ENGINEERING AND TECHNOLOGY IN INDIA

Volume 6 | Issue 1 | Apr, 2015 | 35-40
e ISSN-2230-9284 | Visit us : *www.researchjournal.co.in*
DOI : 10.15740/HAS/ETI/6.1/35-40

ARTICLE CHRONICLE :
Received : 17.02.2015;
Revised : 10.03.2015;
Accepted : 19.03.2015

RESEARCH PAPER

Evaluation of rotary mode of application of ponies/horses for generation of electricity in Imphal, Manipur

■ **R.K. TIWARI**

ABSTRACT

The animal driven rotary mode system was evaluated to generate electricity for battery charging. The cost economics of electricity generation and storage was worked out. The ponies energy in rotary unit to generate the electricity for battery charging was best utilized with proper work-rest cycle and nutritive feed. The main objective of the establishment of rotary power transmission system was to utilize power of pony during idle period. Fatigue score was found to be increased with duration of work. The physiological responses of the pony *viz.*, pulse rate, respiration rate and rectal temperature increased with duration of work whereas speed of operation decreased. The battery (12 V, 35 Amp.-h) could be fully charged (specific gravity = 1.265) after 6 hours of pony operation following work-rest cycle of half an hour: 1 hour rest. The CFL (8 W, DC) were used for test trial which were glowing brightly. The average speed of pony at no load and loads were 4 and 3 revolutions/min, respectively. The overall body length and girth of pony were 1150 and 1450 mm, respectively. Time of charging was depended on the size of the battery as 35Ah battery required 6 hour for full charging. The alternator started emitting current at 1265 rpm and at this stage the battery started drawing current. Voltage increased and current drawn decreased with the state of charging. The power output reduced with reduction in current drawn. Battery charging was recommended at 50 per cent discharge level. At specific gravity of 1.200 the battery is charged at 50 per cent level and the draught requirement was observed to be 53 kgf which was well within the draught capacity of animals. Thus, it is recommended that battery should be put on charge at 50 per cent discharge level. Below this the draught requirement was observed high. The cost of pony and labour was therefore may be excluded from cost estimation. After excluding the cost of animal and labour the cost of battery charging was worked out as Rs. 9.62 and total cost for charging a battery of 35 Ah was found to be Rs. 57.72.

KEY WORDS : Rotary mode, Battery fatigue work-rest, Rectal

How to cite this Article : Tiwari, R.K. (2015). Evaluation of rotary mode of application of ponies/horses for generation of electricity in Imphal, Manipur. *Engg. & Tech. in India,* **6** (1) : 35-40.

INTRODUCTION

The pony breed is sturdy, sure-footed with a good shoulder, short back, well-developed quarters, strong limbs, and a high-set tail in Manipur. The face is concave with small pointed ears and alert eyes The Manipuri ponies were used for riding, racing and polo game. The height of ponies varid from 1120 to 1320 mm 'Manipuri Ponies' were recognized as one of four recognised breeds of horses found in India, the rest being Kathiawari, Marwari and Bhutia. The population of this pride of Manipuri is decreasing alarmingly, as per the livestock census, 2007, the population of the Manipur pony breed has declined to 1218 (Livestock Census, 2007) against the 1893 ponies as per the Livestock Census, 2003. It is a strong and hardy breed and has very good adaptability to extreme geo-climatic conditions. It is one of the well-known breeds of India and has been claimed as the oldest polo pony The breed is available in 14

different colours *viz.*, Bay, Black, Gray, Mora white, Leiphon white, Sinai White, Stocking, liver chestnut, Roan, light gray, Reddish brown and dark bay. National Research Centre on equines, Bikaner studied on work stress on equines using rotary mode system for single donkey which succeeded to pull the shaft of the rotary mode system and generated electricity for charging the battery (two batteries of 12 V each attached parallel) placed at a distance place from the alternator (24 volt) (Anonymous, 2010). According to Ghosal *et al.* (2012) conducted test trials on use of bullock power for chaffing rice straw with the help of a rotary gear complex, driven by a pair of local non-descript bullocks with combined body weight of 620 kg. The average revolution of the bullocks was 40.6/ 0.5 h. The bullocks walked at an average speed of 1.61 km/ hour. The bullocks generated on an average 0.26 kW of power. The highest fatigue score during the operation was 19, which was below the threshold of fatigue (20).

To increase the annual utilization of draught animals, rotary transmission system was developed for rotary mode application of draught animals, especially during off-seasons with gadgets for electricity generation and agro-processing by Maharana Pratap University of Agriculture and Technology centre of Utilization of Animal Energy, Udaipur in Rajasthan. Gear transmission system is with speed step up of 01:125; further stepping the speed up by pulley-belt combination to the input shaft of the alternator. The generated electricity is stored in battery (17 plate, 12 volt) with back-uptime of 04 h at output load of 250 W (Anonymous, 2008). The bullock (Breed : Ongole) drawn rotary mode system was tested for loads from 180 to 1200 watts for half an hour rest between total 4 working hour trials. The speed of output shaft of gear box varied 200-300 rpm. The physical behavioural responses were observed. The minimum draft value was 34 kg for loading of 180 W and the unit was tested for maximum load of 1200 W delivering 112.50 kg draft (Anonymous, 2012).

The bullock drawn rotary mode system was designed for average pair weight of bullocks of 1100 kg for exerting a pull force of 10 per cent. The gear box was made using EN 8 steel for spur gear (pressure angle of 25 degree) and shaft (length : 130 mm, power transmitted : 1kW). The designed gear box stepped up 2 rpm to a staggering 1800 rpm giving a velocity ratio of 900. The ultimate tensile strength and hardness of gears were 1000 MPa and 350 BHN (Anonymous, 2011).

EXPERIMENTAL PROCEDURE

The Manipuri horses of smaller sizes were practised as riding and pack animals in the hilly tracks. These were generally shorter, thick boned sure footed and rather hairy and could withstand inclement weather conditions for considerable periods. The body weight was computed as per the formula suggested by Dewrst (1975) as given below:

Body weight (kg) : chest girth (cm) × 2.7

College of Agricultural Engineering and Post harvest Technology centre of AICRP on UAE, Ranipool conducted test trials of rotary system using pony (weight : 212 kg) at Andro Farm, CAU, Imphal for battery charging from 50 per cent to fully charging state. The physical body dimensions of pony were measured to estimate body weight. During testing variations in physiological parameters (pulse rate, body temperature and respiration rate) were measured before and after the trials. Due to light weigh and poor physical condition (body weight =212 kg) of the pony it could be operated in rotary unit for half an hour at a stretch after which rest for 1.0 hour was given for next trial run. The battery (12 V, 35 Amp.-h) could be fully charged (specific gravity = 1.265) after 6 hours of pony operation following work-rest cycle of half an hour: 1 hour rest. The CFL (8 W, DC) were used for test trial which were glowing brightly. The average speed of pony at no load and loads were 4 and 3 revolutions/min, respectively. The overall body length and girth of pony were 1150 and 1450 mm, respectively. The average values (s) of variations of respiration rate and pulse rate before and after half an hour of work were 17-28 and 60-68 per minute, respectively. Within half an hour work operation the pony showed symptoms of distress (staggered walking, protruded tongue watering from nostrils and mouth and unwilling to walk).

The alternator (24 V, 2 kW) could not serve the purpose as was initially supplied by the manufacturer and it may be suitable to other stronger draught animals. Therefore, the alternator was replaced with another one (Lucas make, 12 V, 30 Amp-h) matching to the pull developed by the pony (Weight: 212 kg). The pulleys diameter on alternator shaft

and on gear box shaft matching to the system were also replaced for required r.p.m and is resulted for producing current of 3-5 ampere-h corresponding to 13.289-14.912 V. The specific gravity of battery increased from 50 per cent discharging stage (1.200) to fully charging condition (1.265) in total 6 hours of operation. The test was carried out for 04 days at Andro farm. The test trial of rotary unit performed at Andro farm Imphal, Manipur were represented in Fig. A to F.

Fig. A : Rotary unit in operation at Krishi Vigyan Kendra, Andro

Fig. D : Interaction with the HOD, COA, Manipur at Krishi Vigyan Kendra

Fig. B : Measurement of current and voltage of Alternator

Fig. F : Speed measurement using tachometer at pulley

Fig. C : Measurement of pulse rate of pony

Fig. E : Improved harnessing system of ponyfor rotary unit

EXPERIMENTAL FINDINGS AND ANALYSIS

Battery charging parameters were measured for rotary unit operated by pony in field conditions. Battery voltages, current drawn and power requirement at different alternator rpm were measured. The results are in given in Table 1.

It is clear from the Table 1 that alternator started emitting current at 1265 rpm and at this stage the battery started drawing current. It was observed that 35 Ah battery drew 5 amp current at this rpm. A minimum power of 0.2 kW was required even when the battery was not drawing current. Power requirement increased with increase in rpm and current drawn by the battery. It was noticed that once the alternator starts emitting current at 1265 rpm and as the rpm were reduced it continued to emit current up to 836 rpm. Considering above results, further experiment was conducted at 1265 rpm and battery charging parameters were measured at different time interval. One of the key parameters of battery charging was the specific gravity of the electrolyte. Specific gravity was used as an indicator of the sate of charge of cell or battery (Table 2).

The battery parameters and power parameters and power requirement at 1265 alternator rpm are given in Table 3.A 35 Ah battery was used for experiments on battery charging by pony powered rotary transmission system at 1265

Table 1 : Power requirement and output parameters of alternator at different rotational speeds

Sr. No.	Alternator, rpm	35 Ah, 12 volt battery		
		Current, Amp	Voltage, Volts	Power, kW
1.	1076	0	12.75	0.2
2.	1265	5	13.90	0.3
3.	1324	5	14.09	0.4
4.	1423	5	14.11	0.4
5.	1581	4	14.13	0.5
6.	1915	4	14.14	0.6

Table 2 : Specific gravity at different charging condition of battery

State of charge	Specific gravity
100%	1.265
75	1.239
50	1.200
25	1.170
Fully discharged	1.110

Source: Engineers edge: *http:/www.engineersedge.com/battertry/specific gragvitybattery.htm*

Table 3 : Battery charging parameters at 1265 rpm

Duration h	35 Ah battery			
	Amp.	Volts	Sp. Gr.	Power kw
Initial	3	13.30	1.120	0.5
0.5	3.2	13.42	1.138	0.4
1.0	3.0	13.80	1.147	0.4
1.5	2.6	14.10	1.160	0.4
2.0	2.1	14.28	1.176	0.3
2.5	1.5	14.36	1.195	0.3
3.0	1.25	14.43	1.200	0.3
3.5	1.0	14.48	1.215	0.3
4.0	0.85	14.50	1.225	0.3
4.5	0.35	14.53	1.225	0.3
5.0	0.35	14.53	1.230	0.3
5.5	0.20	14.55	1.245	0.3
6.0	0.0	14.55	1.265	0.3

alternator rpm. The physiological parameters such as pulse rate, respiration rate, rectal temperature and speed of operation, draught and battery charging parameters are in given in Table 4.

The draught requirement was 82.2 kgf (21% of body weight) and the respiration rate, pulse rate and rectal temperature of pony increased rapidly only after 30 minutes of work. This draught was within the draught capacity of pony in rotary mode of operation. The pony showed willingness to move and thus for efficient output, rest of 60 minute was given after 30 minutes of work. After rest again it could work only for 30 minutes and rest was provided again. In the third session pony could work for 30 minutes. In the second and third sessions the draught values were 78.3 kg and 70.47 kg, respectively. It was observed that after four sessions of each 30 minutes of work pony could work for 2.0 h as the draught reduced up to al level of 59.4 kgf *i.e* below 15.17 per cent of body weight. To bring the

Table 4 : Physiological observations of pony corresponding to durations of rotary unit

Duration, min	Cumulative duration, h	Draught, kgf	Sp. gravity	Amp	Volts	Physiological parameters			
						RR	PR	RT	Speed
Initial	Initial	-	1.120	-	-	17	28	37.3	-
30 (W)	0.25	82.2	1.120	3	13.30	60	68	37.9	2.7
60 (R)	0.5		-	-	-	22	39	37.4	-
30 (W)	0.75	78.3	1.125	3.2	13.80	62	73	38.0	2.7
60 (R)	1.25	-	-	-	-	26	37	37.5	-
30 (W)	1.75	70.47	1.176	2.9	14.28	65	84	37.9	2.8
60 (R)	2.75	-	-	-	-	29	37	37.5	-
30 (W)	3.25	59.4	1.215	1.8	14.48	73	92	37.9	2.7
60 (R)	4.25	-	-	-	-	27	38	37.4	-

W-Work, R-Rest, RR in Breaths/Min, PR in Beats/Min, RT in °C and speed in km/h

Table 5 : Cost estimation of battery charging by rotary power transmission unit

Particulars	Amount, Rs.
Fixed cost	
Cost of complete rotary power transmission unit with shafts, railing, etc	1,18000
Civil work	7000
Total	1,25,000
Interest	8250
Depreciation	11250
Annual fixed cost (A)	19500
Fixed cost per day	65
Fixed cost Rs./h	8.12
Cost of animal	30000
Interest	600
Depreciation	3000
Total (B)	3600
Fixed cost /h	1.50
Total fixed cost for battery charging/h (A+B), Rs./h	9.62
Variable cost/day	
Feed and fodder	150
Labour	200
Total variable cost Rs./day	350
Total variable cost/h	43.75
Total operating cost (fixed + variable) Rs./h	53.37
Cost of charging a battery	320.22

battery in 100 per cent charging sate it required total 6 hours. At specific gravity of 1.200 the battery is charged at 50 per cent level and the draught requirement was observed to be 53 kgf which is well within the draught capacity of animals. Thus, it is recommended that battery should be put on charge at 50 per cent discharge level. Below this the draught requirement will be high. The operating cost was estimated by assuming 300 working days with 8 working hours per days and the details are given in Table 5.

The cost of battery charging was found to be very high as the variable component of the cost is contributing major cost. The main objective of the establishment of rotary power transmission system is to utilize power of pony during idle period. The cost of pony and labour is therefore may be excluded from cost estimation. After excluding the cost of animal and labour the cost of battery charging comes out to be Rs. 9.62 and total cost for charging a battery of 356 Ah was found to be Rs 57.72.

Conclusion :

- The physiological responses of the pony *viz.*, pulse rate, respiration rate and rectal temperature increased with duration of work whereas, speed of operation decreased with duration of work.
- Fatigue score was found to increase with duration of work.
- Time of charging depends on size of battery as 35Ah battery required 6 hours for 100 per cent charging.
- The alternator started emitting current at 1265 rpm and at this stage the battery started drawing current.
- Voltage increased and current drawn decreased with state of charging.
- The power requirement reduced with deduction in current drawn.

REFERENCES

Anonymous (2008). Agricultural Mechanization and Energy Management. DARE/ICAR Annual Report. 2008-09. 81pp.

Anonymous (2010). Biennial workshop report 2010-12. AICRP on UAE centre, University of Agricultural Sciences, Raichur, Karnataka (India). 94pp.

Anonymous (2011). Biennial workshop report 2009-11. AICRP on UAE centre, AICRP on UAE centre, GBPUAT, Pantnagar, Uttarakhand, 85-86pp.

Anonymous (2012). Biennial report of AICRP on utilization of animal energy, NRC on equines, Bikaner, Rajasthan (India).

Ghosal, M.K., Behera, D. and Mohapatra, A.K. (2012). Sustainable utilization of bullock power for chaffing operation through mechanical gear system. *Animal Sci. Reporter*, **6**(4): 123-130.

AUTHOR FOR CORRESPONDENCE

R.K. Tiwari
AICRP on Utilization of Animal Energy Centre,
Central Institute of Agricultural Engineering,
BHOPAL (M.P.) INDIA
Email: rk96tiwari@gmail.com