Extensive Support to HEV by Designing a Hybrid Energy storage System.

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Abstract:Forelectricdrivevehiclesincludingelectricvehicles,pluginhybridelectricvehiclesandhybridelectricvehicles,ahybridenergystoragesystem(HESS)isrecommended.Thetraditionalenergystoragesystemcontainsonlybatterywithlargerboostconvertertomeetthesteadystateandmaximumpowerrequirements[2].Theproposeddesignbooststhevoltagelevelsofbatteryandultracapacitorusingmuchsmallerboostconverterstomeetsteadystateandmaximumpowerrequirementsbasedontheroadconditions.Batteryprovidespowerdirectlyonlywhenthevehicleisundersteadystateconditionandwheneverthevehicleexperiencestotransientcondition;ultracapacitorcomestothepictureandprovidesthenecessarypeakpowerrequiredtothevehicle.Withthisarrangementbatterycanbeseparatedfromcontinuouscharginganddischargingproblem, andfurther it increases the batterylife.

Keywords—Boostconverter,Buck/Boostconverter,HESS,Battery, Hybridelectricvehicles(EHVs),Pluginelectricvehicles, Ultracapcitors.

INTRODUCTION

Energystoringsystemplaysvitalroleinsuccessfuloperationofelectric,pluginelectricandhybridelectricvehicles.Tillthedatebatteryisthemajorenergysourceofallelectricvehicles.Andbatteryalonedoesnotgiveexpectedoutputfromthevehicle.Duringthepeakloadperiodbatteryunabletomeetrequiredpowerdemandneededbythevehicleduetoitspoorpowerdensitycharacteristics.Evenbatteriesalsoavailablewithhighpowerdensitybutthesareeconomicallynotsuccesses.Anotherwayofi

ncreasethepowerdensityofthebatteryisthatincreasingitssizebutthismethodalsotakeshugecostandsizeofthebatteryintroducesthecarrying,occupyingcalamities[2].Inaddition,batterieshavelotofchallengesrelatedtothermalmanagementduringthemeetingoftherequiredpowerdemand.Duetoimproperbalancingofthesystem,individualcellvoltagevaluemaydropsandthatreducesthetotalpackcapacitythisthinghappensquickly.Anditmightleadstofailureofthebatterysystem.Thistypeofissuesisdominantlyconsiderableduringhighrateofcharginganddischarging.Duetotheinstantpowerneededforthevehicle,batteriesaresufferingwithregularcharginganddischargingproblemsthismayleadstodiminishthelifeofthebattery[6].sothistheseenergystoragesystemcannotprovidethepeakcurrentrequiredforthevehicles.inordertodiminishallthedifficultiesrelatedtotraditionalenergystoragesystem,aHESShasbeenintroduced[5].ThemainaimofHESSisthattoattainbetterperformancebycombiningbatteryandultracapacitor.Becauseultracapacitorhavingthebestpowerdensitycharacteristics.Sothegroupingofbatteryandultracapacitorgivesthedecentperformancethaneitherofone.FewHESSconfigurationshavebeenintroducedandtherangeofthemodelisformsimpletodifficultylevel[1].HESSisalwayscombinedwiththeDC/DCconvertersandthisconverterdirectlylinkedwiththeDCbus.GenerallybatteryisconnecteddirectlytoDClinkbutultracapacitorconnectedthroughhalfbridgeconvertertoDClinkandtousethehighpowerdensitypropertyoftheultracapacitorweshouldmatchthepowerlevelsofbothUCandhalfbridgeconverterandthisschemeresolvesthedifficultyofthemaximumpowerrequirements,traditionalstoragesystemfacingtheproblemlikeregularcharginganddischargingprocesses.Tocrackabovementioneddifficulties,anewHESSisintroduced in this paper.

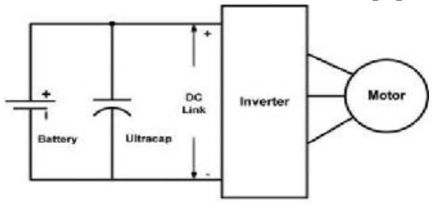

Figure1: ConventionalParallelingof Sources

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BatteriesandUCsgivestheelectricaloutputinDCformonlybuttheyaredifferintheirworkingprinciple.BatteryandUCshavequiteoppositecharacteristics. UCshavinghighpowerdensityandlowerenergydensityonotherhandbatteryhasquiteoppositecharacter[7]. UCsaremorecapabletogivegoodresultsduringlowtemperatureperiodanditrequiredlesstimeforcharginga nddischarging,lifeperiodoftheUCismorecomparedto battery.socombinationofthesetwosourcesgivesgood performance over previoussystem.

conventionalparalleling of sources:

Figure1showsthatconventionalparallelingofsourcesistheeasiestway.HereUCandbatterybothare connectedinparallelandagainthesecombinationoutputsimplyconnecttoDClinkdirectly.Sothiscombinationsimplylookslikeaparallelcircuitthatmeansallthevoltages.areequal.Inthiscaseultracapacitoractsasalowpassfilter[9].Thistypeofconfigurationisveryeasytodesignbecausenoneedtostruggleaboutdesigningofcontrollerspartanddon'thaveanypowerelectroniccircuitry. Butwiththisconfigurationwecannotutilizetheadvantageofultracapacitor.

A. UC-Battery Modelconfiguration:

Batterymodel,hereintegrationofUCandbatterycandonebybidirectionalconverterandthevoltagevalueofUCcanuseduptowiderange.Tomeethigherpowerrequirementsbigsizeconverterneeded[9].HereDClinkvoltageisfixedbecausebatteryis directlyconnected to thelink.

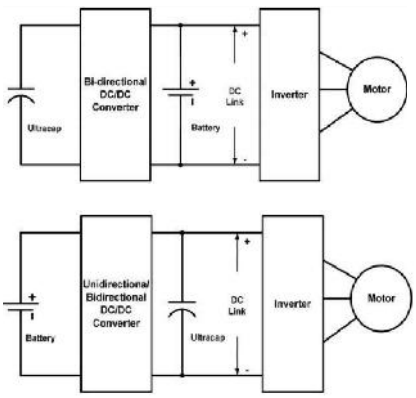


Figure2: UC-batterymodel.

B. Battery-UCmodel:

Figure3showsthatbatteryUCmodelandhere integrationofbatteryandUCcanbedonebyunidirectionalconverter[5].UCconnecteddirectlytotheDClink,and it acts as a lowpassfilter.HereUC power used effectively than previous model because DClink voltage value can change with in the specified values.

C. Cascadedmodel:

Figure4showsthatthecascadedmodel,inthis twoseparateconvertersarerequiredoneisunidirectionalandanotheroneisbidirectional[4].Unidirectionalconverteris connectedbetween batteryand UCon otherhandbidirectionalconverter is used to integrate to DC link.

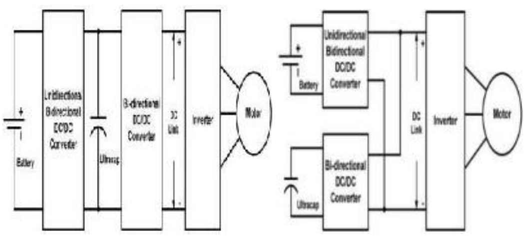


Figure4: Cascadedmodel.

D. Multiple Converter model:

Figure5showsthatthemultipleconvertermodels,inthe etwoseparateconvertersarerequiredoneisunidirectio nalandanotheroneisbidirectional[3].Generallybidire ctionalconverterisusedtointegratetheUCtoDClinkon otherhandunidirectionalconverterisusedtointegrateb atterytoDClink.Withthisconfigurationachievesbette rperformancethatmeansmaximum utilization ofUC can happens.

1. HYBRID ENERGY STORAGE SYSTEM DESIGN

This sectiondeals with considerationswhich aredevelopment of battery/UCdiscussedindetail. Thebasicdesignconsidered in the HESStopologies is discussedin detail[8].

A. Battery Model

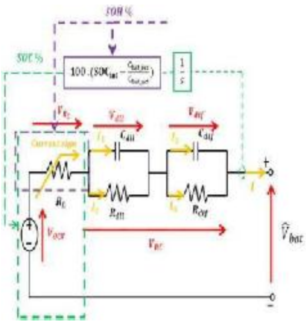


Figure6: dynamicalmodel of abattery

Figure7 representingthat the equivalentelectricalmodel ofUC.Thevoltagestateof UCforRC is givenby[9] Figureshows that the dynamicalmodel of the battery, herethe terminal voltageis afunction oftime and is findingfrom 3components[7]-[10].Thesource V_{OCV} tells aboutopencircuited value, andthis is directlyproportional to SOC of thebattery

•Thevoltage dropin terminal of the circuitcanbemodelled from the resistor R_{Ω} and thisresistance is directlyrelated to theSOC of thebattery

• Voltagedropdueto $R_{dll}C_{dll}$ and $R_{dif}C_{dif}$ models simulatethe polarizationprogressionof thebattery[8].Voltageacross the batteryat terminals is given bellow

Sate ofcharge of batteryis givenby

$$SOC = 100.\left(SOC_{int} - \frac{1}{Q_n}\int \eta I_b \, dt\right) ------(2)$$

Voltageacross internalresistance of batteryis

$$V_{R\Omega} = I_b.\frac{x_{14}}{\sqrt{SOC + x_{15}.SOC.sign(I_b)}} --------(3)$$

B.UltracapacitorModel

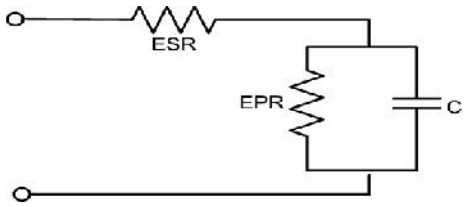
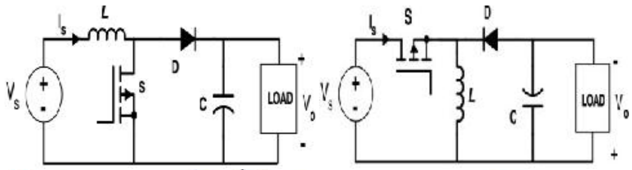


Figure7: Equivalentelectricalmodel of UC



$$V(t) = V_i \exp\left(-\frac{t}{RC}\right) --------(4)$$

C.DC/DC ConverterModel

(i). BoostConverterModeling

Figure8: DC-DC Converter(boost)

Figure8representsDC-DCConverter(boost),andthestatespaceexpressionforDC-DCconverter(boost) duringswitch is in ON condition is[6]

During OFF condition is,

$$\begin{cases} \frac{di_L}{dt} = \frac{1}{L}(V_{in} - v_0) \\ \frac{dv_0}{dt} = \frac{1}{C}\left(i_L - \frac{v_0}{R}\right) \end{cases} \quad DT < t < T, Q: OFF -$$

(ii)Buck-BoostConverterModeling

Figure9representsDC-DCConverter(buck/boost),andthestatespaceexpressionforDC-DCconverter(boost)duringswitch is in ONcondition is

$$\begin{cases} \frac{di_L}{dt} = \frac{1}{L}(V_{in}) \\ \frac{dv_0}{dt} = \frac{1}{C}\left(-\frac{v_0}{R}\right) \end{cases} \quad 0 < t < DT, Q: ON - - -$$

During OFF condition is,

$$\begin{cases} \frac{di_L}{dt} = \frac{1}{L}(V_0) \\ \frac{dv_0}{dt} = \frac{1}{C}\left(-i_L - \frac{v_0}{R}\right) \end{cases} \quad DT < t < T, Q: OFF$$

THE PROPOSED HESS

Tosatisfythepeakpowerdemandsalongwithsteadystatepowerdemandofelectricalvehicle,ultra capacitorhasbeenconnectedadditionallytotheconventionalenergystoragesystemthroughDC/DCconverter.ThedesignedhHESSachievesthisbytheapplicationoftheaveragingconcept.IntheproposedconfigurationvoltagevalueintheDClinkisalwaysmaintainedtheconstantbyDC/DCconverters[2][6].Herethedesignedelectricalvehicleiscapabletohandlethecurrentsatlowervoltages.Inordertoprovidepeakpowerdemandsanultracapacitor is connectedthrough the buck/boost converter to theDC link.

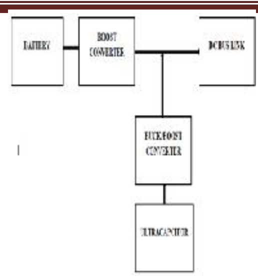


Figure10:Block diagram representationforproposed model

SIMULATIONRESULTS

ThesimulationresultsofHESSplottedbellowthatarerelatedtomeetthepowerrequiredvaluebytwoenergysourcesandalsomaintainedvoltagevalueofDClinkconstantfor48vbyusingthe two convertersoneforUC andanother for Battery.

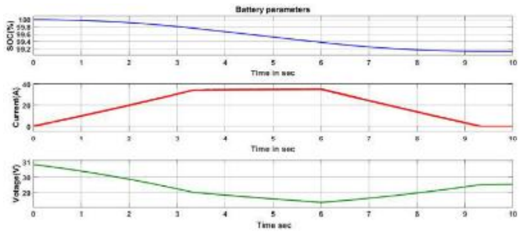
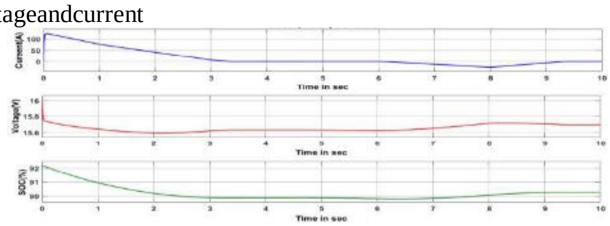


Figure11:BatterySOC,voltageandcurrent



CONCLUSION:

Inthispaperahybridenergystoragesystemisproposedforelectricvehicleapplications.Byusingtwoconverters,thevoltagelevelofaDClinkmaintainedconstantfrombatteryandUC.DependinguponttheratelimitervaluesthebatteryanUCarecapabletosupplyenergytothevehicledependinguponitsrequirement.Andproposedmodelcapabletoattainthepowerrequirementofavehicle.Allthesimulationresultsplottedandcomparedthepowerattainedfromsourceswiththe powerrequired value.

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