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Development And Performance Evaluation Of Nursery Fertilizer Mixer using Human Powered Flywheel Motor as Source of Energy

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Abstract - *Since invention Flywheel motor is being extensively used in various application. Because of increasing range of application flywheel motor is being the subject of interest of the researchers for the optimum use of human energy .Literature survey reveals that a system for pumping energy in flywheel using muscular energy is feasible and the energy stored in flywheel can be used for different applications[1]. In an attempt this paper presents the development and performance of a Human Powered Flywheel Motor (HPFM) operated Nursery Fertilizer Mixer to mix nursery fertilizers in proper proportion which is then used for plantation in small size farming [3].Since this is a man-machine system, it is rather difficult and unreliable to adopt total theoretical approach for the development, thus, the experimental approach is adopted. This set up consists of three subsystems namely. (i) Human powered flywheel motor (HPFM) i.e. energy unit. (ii)Torque amplification gears and clutch unit and (iii) process unit i.e. Nursery Fertilizer Mixer. In this paper an attempt is made to develop and experimentally validate a human powered mixing machine to mix nursery fertilizer in proper proportion*

Key words: Human powered Flywheel Motor, Peddling, Nursery Fertilizer Mixer

1. INTRODUCTION

Agriculture is an economic driven activity aims to produce and increase production to feed the human population. However, the continued exploitation of our natural resources such as land and other resources lead to poor productivity level and future shortage of food supply. Agriculture and environment has a relationship. Agricultural production affects and contributes to climate change. The use of agricultural land contributes to 12% of global greenhouse gas emission The figure will continue to increase due to the increase in the demand of food, farmers are clearing new land resulting in deforestation, tilling of pasture and soil degradation. This activity opens carbon sinks and so releases greenhouse gases (International Trade Center UNCTAD/WTO, 2007). For the agricultural sector, the need to shift into a sustainable farming practices is necessary for food security and to mitigate climate change. Organic land management i.e. use of organic fertilizers may help to stop soil erosion and convert carbon losses into gains (Reganold *et al*.,1987). There are several methods for mixing the various ingredients of fertilizers together. A good system for mixing fertilizers components in a nursery is use of a rotary-type mixer, such as a cement mixer or a drum and paddle type mixer. A shovel could be used to manually stir the media, but it is extremely important that mixtures so formed should be uniform and consistent in quality so that plant growth results are also uniform. However the increasing prices of such mechanized machines in the market is a common problem to small farmers because not everyone could afford to buy farm inputs just to increase productivity . Also there is a huge scarcity of electricity in most of the rural part of india .Because of the socio-economical conditions of farmers in developing countries including India, human muscle power is going to contribute energy requirements for performing many farm activities for the next two decades. Pedalling is the most efficient way of utilizing power from human muscles. Keeping these points into consideration ,human powered brick making machine was first of its kind developed for the manufacturing of bricks (Modak J.P. J.P.1982, 1994, 1997, 1998) [4]. and since then various processes are energized by the human power such as chaff cutter, wood turning, cloth washing, potter‟s wheel, flour mill etc [5]. In an attempt this paper presents the development and performance of a Human Powered Flywheel Motor (HPFM) operated Nursery Fertilizer Mixer to mix nursery fertilizers in proper proportion which is then used for plantation in small size farming. This machine is evolved applying methodology of experimentation proposed by H. Schanck Jr. (1961).

2. SCOPE OF PRESENT RESEARCH:

Scope is to establish design data for low to medium capacity nursery fertilizer mixer energized by human powered flywheel motor. With the help of this design data the specific unit for a low to medium capacity mixer can be designed. The utility of such a mixer will be for a small

farmer for bringing about low cost automation in his farm. Thus end result of this project will be useful (1) Partly as an aid to a low/ medium capacity farmer (2) alternatively to a low profiled entrepreneur who can execute the business of manufacturing ready made nursery fertilizer to be used by small farmer. As the work is ultimately useful for a low profiled farmer in present context of lot many cases of suicide of farmers in India this scientific research effort is likely to be useful in lessening the severity of this socio economic problem

3. MATERIALS AND METHOD

3.1 Human Power

Until about two and half centuries ago, muscle power was the prime source of energy for performing all the physical activities on our earth, and much of this power had been from human muscles. Because of the socio-economic conditions of farmers in several developing countries including India, human muscle power will go on contributing energy requirements for performing many farm activities at least for next two decades. In remote villages in India, where electric power supply is not available and repair and maintenance facilities for internal combustion engines are scarce, human power is still one of the major contributors of energy for production agriculture as well as for post harvest agricultural operations. Human energy has generally been utilized through arms, hands, and back. It was only with the invention of the bicycle, that legs also began to be considered as a means of developing power from human muscles. Maximal power produced with legs is generally limited by adaptations within the oxygen transport system[1]. On the other hand, the capacity for arm exercise is dependent upon the amounts of muscle mass engaged (Shephard, 1967). Owing to these limitations, a person can generate more power (about four times) by pedalling than by hand cranking (Wilson, 1986). Pedal power enables a person to drive devices at the same or higher rate as that achieved by hand cranking, but with far less effort and fatigue. The main use of pedal power in the high-power range (75Wand above) is still for bicycling during exercise training, sports and rehabilitation activities. In the low-power range the major occupational use of pedal power is for transport of people using cycle rickshaw. However, pedal power seems to be potentially advantageous in agriculture, construction and electrical power generation, when electrical or internal combustion engine power is unavailable/expensive. The power levels that a human being can produce through pedalling depend on how strong he/she is and on how long he/she can pedal. If the task to be powered has to continue for hours at a time, 75W mechanical power is generally considered the limit for a larger, healthy non-athlete. A person who is smaller and less well nourished, but not ill, would produce less; the estimate for such a person should probably be 50 W for the same kind of power production over an extended period (Wilson, 1986). Power levels are also directly related to the environment in which the person is doing pedalling. [1]

3.1.Human Powered Flywheel Motor

Because of the wide range of applications, the flywheel motor is being the constant subject of researchers for the performance improvement of the many system through parameter optimization. For this various experimentation is done on the flywheel motor. Alexandrove 1981 stated that to power any machine by human energy, its driving power should be less than 75 watts but if any machine or process requiring more than 75 Watts and if process is intermittent without affecting end product, it can also be operated by human energy with the provision of intermittent energy storing unit such as flywheel [6]. This stored energy is supplied periodically at required rate to process unit. This necessitates the use of flywheel in human energized machines and called as flywheel motor. This machine system comprised of three subsystems; energy unit, mechanical power transmission system and process unit. Energy unit comprised of an arrangement similar to a bicycle, a speed raising gear pair and a flywheel. The flywheel size is 1m diameter, 10 cm width and 2 cm thickness. The flywheel is with 6 armed constructions and each arm is with elliptical cross section. Mechanical transmission comprises of spiral jaw clutch and torque amplification gear pair. The process units is a actual machine use for doing the work . Schematic arrangement of a this system is shown in fig below

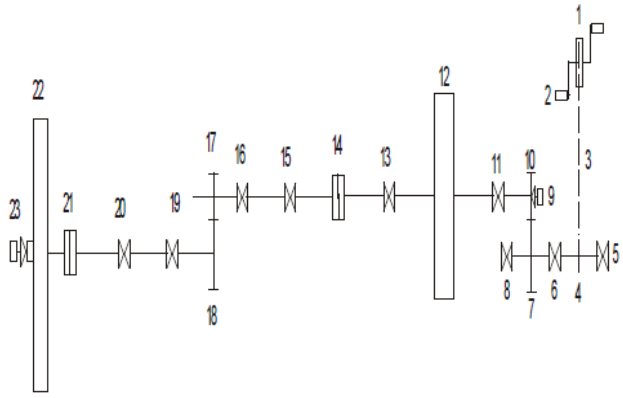
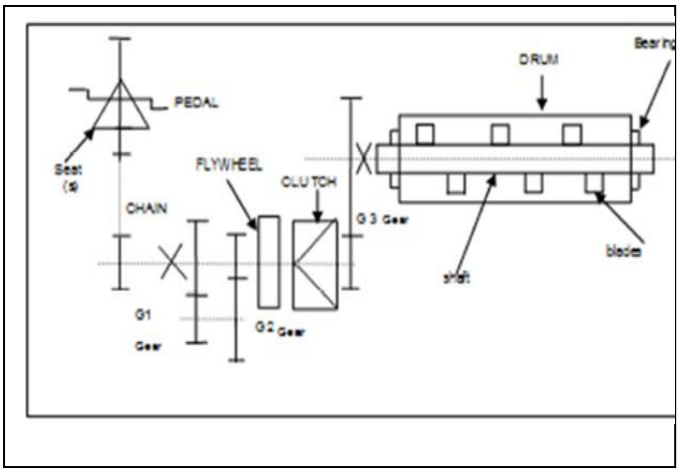


Fig 1. Human powered Flywheel Motor system

1-Chain Sprocket 2-Pedal 3-Chain 4-Freewheel 5,6-Bearings for bicycle side 7-Gear-I 8-Bearing 9-Optocoupler for flywheel shaft 10-Pinion-I 11-Bearing for flywheel shaft 12-Flywheel 13-Bearing for flywheel 14-Two jaw clutch 15,15-Bearing of intermediate shaft 17-Pinion II 18-Gear II 19,20-Bearing for process unit shaft 21-Coupling 22-Mixer 23- Optocoupler for mixer shaft

4.OPERATION OF THE HUMAN POWERD NURSERY FERTILIZETR MIXER

Schematic arrangement of a Nursery shown in fig below.



Developed fertilizer mixer is type of cylindrical drum of 40mm diameter in which a shaft of 35 mm diameter & 900mm in length supported in between two bearing is rotated when it receive the energy from energy unit. Drum has a opening at top to fed ingredients .After mixing material can be taken out from bottom opening. No of rectangular blades are attached to the rotating shafts which are adjustable along its length to change the pitch. In operation various ingredients of the fertilizer viz Soil, Sand, water and Cow dung in required proportion by weight is admitted in the drum through the opening . Then operator seats on the seat(S) and peddles the bicycle mechanism. The rider accelerates the flywheel to a desired speed in about one minute, through a chain and a pair of gears . A free wheel is used between pedals and the flywheel to prevent the back flow of energy from flywheel to pedals. Initially the operator has to put in somewhat more driving torque to overcome the inertia during initial acceleration phase of the motion. Once the steady speed of the motion is reached, the torque input gets reduced. This torque now just balances all the resistances. When flywheel attains desired speed, pedaling is stopped and it is connected to the process unit i.e. Mixer though torque amplification gears by engaging a two jaw spiral clutch. The energy stored in flywheel is supplied at the required rate to nursery fertilizer mixer for mixing ingredients .There is a provision of operating the system at five different speeds by properly choosing the gear ratio of a torque amplification gear pair G3 provided on the shaft of the drum.

5.SELECTION OF INSTRUMENT FOR MEASUREMENT

- Linear measurement- By various caliper, micrometer, scales
- Angular velocities- Angular velocity of cutter shaft and flywheel shaft is to be measured. The slotted opto-couplers were mounted on the shaft. These sensors measure the angular velocity with real time clock. This angular velocity is recorded and stored via micro controller 89C51 RD2 which is connected to personal computer through USB port
- Variation in torque: The variation of torque on cutter shaft will be evaluated on the basis of speed plots of mixer speed verses time.
- Process time: It can be evaluated on the basic of π terms obtained from dimensional analysis

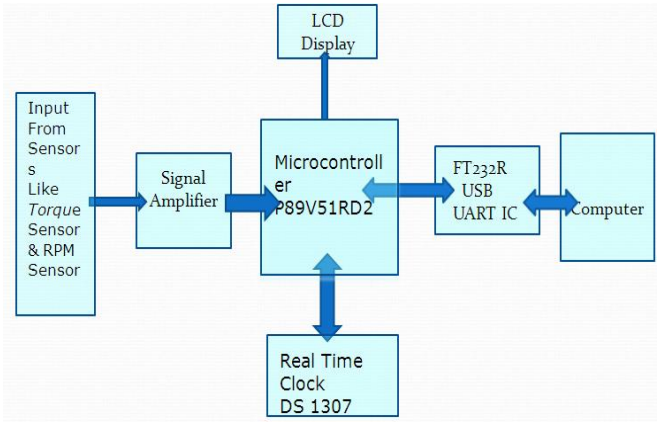


Fig 4. Block Diagram of Instrumentation

6. TEST PROCEDURE

As per the plan of experimentation , various ingredients of fertilizer like Soil, Sand, water and Cow dung are measured in required proportion by weight and admitted in the drum through the opening provide .The (human) input energy given to the flywheel to reach its required speed. As the required speed is obtained, the clutch is engaged to communicate energy from the shaft of the flywheel to the shaft of the process unit. As soon as the energy is transferred, the shaft of the mixer rotated and ingredients get crushed and mixed uniformly. During experimentation process , as per the test plan ,the input and output speed i.e. speed before and after engagement of the clutch , time taken by flywheel to speed up and time taken by the mixer to mix the sample recorded with the help of real time clock integrated circuit DS1307 and microcontroller 89V51RD2. This data is saved in Personal computer by connecting microcontroller through USB connecter. Thus time is recorded at all gear ratio and speed, for various blade tip diameter , and pitch as per the test plan/sequence. Recorded data is converted into the graph which helped to get instantaneous torque on the mixer shaft. Sample set of reading of input/output speed

at various time interval & resistive torque on mixer shaft is shown in table below

Sample reading for			
Blade tip Diameter	Pitch of blade	Gear Ratio	Speed of Flywheel
300	130	0.5	600

Time Interval	Flywheel speed	Flywheel speed	Resistive Torque
5	18.3	0	0
10	42.7	0	0
15	64.9	0	0
20	154.6	0	0
25	211.3	0	0
30	306.1	0	0
35	389	0	0
40	421.2	0	0
45	502.3	0	0
50	606	288	27.96592
55	529.6	251.3	25.97943
60	487.2	231	28.41684
65	401	189.2	23.36101
70	369.3	177	27.19366
75	305.6	144.2	27.45149
80	245.3	117	26.31231
85	199.2	93.6	28.44567
90	133.6	59	28.6408
95	92.2	42.9	21.22176
100	77	34.3	27.82343
105	43	19	29.59601

Table 1.Input/Output speed at various time interval

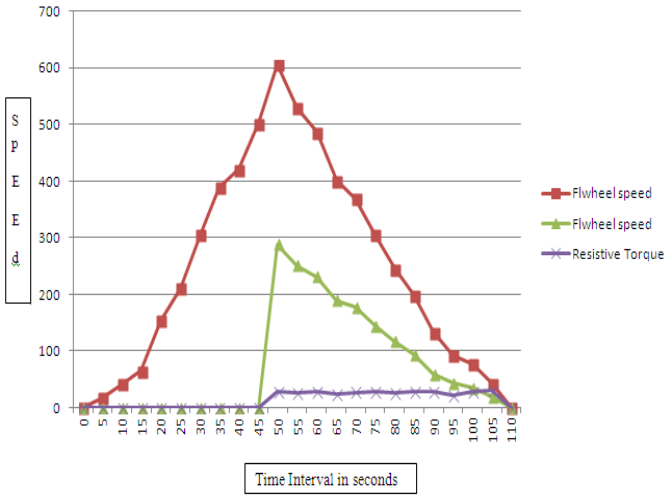


Chart 1. Speed plot Time Vs Speed

7.CONCLUSION

A new theory of mixing of nursery fertilizer from the manually driven nursery fertilizer mixer is proposed. This hypothesis states that on engagement of the clutch, the speed of flywheel suddenly falls indicating energy loss. A part of this energy loss is due to developing pressure due to mixing resistance offered by the ingredients when this pressure in the ingredients crosses yield stress, mixing commences. It is further hypothesized that the mixing time is a function of available energy for mixing, resisting torque and average angular speed of the mixer shaft. In designing the Human energized mixer, the main objective was on cost and ergonomic designed, readily-available materials and we proposed a simplistic design that can deliver productive, efficient, and reliable mixer for rural area. This equipment can adequately replace electric motor-driven fertilizer mixer in rural areas where there is no or limited supply of electricity. From the output result. From the results of experimentation obtained ,empirical models to predict the performance of the manually driven nursery fertilizer mixer to mix various ingredients of nursery fertilizer can be established and optimum values of various parameters can be arrived at on the basis of experiments.

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