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Renewable Energy Engineering

Elixir Renewable Energy Engg. 66C (2014) 20572-20575

ISSN: 2229-712X

A novel electrical power generation using wind harnessed from train

M.Barathi Selvaraj*, S.Mohanvel, L.Manivannan and S.E.Murthy
Knowledge Institute of Technology, Salem, TamilNadu, India.

ARTICLE INFO

Article history:
Received: 16 November 2013;
Received in revised form:
23 December 2013;
Accepted: 4 January 2014;

Keywords
Train,
GRID,
MLI,
Wind Turbine,
PMA.

ABSTRACT
This paper effort to describe a pioneering method of generating eco-friendly electrical energy that could be obtained from the wind energy harnessed from train. The energy generated from this method can be used to partially fulfil the daily power needs of human being. The method for generating electricity is by using the wind pressure which is generated by fast moving vehicles (train). By channelling the induced wind in the direction of the wind turbine and to convert the kinetic energy of the wind into mechanical energy with the help of wind turbine. The converted mechanical energy is converted into electrical energy with the help of an alternator. The ultimate aim of this project is to develop much cleaner and cost effective way of power generation, which in turns helps to bring down the global warming and to reduce the power shortages. The idea explained here does not interfere in the normal working of the moving train.

Introduction

Now-a-days natural sources and quantum of fossil energy are diminishing day by day and getting exhausted at a very fast rate. Hence conservation, tapping new sources of energy and harnessing of the same from the various non-conventional sources is an important aspect of energy production all over the world. Renewable energy from wind and solar is sustainable and does not lead to increase carbon dioxide emissions. The idea of this project is to harness the wind energy from the train being utilized to generate electricity is very fascinating. Generating power by harnessing the wind energy created by fast moving trains is a new idea. T-BOX (Turbine- Box) is a system which is proposed in [3], it is placed between the tracks. T-BOX is not suitable for generation due to falling of debris inside it and the trains that are running in India are designed with open toilet facilities in the train, leads to dispose the waste between the tracks which pointers to failure of T-BOX. Another method of generation by fixing a small impeller in front portion of the railway locomotive and similarly on top of each coach and in between the coach proposed in [4] is not suitable since it will affect the normal operation of the train. The proposed process in this paper does not involve any sophisticated mechanism and ensures complete safety. This method of power production overlays way to less attentiveness and can be produced in the place. In this method we are implementing our idea to produce energy and tempted new way for producing clean energy. There are 14,300 trains operating daily on 63,000 route kilometers of railway in India. This technique would capable of producing 45 MW per day approximately.

Working Principle

The proposed system is represented through the block diagram in figure 1. In our project we generate electric power with the help of revolving blade arrangement. In this, the blade arrangement is the mechanical arrangements which are easily rotated by the wind flow. The rotating speed depends upon the wind flow. The wind blade rotatable arrangement is coupled with a Permanent Magnet Alternator (PMA). So whenever the wind turbine rotates due to wind flow, Permanent Magnet Alternator is also rotated. The electric power is generated in the PMA.

The AC electric power generated by the PMA is rectified to DC with the help of Rectifier and stores in the battery. The energy stored in the battery is converted into AC with the help of Multi-Level Inverter and Step-up into high voltage with the help of a transformer. Multi-Level Inverter (MLI) and Transformer is used to obtain the required frequency and voltage to synchronize with the grid voltage, frequency and phase sequence. The CT and PT arrangements are used to measure the voltage and phase sequence of the GRID and MLI. The micro controller is used to feed firing angle to the MLI according to the outputs obtained from the CT and PT, to sync the GRID parameters. The stored energy in battery is pumped directly to the grid while the battery is charged above 80% or full by operating the Circuit breaker with the help of Microcontroller.

Block Diagram

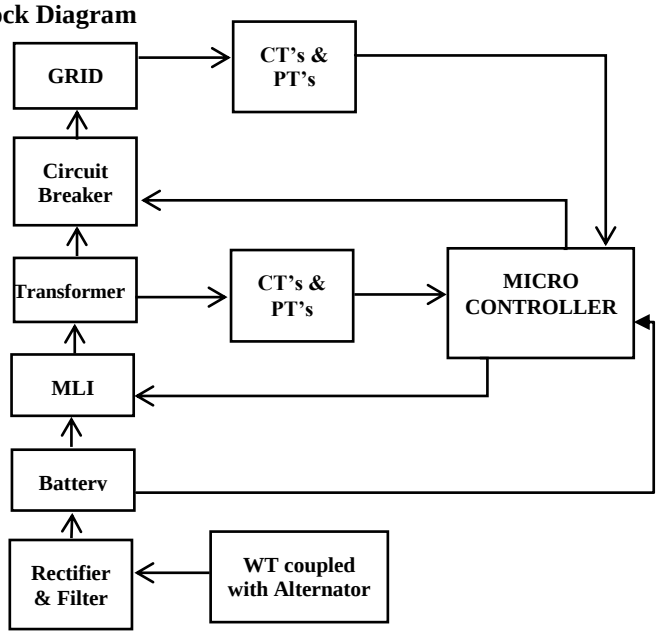


Fig 1. Block Diagram of Proposed system

Tele:
E-mail addresses: barathi_sel@yahoo.co.in

Capturing and Routing Wind Induced By Train

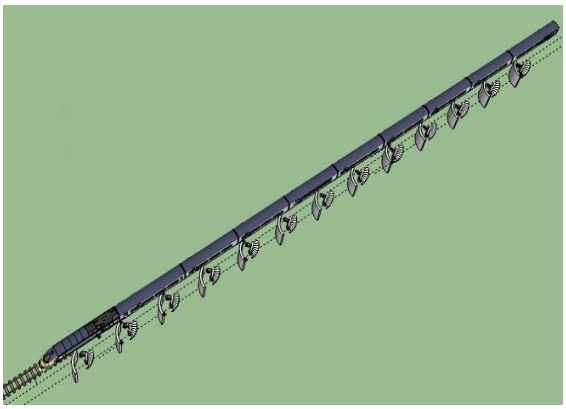


Fig 2. Layout model of the proposed system

The layout diagram shows the arrangements of turbines and channeling ducts in Fig2. The moving vehicles could be railway train which running on railway track. As trains run over the tracks, the alternative form of wind energy produced by train is very unique, as it does not depend on any natural energy resource. If the wind is properly directed towards the wind turbine blades, optimum electricity may be generated. The desired direction of wind is obtained by a means of channeling wind, in the direction of the wind turbine. Channeling the wind in a desired direction may be obtained by building concrete channels in a curved structure or by making ducts using sheet steel converging towards the blades of the wind turbine.

Induced Wind Energy

Beaufort Wind Scale

Table 1. Beaufort Wind Scale

Beaufort number	Description	Observation
0	Calm (0-1 mph)	Smoke rises vertically
1	Light air (2-3 mph)	Smoke drifts slowly
2	Slight breeze (4-7 mph)	Leaves rustle; wind vane moves
3	Gentle breeze (8-12 mph)	Twigs move; flags extended
4	Moderate breeze (13-18 mph)	Branches move; dust and paper rise
5	Fresh breeze (19-24 mph)	Small trees sway
6	Strong breeze (25-31 mph)	Large branches sway; wires whistle
7	Moderate gale (32-38 mph)	Trees in motion; walking difficult
8	Fresh gale (39-46 mph)	Twigs break off trees
9	Strong gale ((47-54 mph)	Branches break; roofs damaged
10	Whole gale (55-63 mph)	Trees snap; damage evident
11	Storm (64-72 mph)	Widespread damage
12	Hurricane (73-82 mph)	Extreme damage

The table 1 mentions the Beaufort Wind Scale. From this we could measure wind speeds. It is to calculate the speed of the wind without any mechanical device and using only the human observation.

If a train is moving at 125mph would generate a wind speed equivalent

If a train is moving at 125mph would generate a wind speed equivalent to 60 feet/second. Wind blowing with such speed will let a normal wind power generator harness about 3500w of power. If a train is about 656 feet long, running at the pace of 187mph, and it moves along a 0.62 mile railway track in about 18 seconds, the power generated in this small period by the turbine laid on the tracks will be 2.6kW approximately.

Kinetic Energy of Wind

The kinetic energy of the wind is the source of the driving force of a wind turbine.

Power = (density of air x swept area x velocity cubed)/2

$P = ½.\ \rho\ (A)\ (V)^3$

Where,

P is power in watts (W)

ρ is the air density in kilograms per cubic meter (kg/m^3)

A is the swept rotor area in square meters (m^2) & V is the wind speed in meters per second (m/s).

Hardware Description

Wind Mill

Figure 2 represents a vertical windmill, it is designed in the form of HELIX and it is made-up of galvanized sheet steel. It is designed in such a way to convert the energy of wind into mechanical energy. The most modern generations of windmills are more properly called wind turbines or wind generators and are primarily used to generate electricity.

Fig 3: Helix wind mill

Permanent Magnet Alternator (PMA)

PMA is an electrical generator and it generates Alternating Current (AC). PMA is used to reduce the friction between the carbon brush and the commutator instead of DC Generator and also used to avoid the energy for field excitation externally.

Rectifier & Battery

Rectifier is used for converting the alternating current to direct current. This process of conversion is known as a rectification. Here Full-wave rectifier is used. The rectified DC is filtered and fed to the charging circuit of the battery to store the energy generated. Battery is used for storing the electrical energy generated. The battery used here is lead-acid type and has a capacity of 12V/100AH. The output from the Rectifier is used to charge the battery.

Multi-Level Inverter (MLI)

Cascaded Multi-Level Inverter is used to convert the DC to AC at desired voltage and frequency. MLI produces a medium-voltage output with almost approximated sinusoidal wave. The multilevel voltage source inverters unique structure allows them to reach high voltages with low harmonics without the use of transformers or series connected synchronized switching devices, a benefit that many contributors have been trying to appropriate for high voltage, high power applications.

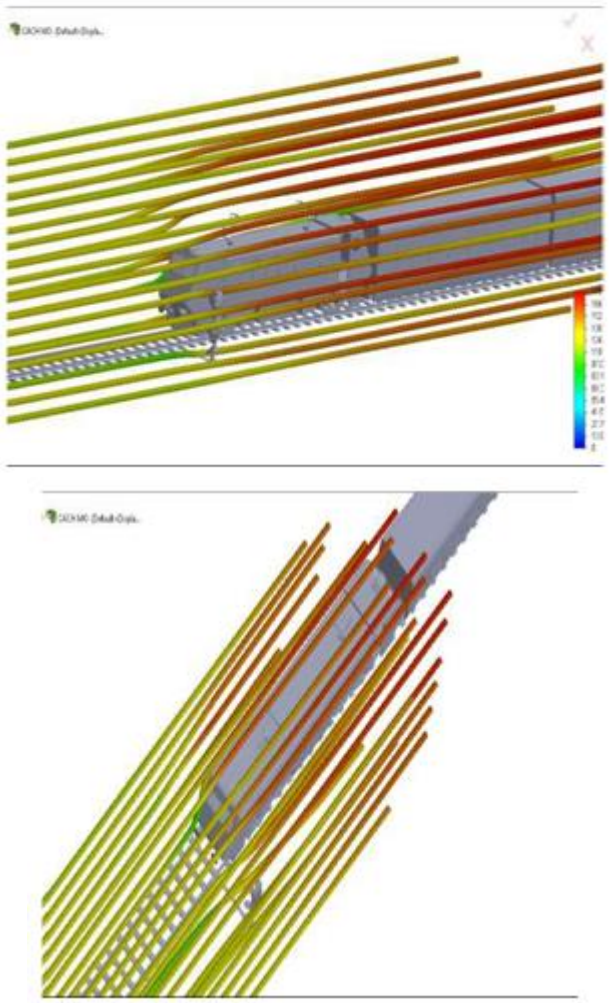
Microcontroller

Microcontroller is used to control MLI and Circuit Breaker. The microcontroller gathers the signals from the secondary of the Transformer with the use of CT's & PT's, from the GRID

with CT's & PT's and from the Battery. If the battery is charged above 80% then the microprocessor compares the output of Transformer and GRID. According to the comparison the MLI is controlled and the MLI firing is done in such a way to match the output parameters of the transformer with grid. If the output parameters are same, the signal is passed to the Circuit Breaker to synchronize the Transformer output with GRID.

Result And Analysis

The results of the wind flow around the train were analyzed using CFD and the results were provided.



Solid Works Flo Xpress Report

Solid works Flux press is a first pass qualitative flow analysis tool which gives insight into water or air flow inside our solid works model.

Model

Model name: G:/ flo ana/ CACH MO.SLDASM

Fluid

Air

Environment pressure 1

Type	Environment pressure
Faces	<0>@ closer-1
Value	Environment pressure:600000.34 pa
Temperature	293.20k

Environment pressure 2

Type	Environment pressure
Faces	<1>@ closer-2
Value	Environment pressure:500000.02

Result

Name	Unit	Value
Max velocity	m/s	180.190

Conclusion

Per capita energy consumption is a measure of growth of a nation. To quench the energy needs of a citizen, there is a need to scale up the power production. The availability of the energy resources stresses the importance of energy efficiency. This proposed project is aimed to provide a new way of producing the electrical energy from the wind caused by the movement of trains. This idea would be capable of producing energy about 45kW per day and 200 MW per month approximately. The produced energy can be stored in the battery and be supplied to the light loads. The proposed method is very simple to implement and leads the way to green way of Electrical Energy production.

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Authors Bibliography:

M.Barathi Selvaraj is currently working as an Associate Professor in the Department of Electrical and Electronics Engineering at Knowledge Institute of Technology, Salem. He is also a part time research scholar in the field of Power Electronics in Anna University Chennai. He is the staff coordinator of Amber'Z Electrical Engineers Association. He presented papers in National and International level conferences.

S. Mohanvel is currently working as an Assistant Professor in the Department of Electrical and Electronics Engineering at

Knowledge Institute of Technology, Salem. He presented papers in National and International level conferences. He is the staff in charge of Entrepreneurship Development Cell at Knowledge Institute of Technology, Salem. His research interests lie in the field of Power Systems, Smart Grid and Distributed Generation

L.Manivannan is currently working as an Assistant Professor in the Department of Electrical and Electronics Engineering at Knowledge Institute of Technology, Salem. He presented papers in National and International level conferences. He also published a journal at International level. He is the member of Board of Studies at K.S.R. College of Engineering. Under his guidance, He received Rs.9,000 fund from Tamilnadu State Council for Science and Technology under Student Projects Scheme for the project titled as," Corporation Mini Hydro Power Plant" during the academic year 2012 - 13.He has guided number of project for students. He is the staff Co-coordinator of Robotics Intelligence Machines Club at Knowledge Institute of Technology, Salem. His research interests lie in the field of Power Electronics, Renewable Energy, Robotics and Power System.

S.E.Murthy is currently working as an Assistant Professor in the Department of Electrical and Electronics Engineering at Knowledge Institute of Technology, Salem. He presented papers in National and International level conferences. He is the staff coordinator of EPE Club at Knowledge Institute of Technology, Salem. His research interests lie in the field of Power Electronics, Control Systems and Renewable Energy.