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RESEARCH ARTICLE OPEN ACCESS

Effect of Process Parameter of Stir Casting on Metal Matrix Composites

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ABSTRACT: In the present study a modest attempt has been made to develop aluminum based silicon carbide particulate Metal MatrixComposites(MMC) with an objective to develop a conventional low cost method of producing MMCs and to obtain homogenousdispersion of ceramic material. Desired improvements in properties including specific strength, hardness and impact can be achieved byintelligently selecting the reinforcement materials, their size, and shape and volume fraction. It has been observed that melting andpouring conditions have directly or indirectly effect on mechanical properties of cast materials as hardness, percentage elongation,percentage reduction in diameter, toughness and so on. The knowledge of melting temperature of metals and alloys is necessary toestimatetheircorresponding pouring temperature.
Keywords: MetalMatrixCompositesMMC's,Cu,SiliconCarbide(SiC),SPSS,Stir,PouringTemperature,UTM,Hardness.

I. INTRODUCTION

Theincreaseinstrengthofcompositesduetosmallerreinforcementparticlesizehasbeenreportedby manyauthors. Statistically, larger flaws and more defects are morelikelytoexistinlargerparticlesand,therefore,will deteriorate the strength of composites when compared withthecompositescontainingsmallerparticles.Thesmallergrainsizeinthecompositescontainingsmallerreinforcement particles can also contribute to the increase instrength. The mechanical properties such as hardness, impactand strength is increase when grit size of reinforcement ofSiCparticle increase.

One of the major challenge when processing on 4% Cu + 5%SiC with balanced Aluminum Metal Matrix Composites areachievingahomogeneousdistributionof reinforcementinthe matrix as it has a strong impact on the properties and thequalityof thematerial.

Amongdiscontinuousmetalmatrixcomposites,stircastingisgenerallyacceptedasaparticularlypromisingroute,currently practiced commercially. Its advantages lie in itssimplicity,flexibilityandapplicabilitytolargequantityproduction. It is also attractive because, in principle, it allowsa conventional metal processing route to be used, and henceminimizes the final cost of the product. The cost of preparingcomposites material using a casting method is about one-thirdtohalfthatofcompetitivemethods,andforhighvolume production, it is projected that the cost will fall toone-tenth. In general, the solidification synthesis of metalmatrix composites involves producing a melt of the selectedmatrixmaterialfollowedbytheintroductionof areinforcementmaterialintothemelt,obtainingasuitabledispersion.

II. EXPERIMENTATION

An open hearth furnace was used for melting and mixing thematerials in flat bottom, cylindrical graphite crucible. Thefabricationprocessisconventionalmechanicalstirringforthedistributivemixingofthereinforcementinthematrix.Forthework,anewstircasterwasdevelopedtofabricate
MMC. The mixing equipment for this stage consisted of adriving motor capable of producing a rotation speed withinthe range of 600rpm, a control part for the vertical movementof the impeller and a transfer tube used for introducing theceramicpowders in the melt.

Balancedaluminiumalloywithcopperweremeltedingraphite crucibles. At the same time the SiC particulate waspreheatedinamufflefurnacesetat1100°Cforapproximately 2 hour to remove surface impurities and assistin the adsorption of gases. The ceramic particles were thenpouredslowlyandcontinuouslyintothemoltenmetalandthemeltwascontinuously stirred at600 rpm.

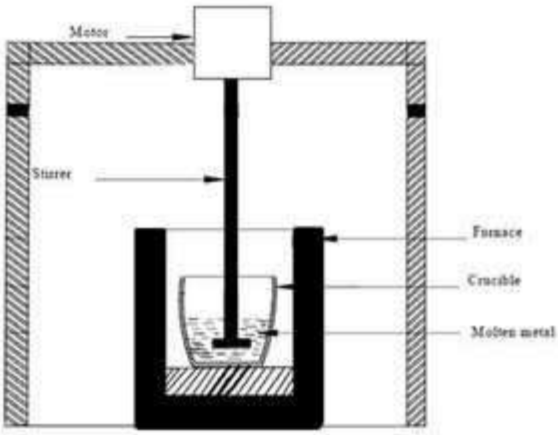


Figure2.1: SchematicViewofExperimentalSetUp

ChemicalReaction
Metalmatrixcomposites(Al+4%Cu+5%SiC)
Inpreparingmetalmatrixcompositesbythestircasting method,therearesseveralfactorsthatneedconsiderable attention,includingthedifficultyofachievingauniformdistributionofthereinforcementmaterial,wettabilitybetween the two main substances, porosity in the cast metalmatrixcomposites,andchemicalreactionsbetweenthereinforcementmaterialand thematrix alloy.

III. METHODOLOGY

First of all, the balanced aluminium with 4% Cu was meltedinagraphitecrucibleinanopenhearthfurnace.Afterautomaticmechanicalmixingiscarriedoutforabout3minutes at normal stirring rate 600 rpm and then poured intosandmouldwithpouringtemperature700°C,725°C and750°Crespectively.AfterthatthebalancedAl+4% Cuand5%SiC(400-grit)weretook.Forthis,thebasemetalAl+4%Cu were preheated at 450°C for 3 hours in a electricalresistance muffle furnace before and mixing the SiC particleswerepreheatedat1100°Cfor2hoursinaelectricalresistance muffle furnace to remove the moisture and surfaceoxidized.

IV. OBSERVATIONS OF PROCESS PARAMETERS

A. BHNTest

Thehardnesstestingwascarriedoutforallcompositespecimens.ThehardnessofthespecimendeterminedbyBrinell hardness testing machine with 250 kg load and 5 mmdiametersteelballindenter.Thedetentiontimeforthehardnessmeasurementwas1minute.


Figure2.2: SpecimenafterBHT

B. ImpactStrength

Izodimpactstrengthtestingisstandardmethodofdeterminingimpactstrength.Izodimpacttestwereconducted on notched sample. Standard square impact testspecimen measured 75 mm x 10 mm x 10 mm with notchdepth of 2 mm and a notch of angle of 45°. The machinecouldprovidearangeofimpactenergiesfrom0to164Joule. The mass of the hammer was 22 kg. It was carried outforall specimensrespectively.

C. Tensile Strength

Tensile strength is defined as a stress, which is measured asforce per unit area. In the SI system, the unit is Pascal (Pa) orNewton's per square metre (N/m²). For tensile test, we usedUniversal Testing Machine.The testing involves taking asample with a fixed cross-section area, and then pulling itwith a controlled, gradually increasing force until the samplechanges shape or breaks. The tensile test was carried out forall specimens respectively. The maximum capacity of U.T.Mis400 KN.

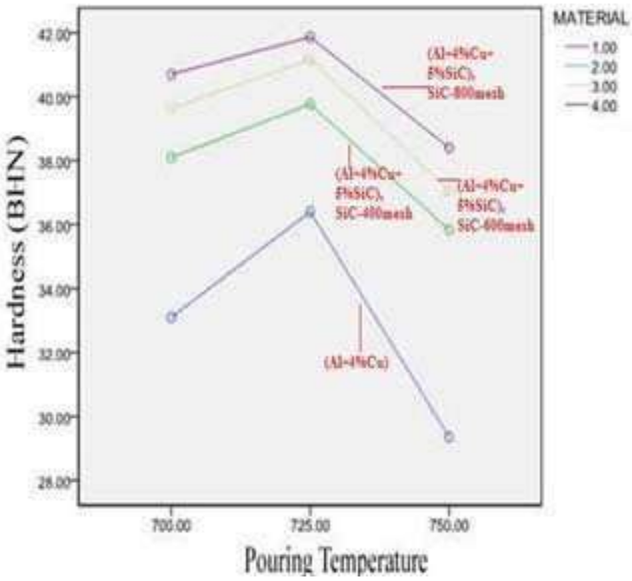
V. RESULT

Theeffectsofinput(independent)variablesas pouringtemperatures (700°C, 725°C and 750°C) and material type's(varyingwithgritsizeofSiCparticles)onoutput(dependent)variablesashardness,impactstrengthandultimatetensilestrength,statisticallyanalysiswereperformedbyusing SPSS17.0.

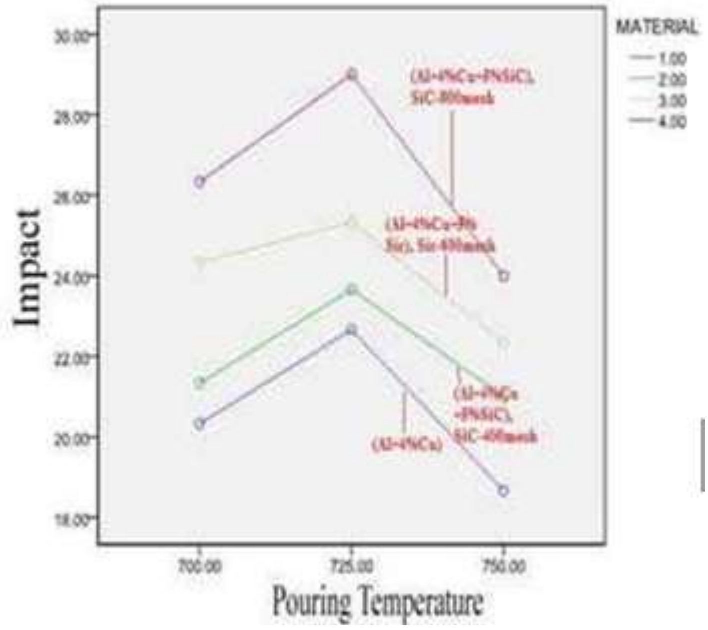
The variations of Izod impact with pouring temperatures areshown in fig-4.2. The impact is increases initially for allcompositeswithpouringtemperatureat700°C.Itlatterattained its maximum value of all material types at pouringtemperature 725°C. After that it falls sharply at the pouringtemperature 750°C. From the figure, it can be observed thatthe impact of the composite material-2 (Al + 4% Cu + 5%SiC) is higher than the base matrix material-1 (Al + 4% Cu).Thereafter,theincreasingimpactwithincreasingthegritsizes of SiC particles. The maximum impact attained whenthereinforcementwas800-gritatpouringtemperature725°C.

Table 1: Showing variation in MP-BHN-UTS with ChangeinPoring Temperature

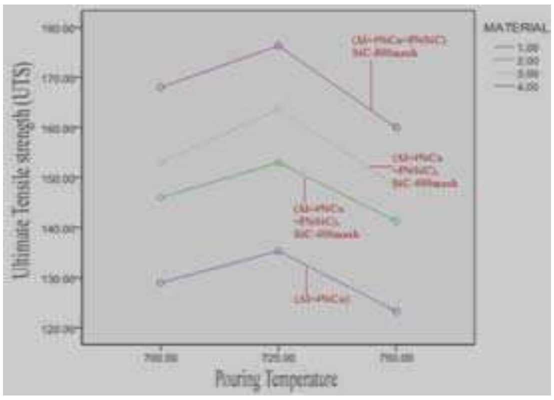
Serialno.	PouringTemperature(C)	ImpactStrength(MP	Hardness(BHN)	UTS
1.	700	26.00	41.00	164.00
2.	725	29.56	41.96	175.00
3.	750	24.45	39.87	162.34



GraphA: Hardnessvs.Poring Temperature



GraphB: Impact vs.PoringTemperature



Graph C: UTS vs. Pouring TemperatureVariationintheUTSwithDifferentPouringTemperature.

VI. CONCLUSIONS

Thesignificantconclusionsofthestudiescarriedouton balanced(Al+4%Cu+5%SiC)compositesare asfollows:

- Cast balanced (Al + 4% Cu + 5% SiC) composites wereprepared successfully using liquid metallurgy techniques(stir rout).
- Hardness of the composites found increased with increasedgritsizeofSiC.
- Impact(Izod)ofthecompositesfoundincreasedwithincreasedgrit size of SiC.
- Thetensilestrengthofthecompositesfoundincreasedwith increasedgrit sizeofSiC.
- Thepouringtemperatureat 725˚C whichgavethebestoptimum value of hardness, impact strength and ultimatetensile strength. When the pouring rate kept constant at 2.5cm/sfor all composites.

ScopeforFuture work

- We only consider three grit sizes (400, 600, and 800);chances may be that with further reduction in grit sizemechanicalpropertiesofcomposite maydecline.
- We added only 5% SiC, however with further addition ofSiCparticlesmechanicalpropertiesmayimprovedasinvestigatedby SinglaM.(2009)forAl andSiC casting.
- Wear resistance may be the parameter which defines thehardness and abrasive property of composite is the scopeforfuturework.
- Experimentsareperformedonopenhearthfurnace chancesofinclusionandblowholesmaymeasure.

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