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Mechanical & Physical Characterstics of Ricehusk Ash in Aluminum Metal Matrix by Conventional Stir Casting

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ABSTRACT

The application of low-cost material reinforced metal matrix composites is growing rapidly in various engineering fields. Rice Husk Ash Reinforced in Aluminum Metal matrix indicates the possibilities of reinforcing aluminum with locally available inexpensive rice husk ash for developing new material, an agricultural by-product with a high amount of silica. This article shows is to fabricate the composite material consists of pure aluminum and adding Rice husk ash by stir casting method with 8%,12%,15% composition of rice huskparticles in aluminum metal matrixandthe mechanical and physical properties such as tensile strength, compressive strength, hardness, heat treatment, corrosive and wear resistance are measured. The results indicate that the tensile, compressive, heat treatment and hardness is increases by increasing ricehuskparticles and corrosive resistance and wear resistance are decreases.

KEYWORDS: Rice husk ash particles, aluminum, corrosive resistance, wear resistance, tensile and compressive.

1. INTRODUCTION

Composites are manmade materials consisting of one or more discontinuous phases havingintimate contact with each other, with are knowable interface between them. Theseare useful material systems provide characteristicsnotobtainablefromindividualphases.Further, composites are tailor made to, cost-effectivepropertyeffectiveandapplication oriented.Ingeneral,the discontinuous phase is harder and stronger than the continuous phase and is called the 'reinforcement'; whereas continuous phase is termed as the 'matrix' [1]. Thematrixholds reinforcement to form the desired shape and bears the major portion of an applied load, while. Reinforcement improves overall mechanical properties of the matrix. Reinforcement increasesthe strength, stiffness, wear resistant and the temperature resistance capacity andlowersthedensity. In general; composites are classified according to the type of matrix material and then nature of reinforcement at twodistinctlevels [2]. Thefirst classificationincludesceramicmatrixcomposites (CMCs),organicmatrixcomposites (OMCs)andmetal matrixcomposites (MMCs).The termorganic matrixcompositesgenerallyassumetoincludepolymerMat rixcomposites(PMC)smandcarbonmatrixcomposites.The secondclassification refers to there in for cement form; particulate reinforcements, whiskers, continuous fiber, laminatedcompositesandwovencomposites[3].

Depending upon the application in-service, a variety of composites with different combinations of matrix materials and reinforcements are being produced through different fabrication methods, various systems and processing routes Proper mixing method to minimize the agglomeration of theirenforcement and settling of the particle scan minimized by the quick pouring and employing chill castingtechnique.Secondaryprocessinglikerolling, forging,andextrusiongivesbetterdistributionofreinforcements [4].

2.LITERATURE

R.S.Rana,Rajesh,and S Das [5],successfully fabricated theAl composites with micaandkaolinite reinforcements using stir casting technique.They used equal volume fractions of mica and kaolinite are [(2+2) %, (4+4) %, (6+6) %,(8+8)] and conducted a wear test for various time intervals at constant load. The wear loss in composites with 8% volume of mica and kaolinite are observed to decrease at a slower rate. The SEM microstructure of the composite indicates a homogeneous reinforcement distributionintomatricesandno evidence ofagglomerate. Fromtheaboveresearchpaper,Iconcloudedthatthepresenceofmicaandkaoliniteinthematrix decreasedwear loss byincreasing wearresistance.

M.B.N.Shaikh And M.ali, [6], has fabricated Al .and Titanium DIBoride(RH)viathestircastingtechnique.Thequantityfractionof RHpromptedis4%,6%and8%.Theyevaluatedthemicrostructure,wear,hardnessproperties.At8%wtofRHnoticesthemaximumhardnessof126VHNandstrengthensthebasematrix.Explicitwearratediminishes as the sliding rate increments up to rotation speed (1.6 m/s) and weight, in lightofworksolidifyingofthematerialsurface.Minimaleffectofthewearrategotfromthe8Wt.% of RH fortified composite. The speed and the sliding distance are in most extreme with the insignificant weight. The micro image indicates the Aluminum debris are unvaryinglydispersedwithin the highest volume fractionofparticulatematrix of8Wt.The Al metal matrix composites offer wide range of properties suitable for a large number of engineering applications. Sufficient literatures are available on differentaspectsoftribologyandmachiningofconventional metalsandalloysbutlimitedliteratureisavailableforreinforcedmetal matrix composites.

3. MATERIALS AND METHODS

Stir casting is a type of casting process in which a mechanical stirrer is introduced to form vortex to mix reinforcement in the matrix material. It is a suitable process for production of metal matrix composites due to its cost effectiveness, applicability to mass production, simplicity, almostshapingandeasier controlofcompositestructure.Stir casting setup as shown in Figure1;consist of a furnace, reinforcement feeder and mechanical stirrer. The furnace is used to heating and melting of the materials. The bottom-pouring furnace is moresuitable for the stir castingas after stirringof the mixed slurry instant poring isrequiredtoavoidthesettling of the solid particles in the bottom the crucible. The mechanical stirrer is used to form the vortex, whichleadsthemixingofthereinforcementmaterialthatareintroducedinthemelt.Stirerconsistofthe stirringrodandtheimpeller blade. Theimpeller blade may be of, various geometryandvariousnumber of blades.Flat blade with three numbers is the preferred as it leads to axial flow pattern in thecrucible with less power consumption. This stirrer is connected to the variable speed motors; the rotationspeed of the stirrer is controlled by the regulator attached with the motor. Further, the feeder is attachedwith the furnace and used to feed the reinforcement powder in the melt. A permanent mold, sand molderlost-waxmold can beusedforpouringthemixedslurry.Decreaseof density from Al+8%RHA,AL +15%RHA, Al+12%RHA canbe improved to some extent by incorporating an inert or closed system during stir castingby insulating the setup from the atmosphere. This would reduce the contact of the meltwith the air to reduce oxidation and air entrapment to remove porosity to give a bettercontrol over +the process and hence obtain better set of properties.

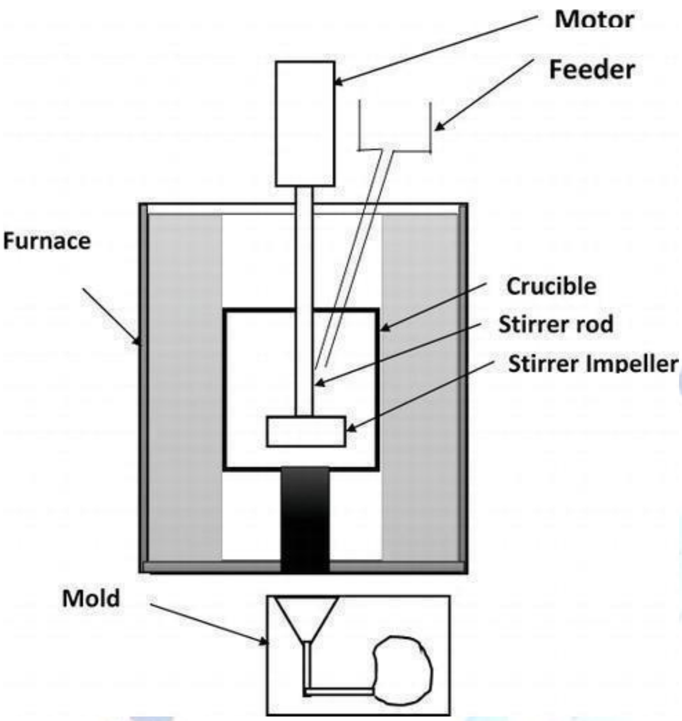


Figure 1: diagram of stir casting method

3.1 ALUMINUM

Aluminum is lightweight, durable, malleable and corrosion-resistant. This metal is widely used for components in the aerospace, transportation and construction industries.

- Non-corrosive.
- Easily machined and cast.
- Lightweight yet durable.
- Non-magnetic and non-sparking.
- Good heat and electrical conductor.
- Pure aluminum doesn't have a high tensile strength. However, the addition of alloying elements like manganese, silicon, copper and magnesium can increase the strength properties of Aluminium and produce an alloy with properties tailored to particular applications.

3.2 RICE HUSK PARTICLES

Rice husks are the hard protective coverings of rice grains which are separated from the grains during milling process. Rice husk is an abundantly available waste material in all rice producing countries, and it contains about 30%–50% of organic carbon. In the course of a typical milling process, the husks are removed from the raw grain to reveal whole brown rice which upon further milling to remove the bran layer will yield white rice. Current rice production in the world is estimated to be 700 million tons. Rice husk constitutes about 20% of the weight of rice and its composition is as follows: cellulose (50%), lignin (25%–30%), silica (15%–20%), and moisture (10%–15%). Bulk density of rice husk is low and lies in the range 90–150 kg/m^3.

The characteristics of the ash are dependent on (1) composition of the rice husks, (2) burning temperature, and (3) burning time. Every 100 kg of husks burnt in a boiler for example will yield about 25 kg of RHA. In certain areas, rice husk is used as a fuel forparboiling paddy in rice mills, whereas in some places it is field-burnt as a local fuel. However, the combustion of rice husks in such cases is far from complete and the partial burning also contributes to air pollution. The calorific value of rice husks is about 50% of that of coal, and assuming that husks have about 8%–10% of moisture content and zero bran, the calorific valueis estimated to be15 MJ/kg.Undercontrolledburning conditions,the volatile organic matter in the rice husk consisting of cellulose and lignin are removed and the residual ash is predominantly amorphous silica witha (micro porous) cellularstructure.Duetoitshighlymicroporousstructure,specificsurfaceareaofRHAasdeterminedbytheBrunauerEmmettTeller(BET) nitrogenadsorption method can range from 20 to as high as 270 m^2/g, while that of silica fume, for example is in the range of 18–23 m^2/g.

4. EXPERIMENTAL WORK

Taken rice husk and placed at open area for 2 days for removal of moisture content and heated at a temperature of 500-600 degrees for 1 hour and filtered with different meshes .0.5 kg Aluminium is taken and placed in furnace at a heated at a temperature of 650 degrees temperature then after aluminum is changes from solid state to liquid state and then stirrer is lowered to the molten metal and graphite stirrer is used and then stirring intiated and at 500 rpm for creating vortex flow for uniformly distributing rice husk ash particles. And during stirring RHA particles were added in molten metal at different compositions and then after 10 minutes of stirring the molten metal is poured in die here bottom pouring type furnace we are used and die was preheated for uniform solidification here finally 8%,12%,15% RHA composites were prepared.

Figure 2: Aluminum with rice husk ash particles composite material with 8%,12%,15% RSH particle rods.

5.RESULTS

5.1 TENSILE TEST

Here we are using universal testing machine for tensile test.

Table 1: Tensile test values.

s.no	Composition	Yield strength(Mpa)	Ultimate tensile strength(Mpa)
1.	Aluminium+8%RSH	59	98.57
2.	Aluminium+8%RSH	71	138.53
3.	Aluminium+8%RSH	79	141.53

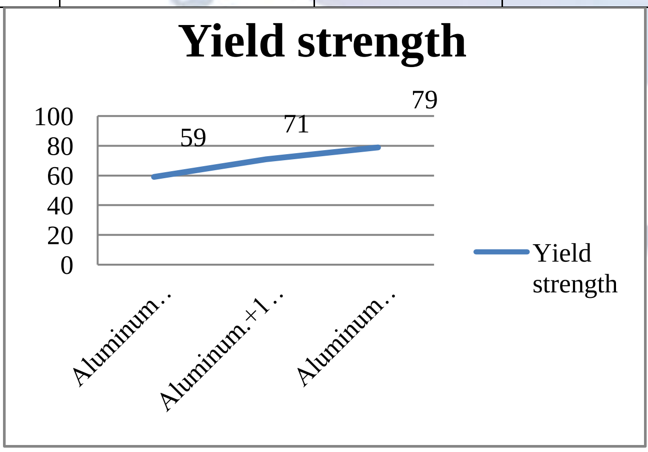


Figure 4: Yield strength

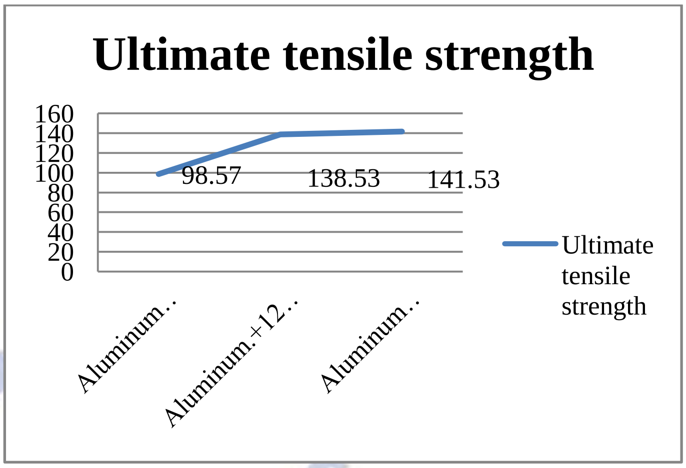


Figure 5: Ultimate tensile strength.

5.2 COMPRESSION TEST

Universal testing machine is used for testing the specimens. D/H =2 as per regulations.

Diameter = 25mm

Length = 12.5mm

Table 2: Compression test values.

s.no	Composition	load(KN)
1	Aluminum+8% RSH	35
2	Aluminum+12% RSH	39
3	Aluminum+15% RSH	41

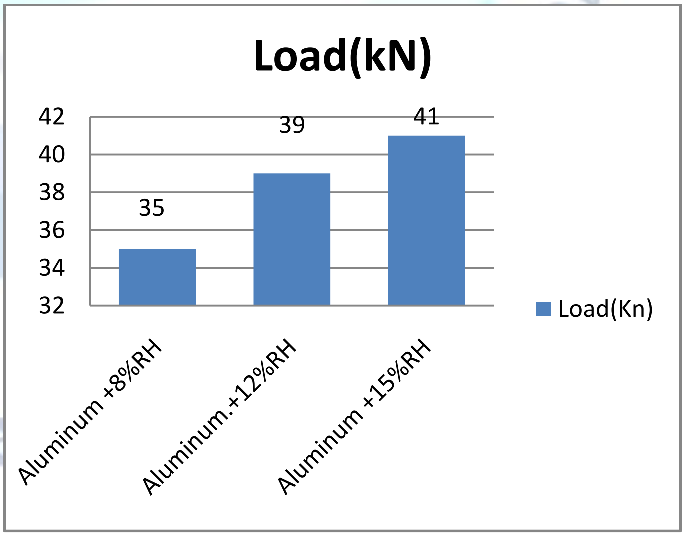
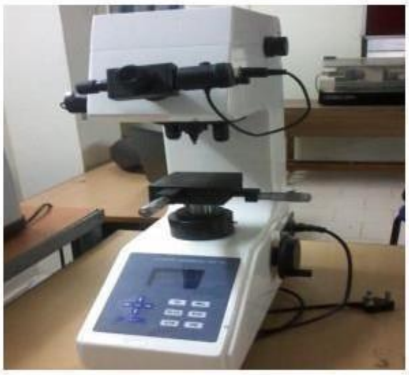


Figure 6: Compression values.

5.1 HARDNESS

It a measure of how much a material resists changes in shape.Ability ofmaterialtoresistwear,tear,scratching,abrasioncuttingiscalledHardness.Hardermaterialsaremoredifficult to cut and shape than softer ones.They are also usually more brittle which meanstheydo not bend much but can



shatter.

Figure 7:VHN hardness testing machine.

Table 3: Hardness values.

compostion	d1	d2	vhn	d1	d2	vhn	Micro vhn
aluminum +8% rsh	76	84	32	75	87	32	32
aluminum +12% rsh	87	89	36	77	89	31	38
aluminum +15% rsh	89	73	41	79	93	39	40

Vickers hardness machine is used for testing hardness. And 0.5 kg load is applied on it. And it shows digital values of D1,D2 and VHN values.

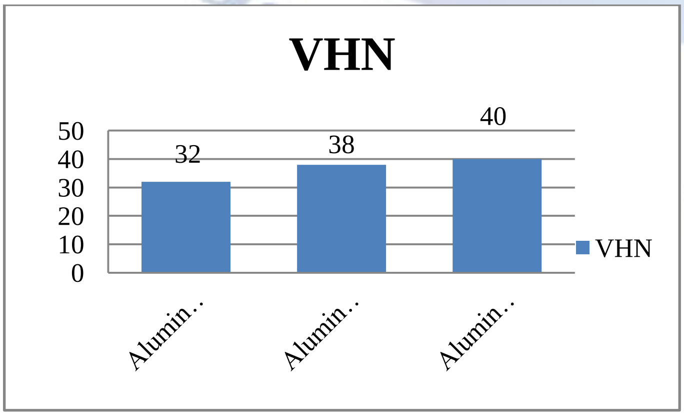


Figure 8: hardness values.

5.2 HEAT TREATMENT

Heat treatment process, a material is typically heated to a target temperature at which its physical properties change. It is then cooled at a controlled rate to anneal or normalize a metal. If a metal has been hardened due to work or heat, then annealing or normalizing may be employed to bring it back to a softer, more ductile state. During the annealing process, the metal is heated above its recrystallization temperature and then cooled very slowly in a furnace or by some other heating method. Normalizing is the same as annealing, except that the metal is air cooled rather than furnace cooled. The metal being heat-treated must be considered heat treatable for any effect to occur. To harden a material. For this process, a material is heated above a certain temperature. The material is then rapidly quenched by a media such as water or oil. This rapid quenching will create a harder, stronger material when performed on a frequently hardened through heat treatment to resist wear and indentation. Metals that require ductility and toughness, such as structural steels, may need to be annealed or normalized if they are subjected to cold.

Table 4: heat treated hardness for 2 hours.

compostion	d1	d2	vhn	d1	d2	vhn	microvhn
Aluminum+ 8% ash	70	78	35	68	73	34	35
Aluminum+ 12% ash	68	73	39	67	74	41	40
Aluminum+ 15% ash	66	72	45	85	71	46	46

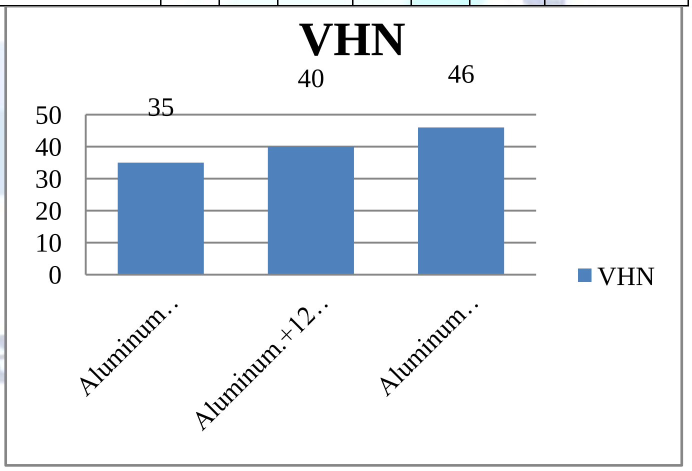


Figure 9: Heat treated hardness.

5.3 WEAR TEST

To determine the test is performed to evaluatethe wear property of a material so as to determine whether the material is adequate for a specific wear application.pin on disc equipment is used for testing the wear property.

Table 5: wear at 1kg load 600 meters.

s.no	Composition	Intial weight	Final weight	Loss of weight
1	Aluminum+ 8% RH	4.798	3.78	1.018
2	Aluminum+ 12% RH	4.739	3.45	1.289
3	Aluminum+ 15% RH	5.047	3.07	1.97

Here 1 kg load is applied and rotation for 600 meters.

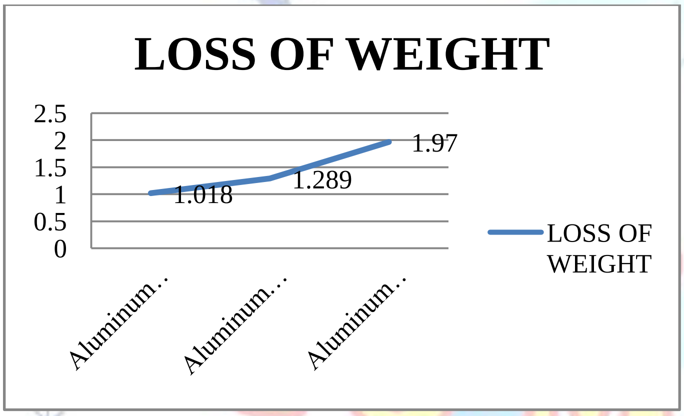


Figure 10: loss of weight due to wear.

5.4 CORROSION

Corrosion test, here we are taking 10 % HCL acid and totally 1000ml acid taken and specimens are dropped in that acid and rest for 1 hour and then we calculate the loss weight by substract the values. And we are taking the specimen size is 25 mm length and dia8 mm for both wear and corrosive test.

Table 6: Corrosive test values for 1 hour.

s.no	Composition	Intial weight	Final weight	Loss of weight
1	Aluminium+8% RSH	5.047	4.48	0.567
2	Aluminium+12% RSH	5.944	5.18	0.764
3	Aluminium+15% RSH	4.634	3.78	0.854

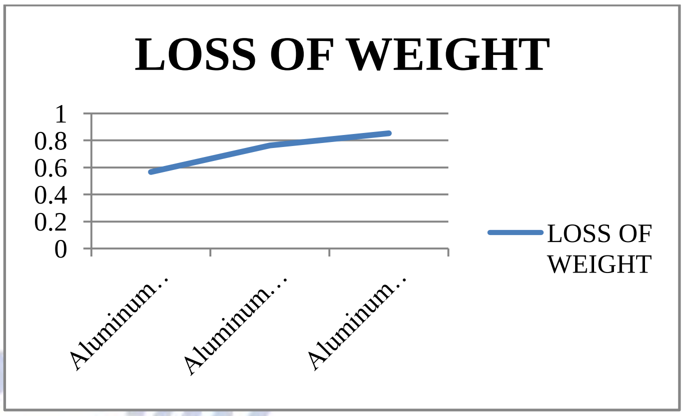


Figure 11: loss weight due to corrosion.

6. CONCLUSION

It can be concluded that by using stir casting method successfully fabricated a metal matrix composites reinforced with rice husk of three compositions,andupto 15 % RSH by weight of aluminum composites was produced.tensile,compressive and hardness is increases by increasing the RHA particles and heat treatment also increases the hardness.heattraetedhardness increased from 35VHN to 46VHN as compare to hardness values.and wear and corrosive resistance decreases while increasing the RHA particles.So,by increasing the corrosion and wear resistance adding some materials to achieve thatlike mica and kaolinite.and ultrasonic assisted stir casting gives better quality of casting. so this material havehigh strength and high hardness and ligter in weight

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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