Revolving Doors Producing Green Energy

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Abstract— Renewable energy is the energy which comes from natural recourses such as sun light, wind, rain, tides and geothermal heat which are naturally replenished. Wind energy, solar energy, biomass, bio-fuel and geothermal energy are the main types of renewable energies used nowadays. All forms of energy are expensive but as time progresses renewable energy generally gets cheaper, while fossils fuels generally gets more expensive. As it is renewable, it is therefore sustainable and so will never run out. Renewable energy has minimal impact on the environment.

Revolving doors can be used for harnessing power generation from wasted human effort applied for opening the door. Since human effort applied on the door is inexhaustible, so we can use revolving door as a new form of renewable energy. Revolving doors which mark the prestige and glamour of building can be efficiently harnessed for power generation. It captures wasted human energy and converts into suitable power source. Though it is not a major production of power but it is a step forward in the direction of renewable energy. This is also used for preventing the global warming and emission of harmful gasses. Today mostly used renewable energy resources are solar energy, wind energy. It is economical, independent, easy to harness and produce electricity can be used for charging batteries, LED'S and CFL bulbs.

Concept used in this mechanism is similar to turbine used in hydroelectric dam or wind turbine to generate electricity. In this mechanism we used revolving door with three wings and Techtronic system which consists of gear mechanism and motor generator to generate electricity.

The prototype which we have made is producing 110 watts and the total output will depend on frequency of people passing through the door. We can also optimize the power by varying various parameters like width of the door, mass of the door and gear ratio.

With the prototype we have chosen width as 2.5 feet and gears are placed at distance of 15 cm from fulcrum i.e. centre shaft. So the lever ratio obtain in this case is 1:5. Hence the torque at gear is 15 N-m but due to longer lever arm it become 3 N-m at door. We have found that as applied torque increases the power produced from motor is also increased but up to motor rating , and for the same applied torque power produced can be increased by increasing the width of the door.

Keywords-Renewable energyt; revolving door; lever rule.

I. INTRODUCTION

A revolving door typically consists of three or four doors that hang on a center shaft and rotate around a vertical axis within a round enclosure. Revolving doors are energy efficient by eliminating drafts, thus reducing the heating or cooling required for the building. At the same time, revolving doors allow large numbers of people to pass in and out. Revolving door producing green power operates by when person passes through it. As door rotates geared pairs convert this motion of shaft into sufficient speed for producing electricity through generator. This is further stored in D.C battery or used for L.E.D. This revolving door designed in this project would help primarily to generate and conserve energy.

II. NECESSITY

Per capita Electricity consumption all over world has increased largely in past few decades. So there is large load on generation of electricity through conventional methods. This may lead extinction of conventional power resources like coal, uranium etc. So there is need of alternative non-conventional energy resources which would lower the power load on conventional resources. Also this conventional sources increase pollution through green house.

III. PRINCIPLE

The torque applied by human being to open door is 15Nm which normally goes waste .It captures wasted human energy & converts it into suitable power source. Principle of this mechanism is similar to turbine used in hydroelectric dam or wind turbine to generate electricity. A revolving door in a busy place usually spins for hours every day. Much of the energy used to turn the door is wasted. A generator at the door could convert the mechanical energy from the spinning door into electrical energy. Revolving door will actually be generating lots of energy. Thus utilizing the kinetic energy in operation of door with help of geared mechanism & generator assembly is the basic principle of this mechanism.

TABLE I.   COMPARISION OF REVOLVING DOOR PRODUCING POWER WITH SOLAR ENERGY

Sr. No.	Points	Solar Energy	Revolving Door Producing Power
1.	Principle	Harnesses Energy from radiant sun rays incident on Earth's surface.	Captures wasted human torque for opening and closing revolving doors.
2.	Devices used	Solar Panels, photo voltaic cells.	Gears and generator, (i.e. Techtronic system)
.. 3.	Cost	1 sq. m. Panel cost Rs. 20000.	Mechanism cost Rs.1500.
4.	Dependant	Depends upon climatic changes.	Totally dependent on passing of human beings.

IV.   MODEL OVERVIEW

Model consist mainly three important parts

- Central working device [Door]
- Techtronic system
- Output device

Figure 1. Model of revolving door

V.   TESTING AND TRIALS

A.   Variations in lever arm distance

The next part of testing is done by varying the width i.e. Lever arm distance and studying its effect on torque applied. This effect which is called lever effect is explained in further topics. The fig indicates the effect of leverage on our prototype.
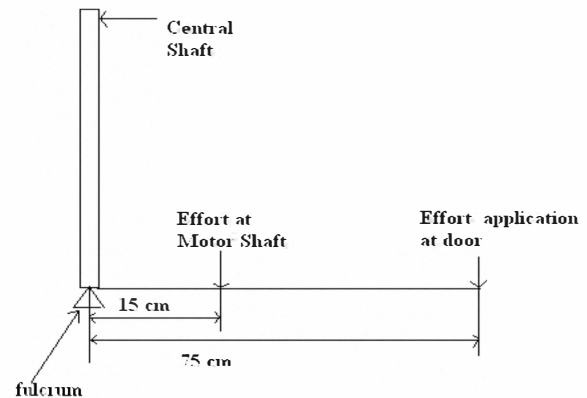

Figure 2. Lever arm rule.

The figure above indicates that lever ratio in our case is 1:5. In our case the fulcrum is the central shaft. The smaller gear is at distance 15 cm from fulcrum which is fixed during testing while the distance which keeps on varying is width. From results and analysis width of door selected is 75cm. Hence the ratio obtained is 1:5.
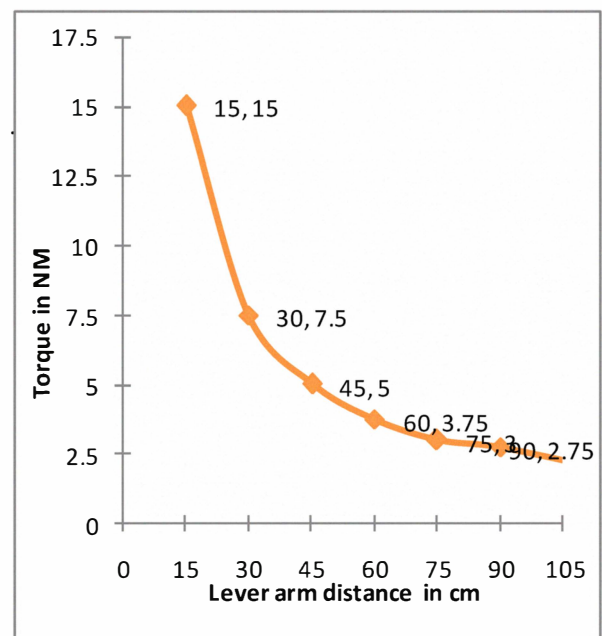

Figure 3. Lever arm distance in cm

The above curve shows lever effect on torque applied. It indicates that as distance from fulcrum point increases the effort applied decreases. With the prototype we have chosen width as 21/2 feet and gears are placed at distance of 15cm from fulcrum i.e. center shaft. Hence the lever ratio obtained in this case is 1:5. The curve depicts that if we keep maximum width of door, we could obtain maximum torque at motor shaft for minimum effort for pushing the doors. Hence the torque at

gears is though 15 Nm but due longer lever arm it becomes 3Nm at door.

VI. CALCULATIONS AND RESULT

Based on readings and results obtained from trials, calculations of prototype are made to obtain maximum possible power from it. Also calculations for torque, effect of lever, payback period are made in this section. In this calculations few aspects are constant they mentioned below -

- For three wing door the minimum opening is 1/3 i.e. 120 degree due enclosure construction. For that rotation, we have designed a torque of 15Nm. The opening or passing time for is found out to be approximately 2s.Hence door rotates 1/3 for 2s, therefore speed of door is –
  Door revolution/min = 1/3 × 30s
                     = 10 rpm
- The gear ratio is constant and it equal to 1: 5.7. Therefore for 1/3 opening the gear attached to motor shaft rotates 2 revolutions for 2s time span. Therefore speed of motor shaft is-
  Speed of motor shaft in rev/min = 2 × 30s
                     = 57.64 rpm.
  This speed is constant for any motor placed in mesh with larger gear due to gear design and 1/3 space for entering through door.
- As discussed in earlier topics lever ratio is 1:5, hence torque at door is at door is five times less than that at the motor shaft.
- Also power is generated with two motors at their full rated capacity and motors used are 30V 3amp & 15V 1.5 amp.
- Table below indicates factors which are fixed during calculations and also their respective values. These values are calculated at beginning and they do not change for revolving door producing power of 120W.

TABLE II. VALUES OF FIXED FACTORS

Sr. no	Factors kept fixed during Calculations	Values for fixed Factor
1.	Minimum angular distance for opening or closing through revolving door	1/3 or 120 degree.
2.	Gear ratio	1:5.7
3.	Lever ratio	1:5

We have changed some operating parameter like:
Width of the door : we saw that by varying width of the door the power output also increases and the torque applied varies

from 75 to 113cm. the torque applied at different point on the door is shown on the graph. The power is increased but up to the motor rating.

- Mass of the door: By increasing the width of the door the mass of the system is increased by 5-10kg and the width is increased by 38cm.
- By doing this the power output is increased to 110w from 80w
- The power output calculation
- The power calculated for 15Nm torque
- According to the lever rule the ratio is
  113/15 = 7.5 (1:7.5)
- The power obtained is
- P = 15x7.5= 112.5w=110w
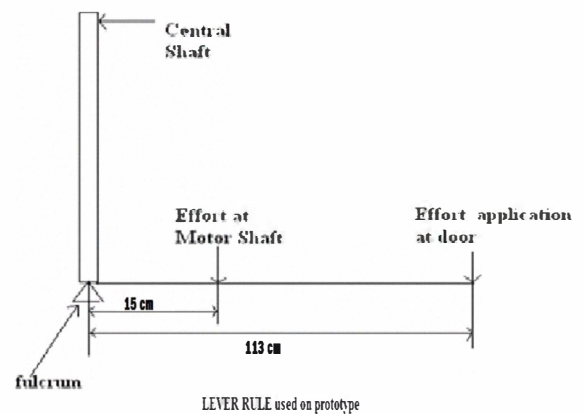- Therefore we have optimized the power Output.

Figure 4. Modified lever arm

VII. POWER GENERAYED FROM TWO MOTORS

A. For 4 Nm torque (prototype)

- Consider calculations for 10000 people passing per day and time for each passing is 2s.
- Through the readings we obtained for two motors
- 1passing – 2s power produced = 110W
- 1800 passing for 1 hr, power produced =   110W.hr
- In 16364 passing power produced =   1800×1000/110 = 1KW.hr
- Per day power produced   = 611.67W.hr/day = 0.61KW.hr/day.
- Power produced yearly = 0.61× 365 days = 222.65 KW.hr / year.
- The torque applied for this much power is = torque due to larger motor + torque due to   smaller motor.

- The torque at larger motor shaft is 14.08 Nm and at smaller motor shaft is 4.14 Nm but due to lever ratio 1:5 at door it reduces to 2.81 and 0.834 resp.

- Therefore the total torque at doors is   2.81 + 0.834 = 3.70 Nm.

VIII.   CARBON CREDIT CALCULATIONS

A. Prototype (4Nm torque)

- Power produced by actual model for designed torque of 4 Nm yearly is approximately equal to 222.5KW.hr/year.

- The amount of coal burned for producing this much power is –

- 1Kg of coal produces 2kw.hr of power considering 30% thermal efficiency of thermal power plants.

- Therefore for 245KW.hr amount of coal burned is 111.25 Kg.

- By burning 1 Kg of coal 2.93 kg of CO_2 is emitted in environment.

- So for 111.25 Kg of coal amount of CO_2 emitted is 0.33 tones.

- Hence with installation of this mechanism we could prevent 0.33 tones of CO_2 emissions yearly.

IX.   CONCLUSION

With the help of this project work we have found a possible source of renewable energy in the form of "Revolving Door". If it is employed in places of high people movement with proper designing we would have sufficient power from it.

The results for above experimental setup are:-

- The power produced from one pass is 110w in final setup.

- Some design parameters were varied to understand their effect on power production.

- The length of door was increased from 75cm to 113cm; this has reduced the torque applied by the person entering the door i.e. from 4 NM to 2.5Nm.

- The mass of the system was varied from 5 to 10 kg; this increased increase in power output as the required torque input is increased.

REFERENCES

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