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Power Generation from Rotational Motion of a Motor

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***Abstract*— The increasing demand for energy has led to the development of various technologies for power generation and conservation. Energy conservation in all areas and industries plays a key role in attaining benefits in both environmental and economic aspects by following ISO standards. As per the study, there are more losses in the form of heat in industries, whereas in domestic areas, it is due to excess and unwanted utilization of motors and other components. This paper concentrates on motor losses. The electrical energy of the motor is converted into mechanical energy, thus making a system work as per its design. The paper aims to explore the potential of using the rotational motion of the motor for power generation. The testing of the system is done using the hardware setup of the water sump motor. The experimental results demonstrate that the system can generate a significant amount of power that can be used for suitable devices and charge suitable batteries for future use. At the same time, cost savings can be achieved.**

***Index Terms*— energy conservation, motor, generator, rotational motion.**

I. INTRODUCTION

The conventional sources of energy in the world are limited, which increases the need to save energy and minimize the utilization of the available resources in the proper manner by recycling them with some alternatives. The power generated is not enough to meet the increasing power consumption. Thus, the concept of energy transformation can be used to convert the energy available in one form to another. This paper deals with the rotational motion of a motor, which can convert mechanical energy to electrical energy by using an alternator. This energy can be directly given to load devices such as mobiles, laptops, iron boxes, lights, fans, etc. for their operation or can be used to charge the batteries. The output can be obtained using an LCD interface module to get an accurate value instead of a manual calculation. Generation of power by train wheels focuses on generating electric power by trains running on the railway track by using the wheel rotating on the track as a drive mechanism. The forward motion of the train is considered for the conversion of rotational motion into electrical energy. [1] Smart Electricity Generator via DC Motor suggests an experimental model for electricity generation by footsteps, which enables every individual to help in the generation of electricity just by walking on a specially modified tile. The kinetic energy is exerted on the tile, which is fixed in crowded places like malls theaters, airports, etc will generate small amount of power, ,which can also be stored for later applications [2] Power generation from rolling mechanisms attempts to concentrate on the electrical energy that can be generated from busy roads using speed breakers. Using a simple mechanism, normal speed breakers are replaced to generate power by tapping this energy [3]. The power generation through agricultural pump sets implies that the agricultural pumps which discharges the water have the potential and kinetic energy which can be used to rotate the peloton wheel, which produces mechanical energy that can be coupled with generator using gear wheels to produce electrical energy [4].

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II. Problem Formulation

Designing and implementing a system that can transform the rotating motion of motors into electrical energy is the major goal. Therefore, it is possible to conserve energy and, thus, money. Faraday's law of electromagnetic induction serves as the foundation for the idea of power generation from the motor's rotating motion. The generator's magnetic field rotates the wire coil, creating an EMF in the wire that, in turn, allows current to flow through the wire, producing electrical energy. The coil of wire is located in the generator's rotor, which rotates, while the magnetic field is located in the stator, which is stationary. The motor shaft and generator rotor are coupled together by a coupling mechanism.

III. Hardware Description

A. Water Pump System

The function of the water pump system is to raise the pressure of water and impart desirable velocity for the transportation of water from one location to another based on the application. We are using a diaphragm water pump, which has a flexible diaphragm that moves back and forth, which in turn creates pumping action for the movement of fluids.

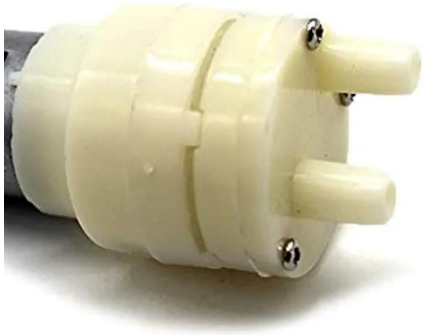

Figure.1. Water Pump

B. Motor

The motor gets a supply and thus drives the water pump system on one side. Using a shaft and a coupler, the generator is connected to the other side. Here we are using a double-shaft 12 volt DC motor, of which one end is connected to the water pump and the other end is connected to the suitable generator.

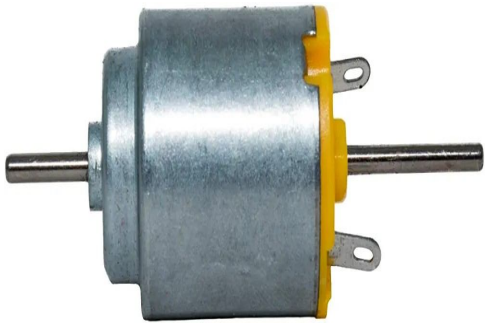

Figure.2 .100 rpm Motor

C. Generator

The generator, which is directly connected to the motor, is used to convert the mechanical energy into electrical energy. It helps in converting the loss of energy (rotational energy) into useful output power. It consists of a coil of wire that is rotated within a magnetic field, which in turn induces current in the wire, which can be used as power input to the electrical devices or stored in a battery for future use.

Figure.3.100 rpm Generator

D. Load / Battery

The load connected to the generator is chosen based on the output power of the generator and may vary according to the area of usage. In the case of the water sump motor, the load can be of <= 400W, and the battery can be of <= 24V, 18Ah, which is used to store the energy from the rotational motion of the motor.

Figure. 4. .Rechargeable Battery

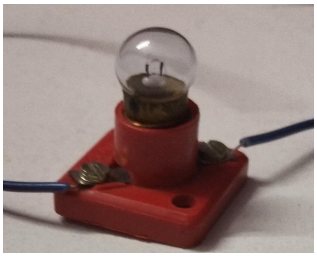

Figure.5.Load

E. Coupler

The coupler couples the shafts of the motor and generator. The main function of the coupler is to ensure the effective transfer of rotational motion from the motor to the generator. It helps to maintain the mechanical integrity of the system by preventing damage to the motor or generator, and it also helps to dampen any kind of vibration or shock that may occur during the operation of the system.

Figure .6. Coupler

F. LCD Display

The liquid crystal display (LCD) panel is used to display the measured output values of voltage and current from the generator. It has been placed for the easy check of an output instead of doing a manual check, which can't be very accurate.

Figure.7. Lcd display

IV. HARDWARE RESULTS

The prototype of the water sump system has a water pump set, motor, shaft, coupler, generator, LCD display, and a load or battery. Here, the supply given is three-phase. The specification of the motor is 100 rpm, and the specification of the generator is 100 rpm. The dimension of the shaft connected is about 3mm. The coupler is used

to connect the motor and generator. The lamp is connected as a load. The LCD displays the current and voltage output from the generator. The water pump system is connected to a motor and generator through the shaft. Thus, the loss of rotational motion by the motor is put into effect.

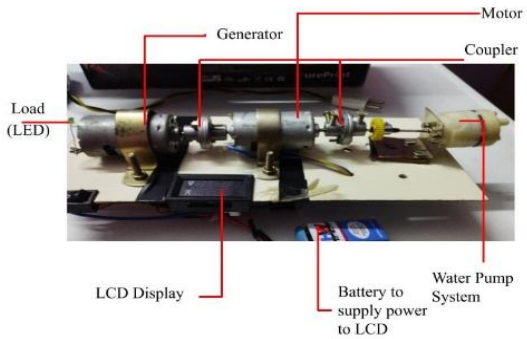

Figure.8. Water Pump System Hardware

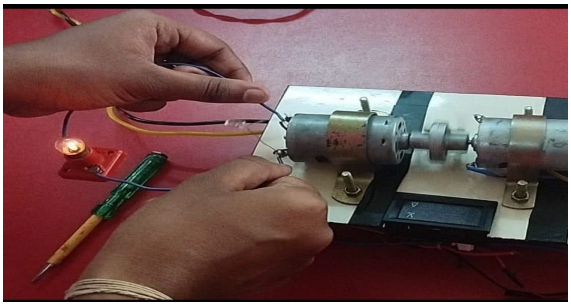

Figure 9. Output from the generator

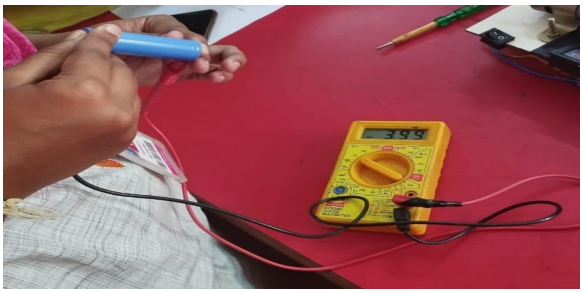

Figure.10.3.99 V (output) battery energy storage

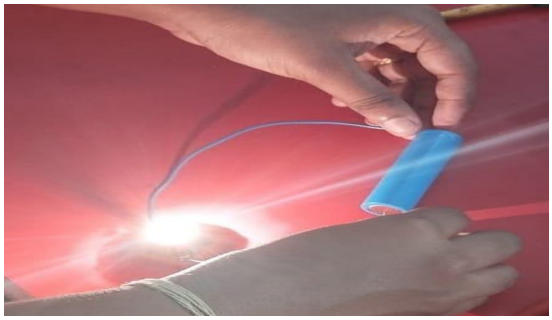

Figure.11.Using the stored energy from battery to a load

V. CASE STUDY

Waste of energy occurs in many areas, such as in the form of heat, more rotational movements,etc. The main area that needs to be reduced in order to save energy and lower system costs is loss. The rotational loss of operating motors is the subject of this project. A few case studies are used in conjunction with the analysis of this issue.

A. Water Sump System

The water sump is the main essential system in our cities to have a regular water supply. A water sump system is built based on the amount of water that is available in each area. We transport water to the tank at the top of the building with the aid of this system. Depending on the height between the sump and the tank, we use a different kind of motor for this action with a different rating.

Motor Rating

Power Rating : 750W
Speed : 2880 rpm
Discharge rate : 600 to 2400 lph
Power = Torque * ω
Torque = Power / ω ω = (2 * pi * N) / 60
ω = (2 * pi * 2880) / 60 = 301.592
Torque = 750 / 301.592 = 2.486 Nm
Now, m - 1000, g - 10, and height (h) - 10 m
Energy = m * g * h = 1000 * 10 * 10 = 100000 joules
Let the Efficiency be 60%
Power Output = 750* 0.6 = 450 W.
Describes W- watts, rpm- rotations per minute, and Nm-newton meter.
Thus, generators with <= 450 W can be connected to get an efficient power output. Thus, loads with less than a 400-watt rating can get power from the rotational motion of the motor, which can charge a battery at a voltage of 24V/18Ah.
Thus generating a current from an already running motor that is used for other purposes, thereby utilizing the loss of rotational energy into useful energy for storing energy to use later and even for some household appliances. For reference, a list of appliances is listed below.

TABLE I. APPLIANCES USED IN HOUSEHOLDS

Appliances	Power Rating
Light	50-100W
Fan	50-150 W
Television	150-200 W
Computer,Laptop,Printer	80-200 W
Hair dryer	300 W
Phone Charger	10 W
Air Cooler	80 W
Refrigerator	220 W
Toaster Oven	250-300 W

For example, if the motor runs for 2 hours per day,

- The amount of energy used by motors in one day:
  = 750W * 2hr = 1500Wh =1.5KWh = 1.5 units
- The amount of energy consumed by motors for 1 month r :
  = 1.5 units * 31 days = 46.5 units

After implementing the new energy conservation system,
The output is approximately 400 watts.
Assume we supply the refrigerator with power generated from the loss of motion

- The amount of energy used by motors in one day:
  = 220W * 5hr = 1100Wh = 1.1KWh = 1.1units
- The amount of energy consumed by motors for 1 month :

= 1.1 units * 31 days - 34.1 units

The amount of energy saved is 34.1 units

The EB cost for 1 unit is Rs. 6.50

The amount saved after implementation of this project from overall consumption per month is

= 34.1 units * Rs. 6.50 = Rs. 221.65

The loss of energy is converted into useful power, thereby reducing energy consumption and saving money.

B. Flour Mill system

Flour mill machines are used to process raw grains or food ingredients into flour for different purposes. The motor that is used has a different rating to serve its purpose. The flour mill contains some additional components to which the generated energy is given other than to the normal lights and switch box, such as the grain cleaner, grain elevator, etc.

Motor Rating

(i) Power Rating =11.185 KW

Speed=3000rpm

Frame Size: 63 to 355L

Voltage=415V

Power = Torque * ω ;

Torque = Power / ω ω = (2 * pi * N) / 60

ω = (2 * pi * 3000) / 60 = 314.159

Torque = 11.185 / 314.159 = 35.59 Nm

If we consider efficiency = 60%,

Power Output = 11.185* 0.6 = 6.7 KW

(ii) Power Rating = 10 KW

Speed=2000 rpm

Frame Size: 70 mm

Voltage =180/200 V

ω=(2*pi*2000)/60=209.43

Torque = 10/209.43 =47.7 Nm

By taking efficiency as 60%

Power Output = 10*0.6 = 6 KW

In both cases, the power output is nearly 6 KW. Therefore, the generator with <=6 KW should be connected to get an efficient output. Thus, loads with less than 6 KW rating can get supply from the rotational motion of the motor, and it can charge a battery of more than 100 Ah. For reference, a list of appliances is listed below.

TABLE II. APPLIANCES USED IN FLOUR MILLS

Appliances	Power Rating
Grain cleaners	0.5 to 2KW
Grain Elevators	1 to 3 KW
Packing Machine	1 to 3KW
Centrifugal Fans	0.5 to 1.5KW

Appliances specification

For example, if the motor runs for 8 hours per day,

- The amount of energy used by motors in one day
  = 10 KW * 8 hr = 80 KWh = 80 units.
- The amount of energy consumed by motors for 1 month
  = 80 units * 31 days = 2480 units.

After implementing the new energy conservation system,

The output is approximately 6 KW.

Assume we supply the grain elevator with power generated from the loss of rotational motion.

- The amount of energy used by motors in one day

= 3KW * 10hr = 30KWh = 30 units.

- The amount of energy consumed by motors for 1 month
  = 30 units * 31 days = 930 units.

The amount of energy saved is 930 units
The EB cost for 1 unit is Rs. 6.50
The amount saved after implementation of this project from overall consumption per month is
= 930 units * Rs. 6.50 = Rs. 6045
The loss of energy is converted into useful power, thereby reducing energy consumption and saving money.

C. Agricultural Sump Motor

The Agricultural Sump Motor is designed to pump the water from sump or well for use in agricultural irrigation livestock watering, etc. They have rugged construction that is durable and capable of continuous operation.
Motor rating
Power rating: 5.5 KW
Speed=2880 rpm
Discharge rate = 22–100 LPM
Power = Torque * ω
Torque = Power / ω = (2 * pi * N) / 60
ω = (2 * pi * 2880) / 60 = 301.592
Torque = 5.5/301.592 = 18.23 Nm
Assuming efficiency of 60%
Power Output = 5.5*0.6 =3.3 KW
Thus, the generator with <= 3 KW can be connected to get an efficient output.

TABLE .III APPLIANCES USED IN AGRICULTURAL LAND

Appliances	Power Output
Small equipment like cultivators	2.5KW
Grain Dryers	1 to 3 KW
Lighting	0.5 KW

Appliances specification
Therefore, a generator with <= 3 KW should be connected to get an efficient output. Thus, loads with less than a 3 KW rating can get power from the rotational motion of the motor, which can charge a battery. For reference,a list of appliances is listed above. The generated power can be used to give power to other motors that are used for other applications nearby on agricultural land.
For example, if the motor runs for 8 hours per day,

- The amount of energy used by motors in one day
  = 5.5KW * 8hr = 44KWh = 44 units.
- The amount of energy consumed by motors for 1 month
  = 44 units * 31 days = 1364 units.

After implementing the new energy conservation system,
The output is approximately 6 KW.
Assume we give the refrigerator the power to generate rotational motion, and the loss of rotational motion causes the refrigerator to lose rotational motion.

- The amount of energy used by motors in one day
  = 3KW * 10hr = 30KWh = 30 units.
- The amount of energy consumed by motors for 1 month
  = 30 units * 31 days = 930 units.

The amount of energy saved is 930 units
The EB cost for 1 unit is Rs. 6.50
The amount saved after implementation of this project from overall consumption per month is
= 930 units * Rs. 6.50 = Rs. 6045
The loss of energy is converted into useful power, thereby reducing energy consumption and saving money.

Farmers can get less pay for their power consumption, and they can invest more in agricultural products.

VI. Conclusion

The proposed system demonstrates a remarkable capacity to generate substantial power, suitable for powering devices and charging batteries. Future research will focus on enhancing system efficiency and exploring its applications in diverse fields, including residential buildings, agricultural fields, and flour mills. The amount of generated power depends on motor and generator size and efficiency, as well as the connected load. Moreover, the recovery of energy losses contributes to increased overall efficiency. By harnessing this technology, the rising demand for electricity can be mitigated, resulting in cost-effective solutions with significant benefits for various industries.

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