Design and Simulation of Wind Turbine on Rail Coach for Power Generation

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Abstract:-

Energy resources in our modern fast paced techno world are fast depleting. Hence a renewable energy source is much required at the moment. Wind energy is a renewable source of energy. today, the output power from wind turbines can be utilized in two ways, either by direct use of the mechanical shaft power (through a gearing ratio) or by letting the wind turbine power t an electrical generator, and utilizing the generated power as electrical power. This paper brings a new possibility for the utilization of the wind generated power, for various electrical components inside a typical railway train through the batteries ,charged by the wind energy harnessed by a wind turbine mounted at the top of the train coaches. This setup consists of duct, turbine, and generator. The setup is designed in such a way that it does not affect the performance of the train.

Average velocity is estimated for the train and the suitable specification of generator is selected. The theoretical calculations of duct, turbine and pulley parameters are calculated and the whole setup is designed in CATIA, also by varying the inlet air velocity, the speed and torque of the turbine can be calculated using CFX software. This parameter are used for calculating generator's speed and torque and validated by comparing with the theoretical calculation. Future advancements are discussed, and a path for experimental verification is proposed.

Keywords: **Renewable wind energy, Duct, Wind, Wind turbine,** Moving **train, Rotation, Electricity.**

INTRODUCTION

In this modern age more and more energy is required fordaily consumption in all walk of life. Sources and quantum offossil energy are dwindling day by day and getting exhaustedat a very fast rate. Hence conservation, tapping new sources ofenergyandharnessingofthesamefromthevariousnon-conventionalsources,isanimportantaspectofenergyproduction/conservation and utilization all over the world. Thesky-rocketing price of crude oil has ruined the economy ofmany a country, hence there is a crying need for production ofenergyfromnon-conventionalsourcesattheearliest.Thepresent concept is one of the answers to this problem, as thesaid induced wind into useable electric energy which can beutilized straightawayor storedinbatteries.

This invention relates to a method for generating electricityusing high wind pressure generated by fast moving vehicleschannelingtheinducedwindinthedirectionofthewindturbine. A fast moving vehicle compresses the air in the frontofitandpushestheairfromitssidestherebycreatingavacuumatitsrearand itssidesasitmovesforward.

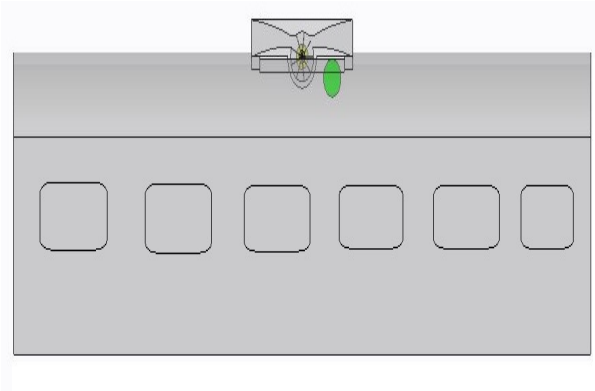

Figure1:basicsetup

The kinetic energy of the wind movement thus created canbeusedtogenerateelectricity.Themovingvehiclesencounterswindmayberailwaytrainsorairplanes,willsweep off it, in a faster manner making heavy winds. Duringthis, when a wind turbine, if fit to the moving vehicle willgenerate adequate amount of energy. The air flow will causeturbine to rotate and thus electricitycanbe produced.

The main object of the present invention is to provide amethod and a system for generating electricity using easilyavailable wind induced by moving vehicles/airplanes in transitor in operation. The other object of the invention is to provideа method and a system for generating electricity by using highwind pressure generated by moving vehicles, using this freerenewable input namely air and independent of the vagaries ofseasonalwindshavingthevariationindirectionandwindspeeds when they do flow and that too neither at all times orplaces nor having the necessary force of wind to operate windmilltogenerate electricityasrequired.

DescriptionofInvention

WindPressure
CompressedAir
RotateTurbine
GenerateElectricity

Energy crisis is one of the major problems of India and toovercomethis,ourgovernmentisaspiringinallpossibleways.Paucityofelectricityhasleftvariouspartsofthecountry in darkness. It is the duty of every organization tocontributeinovercomingthepowercrisis.Ontheirpart,Indian railway has put forth its effort to generate electricityfromwindpowerinamovingtrain.

Once, this was a failure project because of improper designandposition of the turbinewhichmade it hit on the overbridges and electric lines. The othermain reason which madeit unrealistic is the drag force which affected the performanceof the train. By taking these problems into consideration, wehavedesignedourmodelto overcomethesedrawbacks.

CONSTRUCTION

Duct

A duct is defined as a tube, pipe or a canal by means ofwhich a substance, especially a fluid or gas is conveyed. Herethe duct is designed in such away that it reduces the dragforce and increases the velocity of the air that hits the turbineblades.

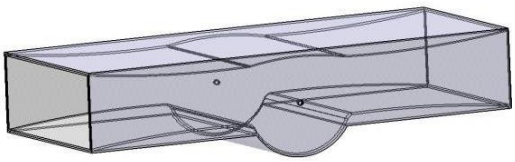

Figure2:DuctDesign

A drag is created due to impulse force created at the sharpedges of the duct. So, to remove this impulse force, the duct isdesigned with a smooth surface by neglecting the sharp edgesallover the pathatwhichtheair passthrough.

Wind Turbine

A wind turbine is a device that converts kinetic energy fromthewindintoelectricalpower.Awindturbineusedforchargingbatteriesiswidelyknownaswind charger.

Generator

A generator is a devicethatconvertsmechanical energyinto electrical energy. Here the generator is coupled with thewind turbine through belt. So, as the turbine rotates, generatoralso rotates. As the generator rotates, gradually electric currentisproduced.

Belt

A belt is a loop of flexible material used to mechanicallylink two or more rotating shafts. Belts may be used as a sourceof motion to transmit power efficiently or to track relativemovement.

Setup

The whole setup which includes a duct, turbine, generatorand belt are placed on the hollow place at the roof top.Asmall portion is made open on the roof for the air to enter intoduct. The setup is placed in such a way that it is fitted withinthe maximum height of the train, so that it does not hit on theover bridgesand electriclinesonthepathwayofthetrain.

Every coach consists of a single turbine generator setup atits middle portion on the roof. The blade of the turbine isdesigned byconsideringthedirectionofrotation.

Here, the duct and blades are designed symmetrically, sothat in whatever direction the wind flows, the blades can rotateand generate electricity.

WORKINGMODEL

A duct is placed on the roof of the train coach. When thetrain moves, air enters the duct and the duct is designedinsuch way that it can reduce the drag force and increase thevelocity of the air.Duct is designed like a converging nozzle atthe entry side, so the velocity of the air is increased when itreaches the turbine. This high velocity air hits on the blades ofthewindturbine.Thus the turbinerotates.

Theexitportionoftheductisdesignedlikeadivergingnozzle,sothattheairgetsexpandedandcooledandgetsintoth eatmospherewithoutprovidingany resistancetotheperformanceofthetrain.

Theturbineisconnectedtothegenerator with a belt. Thus, as the turbine rotates the generator also rotates which results in generation of electricity. The generatedAlternateCurrent(AC)isconvertedintoDirectCurrent(DC)withthehelpofrectifierandthisDCcurren tisstored inthebatterywhichcanbeusedforvariouspurposes.

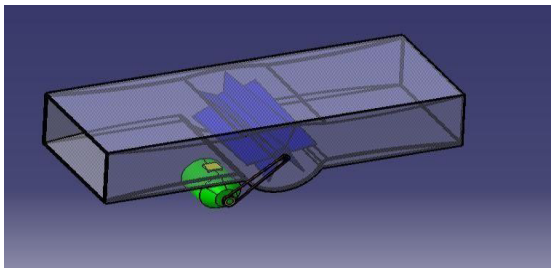

Figure3:CADmodelofthewindturbine

Generator Specifications

RPM	VOLTS	AMPS
150	12	1.5
300	25	4
500	43	7
750	60	10
	70	11

Table1-Generator specification

RESULTSANDDISCUSSION

By employing ANSYS CFX, flow analysis is done for thewind turbine model and the results are tabulated for differentairvelocitiesandthecorrespondingspeedValuesoftheturbine andgeneratorsarecalculated.

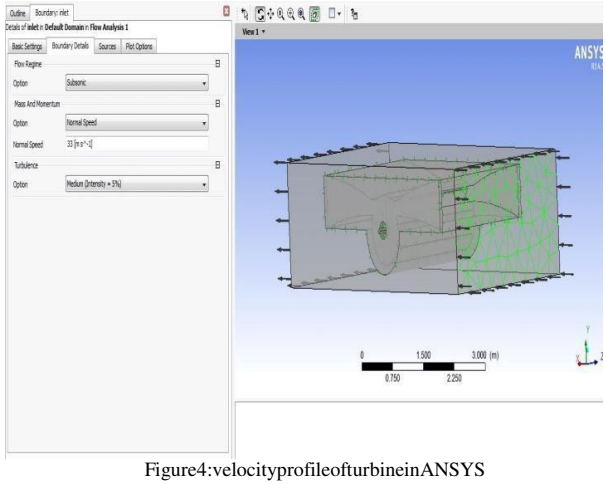

Figure4:velocityprofileofturbineinANSYS

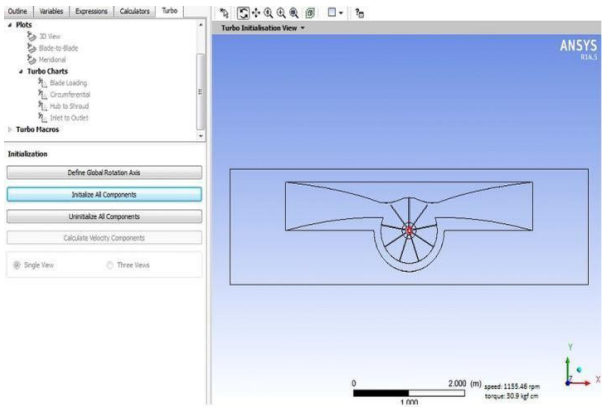

Figure5:Speed andtorquevalues

S.no.	Air inlet velocityv m/s	Turbine speedN1rp m	Generator speedN2rp m
1	33	1666.67	1041
2	32	1604.2	1002
3	26	1336.9	835.5
4	25	1260.5	787.81
5	15	763.94	477.46
6	14	687.54	429.71
7	12	611.15	381.96

Table3-TheoreticalApproach

ThereforecomputationalvalueofF$_b$=0.55mtheabovetabulationofcomputationalapproachitis significant that the velocity of 12m/s i.e. 43.2km/hr. thetorque of the generator falls below 1.14 Nm. Therefore thegeneratorisactiveonlyatspeedrangeof43.2km/hr.-120km/hr.belowthisspeedthedeviceisinactive.

CONCLUSION

This system helps in effectively utilizing the wind energyandgeneratingelectricalenergyatlowcostwithlessmaintenance. WiththeIndianrailwaysnetworkofthousandsofkilometersrunningacrossthelengthandbreadthofournation, by implementing this system of power generation, wecan generate power tosupplement the requirements of railpassengers such as audio facilities, Wi-Fi facilities, lightingfacilities, etc.

The technology is expected to contribute to the cause of theenvironment as it helps to reduce carbon emissions and alsoassiststhe governmentinsavingonfueltoo.
It can be concluded that an effective system can be installed inrailcoachtogeneratepowerwhichispurelyenvironmentfriendlyandcost effective.

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