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Literature Review Paper on Human Powered Food Grain Crusher

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Abstract –*Powdered food grains are a base of almost all foods in India. In ancient times, food grains are ground with the help of hand grain crushers. Today the electric motor driven grain crushers are used. But today there is a huge scarcity of electricity almost everywhere in India which results in six to twelve hours load shedding. In rural areas the load shedding is done daily from ten to twelve hours which badly affects their daily needs requiring electricity such as food grain crushing, water supply etc. To overcome this, we can replace the electric motor driven process units by manually driven process units such as food grain crusher driven by human powered flywheel motor [1]* i.e. manually driven food grain crusher. Also we all know that hand muscles are weaker than the leg muscle [24] i.e. we can operate the food grain crusher without fatigue and smoothly for a longer period if we replace hand operated food grain crusher by pedal operated food grain crusher.*

Key Words: Process unit, food grain crusher, pedal driven, human powered flywheel motor

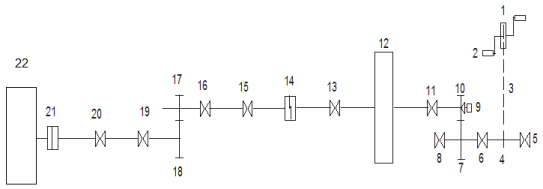
1.INTRODUCTION

The Human powered Flywheel motor comprises of three sub systems namely (i) Energy supply unit(peddling mechanism to supply power or to store energy in flywheel) (ii)Appropriate clutch and transmission and (iii) a process unit.

The complete unit consists of a bicycle mechanism, an appropriate clutch and transmission system and a process unit which could be any process device needing power up to 7 hp. Here it is food grain crusher.

Referring Fig 1.1 The rider sits on the seat and paddles the bicycle mechanism while the clutch is in dis-engaged position. Thus the load on the legs of the rider is only the inertia load of the flywheel. The Flywheel is accelerated to the speed of 800 rpm in minutes time by a young rider of the age group of 20 to 25 physically fit of height about 165 cm. The Flywheel size is 1m rim diameter, 10cm rim width and 2cm rim thickness. Such a Flywheel when energized to the speed of 800 rpm, it stores energy to the extent of 3200 kgf-m. At the end of 1 minute, speed of 800 rpm is reached and so much of energy is stored in a Flywheel. Afterwards the peddling is stopped, clutch is engaged and such a stored energy in the flywheel is communicated to the process unit through the clutch. Obviously the clutch is subjected to sever shock on account of instantaneous momentum transfer. This is so because as the clutches engaged, the Flywheel is subjected to the process load and the process unit consumes shaft energy of the Flywheel. After the clutch engagement, the energy stored in a Flywheel gets exhausted in 5 to 15 seconds for application tried so far (ref [1] to [7],[10],[21]). The capacity of such a system is in the range of 2.5 to 8.5 Hp. The functional feasibility and economic viability of this system has also been confirmed ([1] to [7],[10],[21]).

Schematic arrangement of the complete unit:



1-Chain Sprocket 2-Pedal 3-Chain 4-Freewheel 5,6-Bearings for bicycle side 7-Gear-I 8-Bearing 9-Tachogenerator 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-Food Grain Crusher

Fig -1: Schematic of Human Powered Flywheel Motor

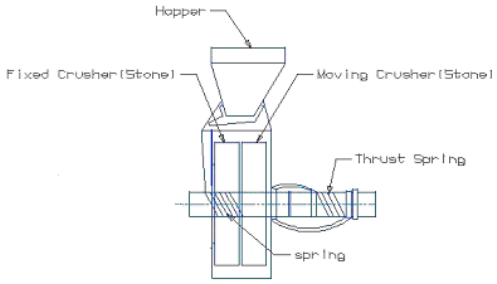


Fig -2: Food Grain Crusher (Process unit)

2. BACKGROUND OF THE PRESENT RESEARCH

Environmental pollution compelled human beings to think of renewable energy resources. In view, this vast research is going on in the field of harnessing human power. R.J. Fuller [21]has argued in his paper about animal power and human power as renewable energy sources. He also argues that human and animal power has significant contribution compared to wind and hydropower in renewable energy sources.

Cori Denison [19] patented human powered device with removable flywheel power unit. As per this patent, the flywheel power unit can be inserted in to desired process unit to power the process.

Almost since 1978, Researcher J. P. Modak and his associates are working on Human powered flywheel motor [1 to 14]. The Human powered Flywheel Motor comprises of three sub system namely (i) Energy supply unit (Pedaling mechanism to supply power or to store energy in a Flywheel), (ii) Appropriate clutch and transmission and (iii) a process unit. (in this case Food Grain Crusher). The complete unit comprises a bicycle mechanism, appropriate clutch and transmission and process unit could be any process device needing power up to 7 Hp.

The concept is applied in past so far for keyed bricks, wood turning, algae formation machine, fodder chopper, oilseed presser [7,10,11,12,13]. etc. and can be looked upon models of those systems as design data for designing such systems.

3. OBJECTIVES OF PROPOSED WORK

The energy sources of such systems are considered as one form of non- conventional energy source. The importance of this source is for the remote and interior area for energizing process unit in the range up to 7 Hp. For this range, large number of process machines is required to be energized [14].

For small farmers, it is necessary to adopt this concept for small agricultural implements. Accordingly it has been adopted for several processes such as keyed bricks, wood turning, algae formation machine, fodder chopper, oilseed presser [7,10,11,12,13]. The suggestions from food grain crusher operators, working in villages and remote areas, to develop such a food grain crusher which will be cheap and independent of conventional energy sources, motivate us. If such a Food Grain Crusher is developed it will be of great help to poor people / people in villages [1], firstly because it does not need conventional energy and it may generate work for one of the family member.

A large area around the vicinity of college is a rural area and almost all rural areas in India are affected by load shedding which greatly hampers the daily needs, growth and development of these rural areas. If the institute focuses its research work on replacing the electricity driven process units by human powered flywheel motor driven process units, then it will be of great help to such rural areas for the overall growth and development. Also it can generate fund for the institute for its self dependence through such research activities.

The basic objective of this work is to generate design data for food grain crusher using human powered flywheel motor by the way of performing extensive experimentation by varying independent variables over widest possible range and gathering the response data generated. Finally the models can be formed as per the data observations obtained from the classical approach of experimentation put forth by H. Schank Jr [25].

4. HUMAN POWER OUTPUT

The maximum power output from a human being occurs in a rowing action because most muscle groups in the body are used. However, these outputs are loosely approached by those obtained from the legs applied to moving pedals. Little advantage appeared to be gained from pedal motions other than simple rotating cranks as on a bicycle and use of cranks gives a fairly smooth rotary motion at speeds of 60-80 rpm. Hand cranking is frequently used but as the arm muscles are smaller than the thighs, power output is reduced. The power output to be expected from normal peddlers are around 0.1HP.This output can be maintained for 60 minutes or more. Higher outputs can be produced for shorter periods. In static applications, the outputs available tend to be lower than those measured from the performance of cyclists because of the effect of winds in reducing body temperature. It may prove advantageous to provide fans for peddlers in static situations to improve output.

5. POWER LEVELS

The power levels that a human being can produce through pedaling depend on how strong the pedaler is and on how long he or she needs to pedal. If the task to be powered will continue for hours at a time, 75 watts mechanical power is generally considered the limit for a larger, healthy non-athlete. A healthy athletic person of the same build might produce up to twice this amount. 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 watts for the same kind of power production over an extended period. The graph in Figure 3 shows various record limits for pedaling under optimum conditions. The meaning of these curves is that any point on a curve indicates the maximum time that the appropriate class of person could maintain the given average power level.

5.1 Pedaling Rate

How fast should a person pedal? Human beings are very adaptable and can produce power over a wide range of pedaling speeds. However, people can produce more power--or the same amount of power for a longer time--if they pedal at a certain rate. This rate varies from person to person depending on their physical condition, but for each individual there is a pedaling speed somewhere between straining and flailing that is the most comfortable, and the most efficient in terms of power production. (For centuries, this fact was apparently not recognized. The predominant method of human power production was to strain with maximum strength against a slowly yielding resistance. This is neither comfortable nor efficient. Neither is the opposite extreme of flailing at full speed against a very small resistance. A simple rule is that most people engaged in delivering power continuously for an hour or more will be most efficient when pedaling in the range of 50 to 70 revolutions per minute (rpm).

See Figure 2. For simplicity's sake, we will use 60 rpm, or one revolution of the pedal crank per second, as an easy reference value for estimates of the gear ratios required to drive a given load.

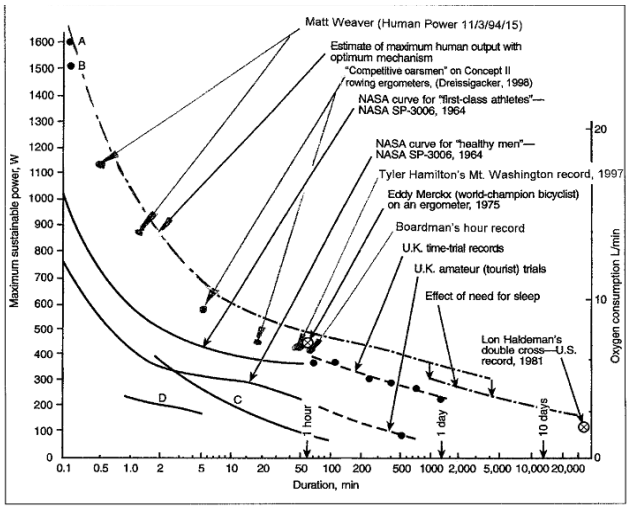


Fig -3: Human Power Output Peddling (From 'Bicycling Science' II Edition,F.R.Whitt,D.G.Wilson,MIT Press)

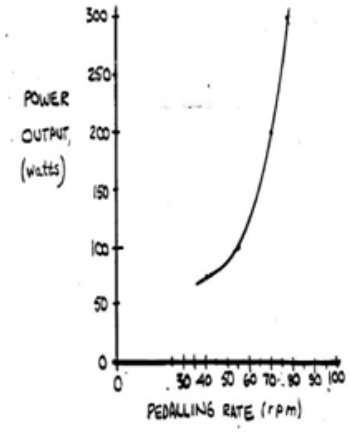


Fig -4: Variation of optimum pedaling rate with desired power output

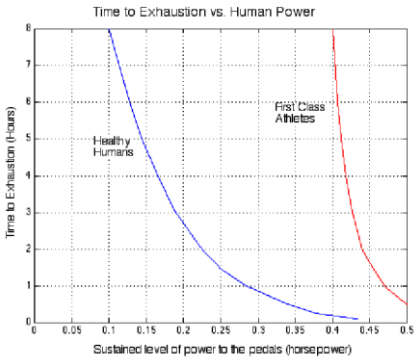


Fig -5: Variation of sustained level of popwer with time to exhaust

6. CONCLUSION

1. A new type of food grain crusher can be fabricated which unlike other crushers will work on non-conventional energy source.
2. Apart from wheat grains, any type of food grains can be crushed using the given food grain crusher.
3. In countries like India where ample human power is available, such human powered man machine systems will help in a great extend to improve the economic condition and employability of such countries in backward or remote areas .
4. Apart from use of such human powered man machine systems, those systems can be used for preparing poultry farm food which makes poultry farms in rural areas independent and such cheap poultry farm food will increase their profit margin.
5. Such systems are of utmost importance in Asian countries as almost all Asian countries are facing electricity scarcity which results in ten to twelve hours load shedding in rural areas.

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