Processed Text

materialstoday proceedingsxxx xxxx xxx contentslistsavailableatsciencedirect material today proceeding journal homepage www elsevier com locate matpr recycling polymer matrix composite used aerospace industry comprehensive review nandini ramawat b tech graduate nidhip sharma b tech graduate pranaya yamba b tech graduate madhavchary sanidhi b tech graduate departmentofaeronauticalengineering mlrinstituteoftechnology hyderabad500043 india r c l e n f b r c articlehistory polymermatrixcompositesareinhighdemandinmanyindustries includingwindturbineblademan availableonlinexxxx ufacturing pressurevesselmanufacturing andaerospace inordertoreduceunsustainabledeconstruc tionthatharmstheenvironmentandthepotentiallitigationriskassociatedwiththereintroductionof keywords uncertifiedsalvagedcomponentstotheaviationmarket flightvehiclemanufacturershavestartedcollab matrix oratingwiththerecyclingsector polymermatrixcompositeshavestrongmechanicalqualitiesthatmake polymer matrixcomposites themappealingforawiderangeofapplications butbecauseoftheirheterogeneousnature recovering sustainabilityperformance compositewasteischallenging thispapercomparesvariouspolymer matrixcomposites pmc waste recycling technique utilizing multi criterion decision making approach literature study mcda pmcwasterecyclingisbecomingmorepopular muchworkneedstobedonetobuildawide spread efficientsystemthatisbothfinanciallysustainableandproducesthehighest qualityrecovered material copyright cid 1 2023elsevierltd allrightsreserved selectionandpeer reviewunderresponsibilityofthescientificcommitteeoftheinternationalconfer enceonadvancementsinmaterialsandmanufacturing 1 introduction semi crystallinepolymers thermosetandthermoplasticpolymers epoxy andnon epoxypolymers 2 initsmostbasicform whentwoormorecomponentsarecom low viscosity resin used create thermoplastic polymer binedtocreateasinglematerialwithbetterqualitiesisknownas may alter physical state response temperature composite reality composite made bulk compositesmade ofthermosetmaterials cannotbe melted even material matrix sort reinforcement aftercuring 1 thismakesitmoredifficulttorecycleinexchange generally used boost matrix toughness rigidity wider range us higher temperature epoxy vinyl reinforcementcouldtaketheshapeoffibers polymermatrixcom ester andunsaturatedpolyestersaresomeofthecommonlyused posites pmcs metal matrix composite mmcs ceramic typesofthermosets matrix whichtypicallytakesabout40 50 matrix composite cmcs make three primary category composite keep reinforcing fiber together composite ofman madecompositesusedtoday 1 thepropertiesofpolymer material reinforcement fiber make 70 matrix composite make competitive enable aretougherandmorepowerfulthanthematrix 3 glassorara replacementoftraditionalmaterials suchaswoodandmetal midfibersareoftenemployedinfrpcarbon 1 duetotheirhigh theirlightnessandmechanicalstrengthincombinationwiththeir specificmechanicalproperties carbon fiberreinforcedpolymersin cheaprelativeproductioncosts particulararefrequentlyutilisedinavarietyofindustries suchas materialsthatuseorganicpolymersasthematrixandfibersas aerospace aviation auto infrastructure etc 4 last ten thereinforcementarecalledaspolymermatrixcomposites pmc year demand carbon fiber reinforced polymer nearly fiber reinforced plastic frp many pmc variant tripled rising 60 170 kiloton according figure based type polymer used including amorphous growth rate anticipated demand material expected slow next 20 year although stillachancethatthedemandforcarbon fiberreinforcedpolymers correspondingauthor increase globally investigating individual fibre polymer e mailaddress 20r21a2137 mlrinstitutions ac n ramawat http doi org 10 1016 j matpr 2023 05 386 2214 7853 copyright cid 1 2023elsevierltd allrightsreserved selectionandpeer reviewunderresponsibilityofthe scientificcommitteeoftheinternationalconferenceonadvancementsinmaterialsandmanufacturing pleasecitethisarticleas n ramawat n sharma p yambaetal recyclingofpolymer matrixcompositesusedintheaerospaceindustry acomprehen sivereview materialstoday proceeding http doi org 10 1016 j matpr 2023 05 386n ramawat n sharma p yambaetal materialstoday proceedingsxxx xxxx xxx demandontheworldmarketisequallyfascinating only500mil 1 1 trashproductionandrecyclingpotential lionmetrictonnesofthe8300millionmetrictonnesofpolymers

produced 1950 2015 recycled enormous anaircraft smanufacturerdetermineshowlongitwilllast amountofwasteproducedbyfiber reinforcedpolymercomposites numberofpressurizationcyclesisusedtodetermineanaircraft madeitimperativetodevelopeffectiverecyclingstrategies 4 lifecycle thedurationofaflightduringwhichanaircraftiskept depthresearchanddevelopmenthavebeenputintopolymer pressure known pressurization cycle airplane matrixcomposites pmcs whichareemployedinarangeoftech 5 70 year old typical aircraft 20 nological field including aerospace aerospace industry yearlifetimewithacertainamountofflightcyclesandhours demandofcompositesisincreasingduetoitslightweight airplanesaretransferredtotheaircraftboneyardaftertheiruseful useslessfuelandwhichin turnsavesmoneyforthefuel advanced life retiredairplanesarekeptataircraftboneyardasstorage lightweightsubstitutesforheaviermaterialsaremadepossibleby 2010 material employed air transport ability polymersas matrix element high load industry composite partly due dramatic increase bearing property reinforcing phase large passenger air use composite raw good production started plane increasingly using fiber reinforced polymer frps back 1970 assessing aircraft lifespan frpcompositeshavedevelopedintoadifferentrangeofmaterials around 20 25 year reclaiming reworking composite whichcanofferconsiderablebenefitsintermsofdensityandfati trashthathascollectedintheaviationsectorovertheyearswould gue characteristic traditional metallic material becriticalinthreetofivedecades 5 thermosetcompositesarelighterthansimilarmetalconstructions composite material account 18 7 resource aeronautical industry noticed growth usage usedbyaerospacecompaniestoconstructaircraftstructures theminaircraft particularlyinairliners frpcompositesnowmake thisfigureisexpectedtoriseinthecomingyears asignificantuser upthemajorityofthestructuralmassofanumberofcommercial composite aviation sector 6 composite widely aircraft including boeing 787 airbus a350 xwb usedinthemarine pipelinesandtanks windenergy construction spaceindustry compositesplayacrucialroleinthedevelopment andothersectors whichincreasesthequantityofwasteproduced andproductionofspacehabitatsliketheinternationalspacesta andtherequirementforrecycling becausethermosetresinisthe tionaswellasrockets satellite andotherspacecraft despitethe often used composite 62 largely constituted fact pmcs particular frps widely used epoxyresin therecyclingandreuseofthesekindofepoxy based composite aerospace industry exceptional thermosetcompositesiscritical 75 strength weightratiopotential theiruseisunquestionablycon strained inability deform plastically result 1 2 recyclingwastecompositematerials absorb energy damage generation lead tofailuremechanismslikedelamination fiber matrixdebonding recyclinggarbageisonlyrankedfourthamongthebestwaysto fibre fracture inadequate plane impact loading per managewastebytheeuropeanunion withavoidance reduction formancesarealsoquiteimportant reuse preferred recycling mechanical thermal epoxiesarethemostoftenutilizedpolymersasmatrixinfrps chemical waste treatment technique frp may generally intheaerospaceindustry comparedtootherthermosettingpoly split three category although technological mers polyester epoxy particularly suited techniqueforrecyclingthisformofgarbageistheeasiest thefinal aerospace industry due excellent mechanical property productisalsotheleastvalued chemicalrecyclingtechniquescan adhesion substrate fiber resistance moisture absorp beusedtoacquirethehighest grademateriał 8 chemicaltech tionandresistancetocorrosiveconditions theyalsooperatewell niques still mostly research employed high temperature high glass transition theindustry 7 temperature study compare different recycling technique frp 1 2 1 mechanicalrecycling trashinordertoassesstheireffectivenessinlightoftheselected thefirststepinrecyclingmechanicalcompositematerialsisto sustainability criterion literature analysis con cut smaller piece maximum size 50 ducted sustainability performance evaluation carried 100mm thepiecesarethenreducedinsizeto10 50mmusing examine applicability mcda type study hammer mill comparable high speed grinding equipment tobetterunderstandtheissuesrelatedtofrpwasterecycling compositematerialissortedintofiber richandmatrix richcom order determine best performing approach based ponentsusingcyclonesandsieves 9 bothsortingandtheinitial selected sustainability factor study compare several frp cutneedlessenergy thecrushingoperationconsumesthemajor wasterecyclingsystemsusingmulticriteriaanalysis ityoftheenergy 710 recyclingoffersasourceofinexpensive high qualitymaterial

thisisthemostpopulartechniqueofrecyclingfrpwastedue help lower high cost raw material aerospace tothetechnologicaleaseoftheprocess howevergrindingsignifi component recycling complicated material cantlylowersthevalueofthematerials accordingtoprojections polymer matrix composite becoming increasingly feasible cost carbon fiber utilized aerospace sector per kilo recycling technology advance indicates aerospace grammustbe81 90usdonaveragein2018 however thisprice industry spotentialusesforrecycledmaterialsaregrowing le raw material used much crushing 7 10 future potential recycling polymer matrix composite 11 whencarbonfibreandglassfibreareemployedasreinforcing utilised aerospace sector positive recycling economic fibre mechanicalpolymermatrixcompositesareformed andenvironmentaladvantageswillbecomemoreevidentastech sincethefibrearebrokenbycrushing thuslargerparticlescan nology advance prompting increasing investment field beusedasreinforcingmaterialforotherfrp becausethefibrepar furthermore theregulatoryclimateisprojectedtobecomemore ticlesarenotcompletelydetachedfromthepolymermatrixafter favourabletorecycling increasingtheindustry sexpansion mechanicalprocessing theyaretoughtouseasreinforcementin anotherfrpbecausetheyarenotastightlyconnectedtothepoly mermatrix 71011 toalleviateadverseenvironmentaleffectsofrisingenergyuti lization fibre creation recycled fibre must used 2n ramawat n sharma p yambaetal materialstoday proceedingsxxx xxxx xxx seenbythedisparityinenergy intensiverecyclingandproduction composite swasteisbrokenupintobits theyarethenintroduced procedure 12 cement concrete product sculpting com intoatankofliquidsiliconsand sandisliquefiedattemperatures pound roofing material drainage different box made rangingfrom450to550 cid 3 cusingahotairornitrogenstream mechanicallyprocessedpolymermatrixcompositesareallexam polymermatrixevaporatesinaheatedsandmass releasingfibres plesoffrpapplications component heated gas used transport solid whencomparedtoalternativemethodsofrecyclingcomposite particle cyclone separated gas material themechanicalprocesshasthebenefitofbeingtechno mass separate area afterburner receives polymer resin logicallysimple boththeprocessingofglassfibrereinforcedpoly gas totally oxidize temperature 1000 cid 3 c mer composite carbon fibre reinforced polymer composite andarethenusedforheatrecovery 17 thetemperatureatwhich acceptable practicable term energy consumption procedure carried impact quality mechanical recycling le hazardous environment treatedfibers muchlikewiththermalprocessingtechniques recycling procedure 12 chemical processing procedure test found tensile strength decline le lower tempera needbetween63and91mj kg pyrolysisrequiresbetween3and turesthanitdoesathighertemperatures 30 mj kg due significantly poor fibre quality reuse morefinanciallyfeasibleaftertworecyclingcycles 10 1 2 3 chemicalrecycling thedisadvantageofchemicalprocessingistherequirementto 1 2 2 thermalrecycling applyittorecycledmaterial dependingonthechemicalstructure garbageiscookedattemperaturesrangingfrom300to700 cid 3 c forexample thebulkofstudiesonepoxyresinmatrixcomposites withouttheuseofoxygenduringthepyrolysisprocess according havebeencompleted andreinforcingfibresrequirediverserecy toonestudy thelowestheatingtemperatureforpyrolysisofwind cling fluid time environment temperature get opti turbinewasteis500 cid 3 c heatingproducescharandsyntheticgasor mum outcome chemical recycling also riskier oilasbyproducts 13 althoughrecoveredfibrescanbereused mechanicalandthermalrecyclingsinceitinvolvespotentiallyhaz optionsarelimited andtheymaybebadlydamageddependingon ardous chemical might harm environment take theheatingtemperature placeatpotentiallydangerouslyhightemperatures pressure studieshaveshownthatglassfiber reinforcedpolymermatrix owing consideration difficult create compositesmayberecoveredwithhigh qualityfibersatatemper industrial scale chemical frp waste recycling facility since ature 450 500 cid 3 c 14 carbon fiber economically bothcostlyandtechnicallydifficult 1819 viable option frp reinforcement moreover composite con low temperaturechemicalrecycling alsoknownassolvolysis taining fibre may treated temperature ranging occurs temperature le 200 cid 3 c normal atmospheric 450to600 cid 3 c 10 stilltheinformationavailableshowsthatthe pressure throughoutthemethod acidorothersolventsareused glassfiberismainlydeterioratesduringthepyrolysisprocess low break chemical linkage make polymer eringmechanicalcharacteristicsby50 whencomparedtovirgin matrix inacidsolvolysis pre

treatmentisrequiredtohastenthe filament 15 polymer chemical chain breakdown particularly process theoilgeneratedduringtheprocessorsyntheticgas typically ingfrpsinceitismadeupofseverallaminasandisthereforesim ch4 h2 co co2 used energy recovery plertosplit 13 thechemicalmakeupoftherecycledglassfibers pyrolysis process 13 theory also possible use oil used investigation caused variation quality recover chemical component needed produce polymer material amount soluble chemical recycled fiber resin forexample pmma smonomermayberecoveredbypyrol inthematerialusedforsolvolysisaffectstheirquality al2o3and ysis different pyrolysis oil provide 15 20 mj kg combustion cao two soluble chemical cause fiber lose 60 energycomparedtopmma s25mj kg dependingontheheating oftheiroriginalweightovertime 20 temperature various oil synthetic gas solid contribute waterisheatedtoatemperatureexceeding374 cid 3 candcrushed differentlytopyrolysis theproportionofsolidsobtainedisgreater toapressureof22 1mpa othersolvents suchasmethanol etha whenheatingatlowertemperatures whereasthepercentageofoil nol propanol andacetone canbeemployedwithglycolswithcat andgasobtainedisgreaterwhenheatingathighertemperatures alystsandco formulantstoreducetherequiredtemperatureand 5 pressure technology recovers high quality recycled carbon thepyrolysisprocessofrecyclingfiberscanalsobeusedtofind andglassfibresfromfrp use automobile sector despite numerous general temperature ranging 230 cid 3 c 500 cid 3 c research pyrolysis large scale enterprise employed investigate chemical frp waste recycling pro make thing recycled glass carbon fibre moreover cessesutilisingsupercriticalwatermixedtovariousliquids quality comparison exist betweenthe product recy studieshavesucceededinobtainingrecycledfibresthathavelost cledfibresareusedinplaceofbrand newfibers 15 0 08 weight retaining original tensile main difference microwave conventional strength whileothershaveobtainednon recyclablematerialsthat pyrolysisisthatmicrowavesareutilisedtoheatfrpwaste micro arenotsuitableforfulfillingnewmaterialfunctions beingusedas wavesheatuprapidly andtheheatingtakesplacewithintherecy amatrix orbeingusedasreinforcement 21 however researchis clablematerialitself additionally garbageisheatedinanoxygen conductedinthelabutilizingtinyfrpsamplesandabroadrange free atmosphere type pyrolysis heating area ofchemicalcombinations experimentsetups andmethodologies around material heatedfrom inside recycling supercritical solvolysis liquid methanol material lower heat loss happens regular pyrolysis ethanol propanol acetone orglycolareused aswellascatalysts thissavesenergy 16 microwavepyrolysisinanargonenviron inthecaseofsupercriticalwatersolvolysis experimentsthatused ment produced highest quality result recycled fibre thesefluidsastheprincipalelementinsolvolysishadgreatresults almostthesametensilestrengthasnewfibre whencarbonfibres intermsofrecycledfibrequality includingglassandcarbonfibre recovered using microwave pyrolysis surface uniform 22 manystudiesfoundthatthemechanicalpropertiesofrecycled flat strength propertiesof 72 module 90 fibreand fibreusedtoenhancefreshpolymermatrixcomposites thenewfibre 16 wereequal nevertheless thepolymermatricesusedincomposite fortherecoveryoftreatedcarbonandglassfibresforfrprecy wasterecyclingarefarfrombeingcommerciallyviableforsuper cling afluidizedbedgasifierisideal theoriginalpolymermatrix criticalsolvolysis theexperimentaldesignofthestudyservesas 3n ramawat n sharma p yambaetal materialstoday proceedingsxxx xxxx xxx proof small sample investigated ideal solvolysis topsis technique order preference similarity ideal condition still sought different liquid temperature solution 28 whendoingmcda thesetwomulticriteriaanalysis pressure examined well machinery technique combined may example used employed make recycling chemical composite waste assessandcomparethesustainabilityperformanceofvariouselec effectiveasfeasible 23 tronic waste recycling system despite fact specific pieceofliteratureusesfuzzynumbersahpandtopsis thebasic concept utilising traditional mcda 2 methodologyandtechniques methodology aconcreteandsimple understandresultisachievedthrough thepolymermatrixcompositesareonlyminimallyrecycled aclearandsequentialsetofstepsinamulti criteriaanalysis since thelocalorinternationallevel noeffectivetrashrecyclingsystem mcda result may arbitrary influenced hasbeenbuilt despiteitsnumerouspotentialuses itswidespread researcher opinion sensitivity analysis also performed adoption impeded lack market recovered polymer checkthevalidityoftheresults matrix composite waste another difficulty expensive complicated technological aspect recycling frp facility built frp trash may

recycled 3 resultsanddiscussion optimal recycling process also chosen due multiplicity variable influencing effective option detailed analysis carried work order term sustainability making decision challenging eco ass compare various polymer matrix composite material nomic ecological social variable often three key waste recycling system literature research analysis aspect taken account approach 5 despite fact theinformationthatiscurrentlyaccessibleonfrpwasterecycling thatalmostallstudiesrelatedtosustainabilityevaluationcontain alternative done introductory chapter based suchaclassification themostrecentresearchonthesustainability information fourrecyclingsystemsarechosenforfurtherevalua assessment analysed study bigger categorization tion using specified sustainability criterion multi criterion criterion includes also technology performance manage decision making analysis particularly analytical hierarchy ment 24 processandtopsis 5 thetwoprimarycategoriesofsustainabilityevaluationcriteria eight sustainability criterion chosen mcda based quantitativeandqualitativeareseparatedintotheaforementioned informationgainedfromliteratureresearchonfrpwasterecycling basicgroupings eachhasadvantagesanddisadvantages quantita systemsandmethodologyguidelinesforsustainabilityassessment tivecriteriacanbemeasuredandcomputedusingstandardmea framework four grouping criterion economic ecological surement calculation method procedure energy use technological social impact represent four fundamental kwh kg trash amount ghg emission produced sa aspect certain frp recycling system received tco2 twaste two regularly used quantitative sustainability moreinvestigationthanothersandbecausemcdarequirescom measure 25 thequalitativeaspectsthatmustbequantifieddur parable data criterion selection process constrained ing review process based survey stakeholder knowledge already available 29 three criterion make experienceandgeneralknowledge innovativenessandpublicper majority technological criterion group workplace ceptionaretwoexamplesofqualitativecriteria qualitativecriteria safetymakesupthesolesocialcriterion allow study broader variety conclusion conclu fig 1 provides mechanical recycling technique sionsforwhichthereareinadequatenumericalmeasurementsor score 0 63 making closest ideal solution pi mathematical physical unit utilised four frp waste recycling method according result quantifythem yet applyingqualitativecriteriamakestheresults mcda evaluation microwave pyrolysis come second arbitrary however shown scholarly publication placewithascoreof0 59 followedbyconventionalpyrolysiswith examined work often utilized sustainability score 0 45 supercritical watersolvolysis score assessment technique permit inclusion criterion 0 38 thegreatestchoiceisjust0 13unitshigherthanthehalfway suchasmulti criteriaanalysis 26 point perfect answer making four option far arangeofsustainabilityevaluationapproachesareusedinthe optimum solution additionally resulting score top scientificliteratureontherecyclingoffrpdebris whileidentify second best performance close however mechanical ingthemostappropriatekindofanalysisforthisstudy itshould recyclingoutperformssupercriticalwatersolvolysisby40 benotedthatmulti criteriaanalysisiscommonlyusedinresearch related sustainability evaluation various trash recycling technology method wide rangeof applicationssince allows selection numerous indicator type applicationtotheimportantassessmentofagivenprocess aswell precise determination criterion significance throughtheassignmentofaspecificsignificance 27 toevaluate therelevanceofthecriteria boththesubjectiveanalyticalhierar chy method objective entropy technique applied theahpisbasedonthepairedcomparisonsconcept whichcom pares two indication rank 1 9 accordingtoimportance oneindicatesthatthecriteriaareequally important whereas9indicatesthatheparticularcriterionismore importantthanthecriterionitisbeingcomparedto theahptech niquemayalsobeusedtonormaliseandassessone sownsustain ability however prioritise alternative simplyutilisedtorankthecriteriainthisstudy 5 theassessment normalization sustainability performance done using fig 1 topsisresults 5 4n ramawat n sharma p yambaetal materialstoday proceedingsxxx xxxx xxx forallottheexaminedfrpwasterecyclingprocesses itisfar creditauthorshipcontributionstatement fromthebestoption whichcanbeunderstoodbyexaminingthe patternsofcriterionvalues someofthesolutionsthathavebeen nandiniramawat supervision resource investigation data compared perform much better area curation conceptualization writing original draft writing poorest result others instance mechanical recycling per review editing madhavcharyatsanidhi datacuration form well across six eight criterion poorly across othertwo mechanicalrecycling

outofthefouroptionsconsidered inthisstudy ispredictedtoperformthebest butitsperformance dataavailability hampered fact least effective approach otherareas inconclusion althoughgettingthehighestassessment datawillbemadeavailableonrequest score ithasseveralshortcomingsthatareevidentinhowfaritis fromtheperfectanswer 5 declarationofcompetinginterest microwave pyrolysis second best alternative according outcome multi criterion decision making study used theauthorsdeclarethattheyhavenoknowncompetingfinan toassessandcomparethesustainabilityperformanceoffourtech cial interest personal relationship could appeared nologies recyclingfiber reinforced plastic waste recycled toinfluencetheworkreportedinthispaper fibertensilestrengthperformanceofthisfrprecyclingprocessis poorest outperform option inanyoftheanalyzedcategories reference accordingto findingsand reviewof theliterature sustainable approach recycling frp trash 1 f c campbell structuralcompositematerials asminternational 2010 employedthemost onemayarguethatthisoutcomeisindicative 2 mbuggy lfarragher maddenw recyclingofcompositematerials jmater processtech 1995 ofthecurrent state offrprecyclingingeneral mostarchaic 3 v goodship uk recyclingissuesinpolymermatrixcomposites 2012 techniquethathasrelativelyminimalenvironmentalandeconom 4 yaoqiao lisad fing madhusudhanr palleka kelvin simmonsl areview icalcosts ismechanicalrecycling also itdoesnotprovidehigh fabrication method mechanical behavior continuous qualityrecoveredfibreormatrix otherpolymermatrixcomposite thermoplasticpolymerfiber thermoplasticpolymermatrixcomposites 2022 5 iltina delveremarija maxat shanbayev aray abildayvea kuzhamberdieva waste recycling technique greater ecological effect svetlana danija blumberga evaluationofpolymermatrixcompositeswaste noted study account indirect recyclingmethods effect reduced global warming potential could 6 alefeuvre garnier ljacquemin bpillian anticipatinginusestocksof carbonfiberreinforcedpolymersandrelatedwasteflowsgeneratedbythe potentiallyresultinrecoveringhigher qualitymaterialsthatcould commercial aeronautical sector 2050 resource conservation beusedinhigh technologycompositesapplications reducingthe recycling need new frp manufacturing saving material 7 nashauib p tmativenga energydemandinmechanicalrecyclingofglass fiberreinforcedthermosetplasticcomposites journalofcleanerproduction energyusedforvirginfibreandpolymerresin 2016 8 wongk rudd c pickering x liu compositesrecyclingsolutionforthe aviationindustry 2017 9 gnilakantan snutt reuseandupcyclingofaerospaceprepregscrapand waste inreinf plastic 2015 10 nvijay battacharjeep rajkumarv assessmentofcompositewastedisposal inaerospaceindustries procediaenvironmentalsciences 2016 11 jhowarth rmareddy mativengap energyintensityandenvironmental analysisofmechanicalrecyclingofcarbonfibercomposite journalofcleaner 3 1 conclusion production 2014 12 pimenta pinho recycling carbon fiber reinforced polymer whilefrphasseveraladvantagesoverhomogeneousmaterials structural application technology review market outlook waste management 2011 recyclingfrpischallengingduetoitscompositenature industrial 13 blazso pyrolysisforrecyclingwastecomposites goodshipv 2010 scale application chemical recycling yield highest 14 yyang rboom birion recyclingofcompositematerials chemengprocess grade recovered material common 21 despite fact intensif 2012 15 srnaqvi hmysoreprabhakara eabarmer wdierkes rakkermanb gbrem manufacturing polymer matrix composite costly acriticalreviewonrecyclingofend lifecarbonfiber glassfiberreinforced energy intensive process vast majority frp plastic waste composite waste using pyrolysis towards circular economy resource landfilled recycling sort rubbish might reduce conservationandrecycling 2018 16 gharde b kandasubramanian mechanothermal chemical recycling amountofgarbagediscardedinlandfillsaswellastherequirement methodologiesforthefiberreinforcedplastic environmentaltechnology fornewfrpmanufacture asrecycledfibrequality chemicalcom innovation 2019 ponentsrecoveredfrompolymerresinmatrix andperhapsenergy 17 skgopalraj karki reviewontherecyclingwasteofwastecarbonfiber glass fiber reinforcedcomposites fiberrecovery propertiesandlife cycleanalysis recoveredamountallimprove sodoesthecomplexityoftechnol 2020 ogy according research frp may chemically recycled 18 j bachmann c hidalgo bricout environmental analysis innovative recoverhigh qualityfibresthatcanbeutilisedinthesameapplica sustainable composite potential use aviation sector lifecycle assessmentreview 2017 tions virgin fibre another obstacle creating worldwide 19 kumars krishnans recyclingofcarbonfiberwithepoxycompositesby industrial scale frp recycling system lack demand chemicalrecyclingforfutureperspective areview 2020 recoveredreinforcingfiber

basedontheliteraturereview multi 20 w dang tsudak kubouchim sembokuyah chemicalrecyclingofglass criterion decision making analysis sensitivity analysis per fiber reinforced epoxy resin cured amine using nitric acid polymer 2005 formedinthispapertocomparefrpwasterecyclingmethods 21 khalily f sustainabilityassessmentofsolvolysisusingsupercriticalfluidsfor determined mechanical recycling method carbonfiberreinforcedpolymerswastemanagement sustainableproduction sustainable specific sustainability criterion used andconsumption 2019 22 wu zhang w jin x efficient reclamation carbon fiber epoxy paper applied study polymer matrix composite compositewastethroughcatalyticpyrolysisinmoltenzncl2 2019 waste recycling method needed scarcity 23 v k soo h c kim p compston doolan comparativelifecycle knowledgeonotherpossiblesustainabilitycriteria iftherewasa energyanalysisofcarbonfibrepre processing processingandpostprocessing recyclingmethods inresour conserv recycl 2020 greaterrangeof correctdata mcdaresults wouldbe lessreliant 24 cyeh xuy sustainableplanningofe wasterecyclingactivitiesusingfuzzy onasmallnumberofcriteriaforwhichinformationisaccessible multicriteriadecisionmaking journalofcleanerproduction 2013 5n ramawat n sharma p yambaetal materialstoday proceedingsxxx xxxx xxx 25 c v amaechi agbomerie c orok e ye j economicaspectsoffiber 27 h li k englund recycling carbon reinforced thermoplastic composite reinforcedpolymercompositerecycling ininencyclopediaofrenewableand wastesfromtheaerospaceindustry j compos mater 2016 sustainablematerials oxford uk 2020 28 avivekanand singh rarvind jayalakshmi rao ksrinivas xizhangchen 26 elgcarbonfibre ltd recycledcarbonfiberasanenablerforcosteffective mechanicalandtribologicalpropertiesofnaturalfiberreinforcedpolymer lightweightstructures inglobalautomotivelightweightmaterials inelg composite 2020 carbonfibreltd 2016 29 r asyraf khan syamsir b supian syntheticandnaturalfiber reinforcedpolymermatrixcompositesforadvancedapplications 2022 6

Top Keywords

recycling: 0.35544445286979454
composite: 0.31482222968467516
polymer: 0.20311111592559689
material: 0.19295556012931703
criterion: 0.1624888927404775
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