. The impact energy of AMC-AV 15% specimen is 22J.

Table 1: Values from impact test

TEST PARAMETER	AL100%	AL 95% & AV 5%	AL 85% & AV 15%
ABSORBED ENERGY(JOULES)	19	20	22

B. TENSILE TESTING



Figure 8: Test piece after tensile test

Table 2: Values from tensile test

TEST PARAMETER	AL100%	AL 95% & AV 5%	AL 85% & AV 15%
ELONGATION (mm)	276	271	286
UTS (Mpa)	116.91	118.52	120.36
UYS (Mpa)	59.047	61.95	63.97

In the tensile test the elongation of the specimen with the composite ratio of AL 95% with AV 5% has higher elongation .The UTS in the tensile test is higher for the composite ratio of AL 85% with AV 15%. The yield strength of the tensile test specimen is higher for the composite ratio of AL 85% with AV 15%.

C. HARDNESS TEST

The hardness when tested by Rockwell hardness machine shows that the hardness of the composite ratio AL 85% with AV 15% is having higher hardness compared to AL 95% with AV 5%. The average hardness value is 17.334 RHN.



Figure 9: Test piece after hardness test

Table 3: Values from Hardness test

TEST PARAMETER	AL100%	AL 95% & AV 5%	AL 85% & AV 15%
ROCKWELL HARDNESS	14,12,15	15,14,16	17,16,19

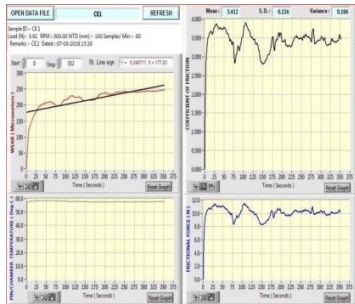
D. WEAR TEST



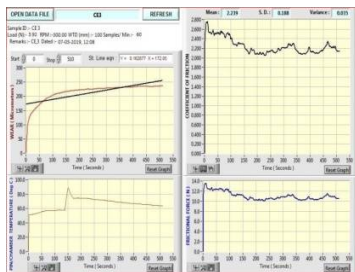
Figure 10: Test piece after wear test

**Table 4: Values from wear test**

TEST PARAMETER	AL 95% & AV 5%	AL 85% & AV 15%
WEAR (m <sup>3</sup> m)	0.00924	0.02352



**Figure 11:Wear test result for AMC-AV 5%**



**Figure 12:Wear test result for AMC-AV 15%**

**REFERENCES**

[1] I.A.Ibrahim, F.A.Mohamed, E.J. Lavernia, Particulate reinforced metal matrix composites - A review, Journal of Material Science, 26(1991), pp. 1137-1156.

[2] K.K.Alaneme, K.O.Sanusi, Microstructural characteristics, mechanical and wear behaviour of aluminium matrix hybrid composites reinforced with alumina, rice husk ash and graphite, Engineering Science and Technology An International Journal, 18(2015), pp.416-422.

[3] R. Pradeep, B.S. Praveen Kumar, B.Prashanth, Evaluation of mechanical properties of aluminium alloy 7075 reinforced with silicon carbide and red mud composite, International Journal of Engineering Research and General Science, 2(2014), pp.1081-88.

[4] Gurvishal Singh, H.Lal, Daljit Singh, Gurdeshbir Singh, An approach for improving wear rate of aluminum based metal using red mud, SiC and Al<sub>2</sub>O<sub>3</sub> matrix composites, International Journal of Mechanical Engineering and Robotics, 2(2013), pp.242-245.

[5] C.U. Atuanya , A.O.A. Ibhado , I.M. Dagwa, Effects of breadfruit seed hull ash on the microstructures and properties of Al-Si-Fe alloy/breadfruit seed hull ash

particulate composites, Results in Physics, 2 (2012), pp. 142– 149.

[6] K. Acharya, V. Dikshit ,P. Mishra, Erosive wear behaviour of red mud filled metal matrix composite, Journal of Reinforced Plastics and Composites, 27(2008), pp.145-152.

[7] D.Siva Prasad, A.Rama Krishna, Fabrication and Characterization of A 356.2 - Rice husk ash composite using stir casting technique, International Journal of Engineering Science and Technology, 2(2010), pp.7603-7608.

[8] S.D.Saravanam, M.Senthil Kumar, Effect of mechanical properties on rice husk ash reinforced aluminum alloy (AlSi10Mg) matrix composites, Procedia Engineering, 64 ( 2013 ), pp. 1505 – 1513

[9] K.K. Alaneme, B.O. Ademilua, M.O. Bodunrin, Mechanical properties and corrosion behaviour of aluminium hybrid composites reinforced with silicon carbide and bamboo leaf ash, Tribology in Industry, 35(2013), pp.25-35.