

Original Research Article

Testing of Animal Powered Electricity Generation Unit for Linear Mode of Operation

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ABSTRACT

Farm mechanization and the utilization of the draught animals, is very important the current time, and they should not burden to the farmers. In this dissertation a machine is tested for utilization of animal power in linear mode of operation of electricity and the main objectives of this dissertation are to generated electricity with the help of animal power in linear mode of operation and store it in the battery for the house hole purpose. Electricity generation by animal power is a novel technology. It has unique future of using animal power as transportation for electric generation. It was feasible to generate the electricity by using draught animal power in linear mode of operation. The system was tested for three times and it was recognized that the speed in the ratio of 1:640 at the input of alternator. The output power to input power ratio i.e. efficiency of the system was found to be 55%.

Keywords

Animal Powered
Electricity
Generation Unit
for Linear Mode of
Operation

Introduction

Energy is a basic requirement of human life, just like in agriculture, industry, transportation, communication. There are two types of energy available which could be use in the form of electricity. First one is the natural energy which is also called renewable energy such as solar, wind, ocean, wave and biomass etc. and the second one is non-renewable energy source which are limited in the nature such as petroleum, coal, wood, hydro and chemical energy sources. Renewable energy is derived from natural processes that are replenished constantly. In developing country man power used in plantation, spraying pesticides, fertilizer & chopping. Animal power used in plugging, water supply & transportation of agricultural products. The power of mechanical energy

is unlimited but increasing the problem of unemployment in our country the use of man & animal power is very necessary. Agricultural operations, transportation, wars, marriages, etc. were dependent on animal husbandry sector mainly on quality bullocks, which are produced by indigenous animals besides milk. Draught animals have been used in agriculture for thousands of years supplying energy for crop production in terms of draught power and organic manure. But due to mechanization in agriculture, the role of animals in crop production became less relevant. But in a country like India where 78% of farmers have less than 2 ha of area for cultivation, the question whether the use of tractors and tillers are economical put forward the importance of draught animals in agriculture. The use of animal power is

inevitable in some conditions like slushy and water logged, hilly and narrow terraced fields, where tractors and tillers are not suitable. Animal drawn vehicle are suitable for rural areas under certain circumstances *viz*, uneven terrain, small loads for small distances where travel time is not important. In spite of high urge for mechanization among farmers, the energy for ploughing two-thirds of the cultivated area and two-thirds of rural transport are coming from animals in India. So the role of animal traction is still proved to be vital for food security and economy of small holder farming systems in India.

Systems which generate such electrical energy are particularly attractive, because of the flexibility of application, cleanliness and storage capability of generated electricity. So renewable energy resources are very useful for use as electricity source in the human life. But it has also some limitations such as installation and maintenance of these systems. One of the ways of utilizing the bullocks power could be for electricity generation in remote villages in hills or plain areas where either the electric supply not regular or erratic to meet out the demand of the house hold for lighting. The average speed draught animal on a circular track is 0.6 m/s for oxen and 0.7 m/s a donkey. The power output by a single bullock is about 0.32 hp of 400 kg body weight. In practice one may expect with a pair of animals an output of 0.3 and 0.6 hp.

Materials and Methods

Materials Used For Development of Machine

Draught Animals

In India bullocks are main draught animals. Bullocks have very good characteristics as

draught animals. The main object is to use the animal power for generating electricity for domestic and agriculture use. Bullocks can walk for 4-5 hours continuously. Bullocks are mainly used in Indian agriculture for different purposes. The weights of bullocks are 456 kg and 478 kg. The mechanical link is fitted with a device pulled by pair of bullocks called *belan* which is made of wood and has the weight of 105 kg.

Modified Chain Sprocket System

This system has two sprockets, one big (diameter of 145mm and 58 numbers of teeth) and one small sprocket (diameter of 80mm and 13 numbers of teeth) and a chain of 1200mm long. This unit gave a speed ratio of 1:17.89 in second stages. Finally gave the speed ratio of 1:598.86 at the input of the alternator due to attach the belt and pulley arrangement.

Mechanical link

Mechanical link of mild steel material having 34mm diameter and 1190 mm length connected to the wheel (710 mm). A frame made of cast iron with dimension of 900mm × 500mm mounted on drive wheel shaft. This frame is connected with two strips on its longitudinal end with length of 330mm. the other end of these strips are connected with the two bamboo pole length of 2710mm and with a shaft base of 1050mm. These bamboos are connecting with the *Jua* (made of wood and mounted on the bullock shoulder).

Speed Increaser

Speed increaser is a one of chain sprocket housed in a frame of mild steel drive shaft and on the frame connected with 1200mm chain. The small one sprocket connected a

shaft (200mm long and diameter of 27mm) which is mounted on an elevation frame with height of 185mm from the main frame. The other end of this shaft is connected with big pulley (diameter of 450mm) which is connected with small pulley (diameter of 15mm) of the alternator. These two pulleys are connected with a belt (800mm). This speed increasing system gives a speed increase in the ratio of 1:640 at the input of the alternator.

Magnetic Alternator

The alternator is a device used to convert mechanical energy into electrical energy. In this experiment, the input pulley is powered by the output shaft of the gear unit with the help of belt and pulley arrangement. The relative motion between magnetic field and armature induces electromotive force which further causes the establishment of electrical potential, i.e. voltage. This alternative current (A.C.) produced is conveyed to output wires with the help of commutator of alternator. The output capacity of the alternator is 1KVA. Single phase, 50 HZ AC alternator was used for this system. In this experimental study we select the car alternator to generate electricity. Lucas-TVS car alternator of 12V and 95 AH is used. Car alternator needs high rpm to work efficiently. It produces constant voltage but current depends on rpm and produce high as rpm is high.

Battery

In this experiment a typical 12V and 40AH, 100AH, 150AH, 180AH, Lead-acid automotive battery is used. An automotive battery is a type of rechargeable battery that supplies electric energy. It shows 12.6 volt at full charge and at fully discharged: 11.8V. Charging time depends on the capacity of that battery and the resting voltage of that

battery when you begin to charge it. If battery is 50% or more full, it takes less time to charge.

Linear Mode Power Transmission Unit

The bullock cart unit (main shaft) has bevel and big chain sprocket to rise the slow moving speed of animals (average 2 rpm) to 25 rpm. The big sprocket is connected with the small sprocket by the chain and it increases the speed of with ratio of 1:16 and this small sprocket was connected with the same shaft of big pulley which was connected with the small pulley of the alternator. Pulley system was increases the speed of the alternator by the means of 1:40. So the final increment of the speed became 1:640.

Instrumentation

Tachometer

Measuring the rotation speed of a shaft.

Digital Multimeter

A multimeter is an electronic measuring instrument that combines several measurement functions in one unit. Digital Multimeter usually displays in digits, but may display a bar of a length proportional to the quantity being measured.

Dynamometer

A device for measuring the torque, force, or power available from a rotating shaft.

Results and Discussion

The experiments were conducted for "Testing of animal powered electricity generation unit for linear mode of operation". This topic mainly deals with the

results of the generation of electricity through alternator by using animal power which was obtained after field testing of the system.

Generation of Electrical Power

The experiment has done for the generation electric power by using of bullock (drought animal) as mechanical power and alternator as a transducer which converted the mechanical power into electrical power in linear mode. In this system, mechanical chain sprocket and pulley arrangement were

used to obtain an overall speed ratio of 1:640. The maximum power was found to be 145 watts at 59 kg.

This was the maximum load the animals could pull with increased symptoms of physiological physical distress. The output power to input power ratio i.e. efficiency of the system was found to be 55%.

Due to the higher ratio of the teeth of the two cranks the speed steps up in the linear power transmission system and so the speed of armature pulley of alternator.

Fig.1 Gear and Pulley of Machine



Fig.2 Magnetic Alternator



Table.1 Variation in torque and rotational speed of output shaft of gearbox with the draft force and speed of bullocks

Bullocks speed (km/h)	Draft (N)	Power (kW)	Torque (N-m)	Rotational speed of shaft (rpm)	Power output (kW)	Efficiency %
0.68	1245	0.20	18	80	0.10	50
1.40	1128	0.32	14	160	0.18	56.25
2.60	976	0.49	10	365	0.31	63.3
2.80	768	0.56	8	400	0.27	48.21
3.00	624	0.53	7	425	0.25	47.3
3.15	524	0.47	5	440	0.22	46.8
3.32	465	0.39	3	460	0.18	46.1
3.40	386	0.31	2	480	0.14	45.1

The rotational speed of alternator increased from 1376 rev./min to 1984 rev/min as the speed of bullocks increased from 2.15 to 3.10 km/h. As speed of bullocks reached at 2.45km/h the alternator gave the 1568 rev/min. and produced 26 V, which was sufficient for charging of two battery of 12 V. But when the armature run at below 1504 rpm the alternator produced about 24V and from this voltage batteries were not charged properly due to drop of voltage in electrical circuit. So, for proper charging of battery, the animal speed must be above the 2.45 km/h.

The system was tested by means of human power for three times and it was recognized that the initial force (torque) to rotate alternator at idle speed was very low. The mechanical link main shaft of the cart was fitted with the first shaft of speed increaser by means of elbo and nut bolt. The speed increaser was fixed into the pit of an elevation frame with height of 185mm from the main frame. The other end of this shaft is connected with big pulley (diameter of 450mm) which is connected with small pulley (diameter of 15mm) of the alternator. These two pulleys are connected with a belt (800mm). This speed increasing system gives a speed increase in the ratio of 1:640 at the input of the alternator. The bullock was harnessed with traditional means.

Experimental result shows that animals take very little time to get their average speed of 0.8 m/s to 1 m/s. But still alternator is not generating current as expected and specified by company due to very quick and abrupt changes in animal speed. Voltage vs. RPM proves to be completely unchanging as expected and alternator generates constant voltage of 12V as specified after reaching ideal speed. State of Charge vs. Charging Time shows that battery takes more time to charge as less as state of charging is low for

charging same amount. Fully charged battery shows 12.6V. Fully charged battery takes the approximately 2 hours and 7 minute to discharge 50% when 6 bulb of 60Watt DC is loaded. Since alternator takes initial current to energize the battery must not be discharge completely. Lighting Time of 6 CFL bulb of 25W AC for different state of discharge is shown in graph. Results shown in the experiments that battery and inverter have more than 80% efficiency as expected.

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