

Human Powered Flywheel Motor Driven Process Units: A Review

Y. M. Sonkhaskar¹, Swapnil S. Asati², Abhinav M. Purohit²

¹Faculty, Dept. of Mech. Engg., Ramdeobaba College of Engg. and Mgmt., Nagpur, Maharashtra, India

²UG Student, Dept. of Mech. Engg. Ramdeobaba College of Engg. and Mgmt., Nagpur, Maharashtra, India

ABSTRACT: In the age of fossil fuels, human power was neglected but hazardous environmental pollution caused by fossil fuels again brought the human power in the main stream of renewable power resources. So in recent past, vast research has been taking place to harness human power for energizing various process units. This review paper reports the various process units energized by Human Powered Flywheel Motor (HPFM), in the literature published between the years 2010 to 2015, to provide an up-to-date scenario of the HPFM driven applications.

KEYWORDS: Human Powered Flywheel Motor (HPFM), manually driven, process unit, wood chipper, stirrup making, nursery fertilizer mixer, utensil making.

I. INTRODUCTION

On an average, the power produced by a man is approximately 75W (0.10hp), if he works continuously. Therefore human power may be used for a process if the power requirement is maximum of 75W. If process power requirement is more than 75W and if the process can be of an intermittent nature without affecting the end product, a machine system can be developed that stores the energy. Generally, a person can generate four times more power by pedaling than by hand-cranking. If a person pedals with his full capacity then continuous pedaling can be done for only short period of about 10min. However pedaling at half power can be sustained for around 60min.

Pedal power enables a person to drive device at same rate as that achieved by hand-cranking but with far less effort & fatigue.

II. LITERATURE REVIEW

1. Fodder Chopper [1]

K. S. Zakiuddin et. al. (2010) developed an experimental data based Artificial Neural Network model for a Human Powered Fodder Chopper. The experimentation had been carried out on a Fodder Chopper energized by human power. In this paper mathematical models had been formulated, validated and optimized. The ANN model was formulated to generate correct values of output parameters corresponding to various values of input parameters. To justify this as a best fit model regression coefficient between observed values and values of response variables computed by ANN was found out. ANN developed can be used to select values of various independent features for designed chaff cutter to match features of machine operator performing chaff cutting task so as to optimize productivity and minimize torque, cutting time. Selecting best possible combinations of input parameters by using ANN can improve productivity of an experimental setup. The schematic arrangement of a fodder chopper machine energized by human powered flywheel motor is shown in figure 1.

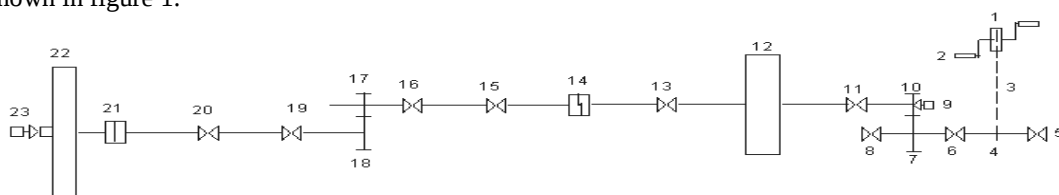


Figure 1: Schematic arrangement of human powered fodder chopper machine

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

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, 15,16- Bearing of intermediate shaft, 17-Pinion II, 18- Gear II, 19,20 -Bearing for process unit shaft, 21-Coupling, 22-Chaff Cutter blade, 23- Tacho generator for chaff Cutter shaft.

2. Oilseed presser [2]

- A. D. Dhale et.al. (2012) had formulated experimental data based model for oil press using HPFM as energy source. An approximate generalized data based model for an oil press was developed by varying independent parameters during the experimentation and the model was optimized. The design data was established for low to medium capacity oil press. All the independent variables were varied over the widest range possible, response data was collected and an analytical relationship was established. The spacing of the test points within the test envelope was selected to have the same precision on every part of the experimental curve map. The choice of test sequence was decided by nature of experimentation i.e. reversible or irreversible. Six independent and three dependent variables were identified for the experimentation. The oil press was designed from the consideration of the dimensions having influence on user's fatigue from ergonomic considerations. The influence of independent π terms was studied by analyzing the indices of various π terms in the models. The model was developed for the investigation of instantaneous load torque and quantity of oil extracted. The ultimate objective was not to develop the model but to find out the best set of variable values, resulting in either maximization or minimization of the objective function. The objective functions found to be were minimization of load torque and maximization of oil extracted. The design data, economic viability, low cost of fabrication and feasibility will help in starting small scale industry. It was observed that the torque falls constantly during the pressing period even if the speed of the presser shaft falls. It was further concluded that the quantity of oil extracted was a function of available energy for pressing, resistance torque and average angular speed of the presser shaft. Figure 2 shows the oil press during the testing process.

B.



Figure 2: Oil press during the testing process

3. Pedal powered multi-purpose machine [3]

S. G. Bahaley et.al. (2012) carried out the performance analysis of pedal powered multipurpose machine. Energy is the most vital aspect in the development of modern technological civilization. The conventional energy sources are being scarce, so alternative energy sources are found which are cheap, easily available and also satisfies the technical requirements. During the last recent work, a human powered multipurpose machine was being developed which lifts water to a height of 10 meter and generates 14 volt, 4 ampere of electricity in most effective way.

It was concluded that, the working of human powered multipurpose machine was quite satisfactory for longer durations of time. At an average head of 6 m, time required for filling a water tank of capacity of 1000 litres was found to be 33.33 min. Also the generator was working satisfactorily by which they charged a battery of 40 Ah within 10 hours, when fully discharged. Power required for pedalling was well below the capacity of an average healthy human being.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

The system was also useful for the workout purpose because pedalling directly act's as a health exercise by providing useful work. Undoubtedly, the system was working properly by satisfying the requirements of a user in terms of domestic & other purposes. Figure 3 shows the actual setup of a pedal powered multipurpose machine.

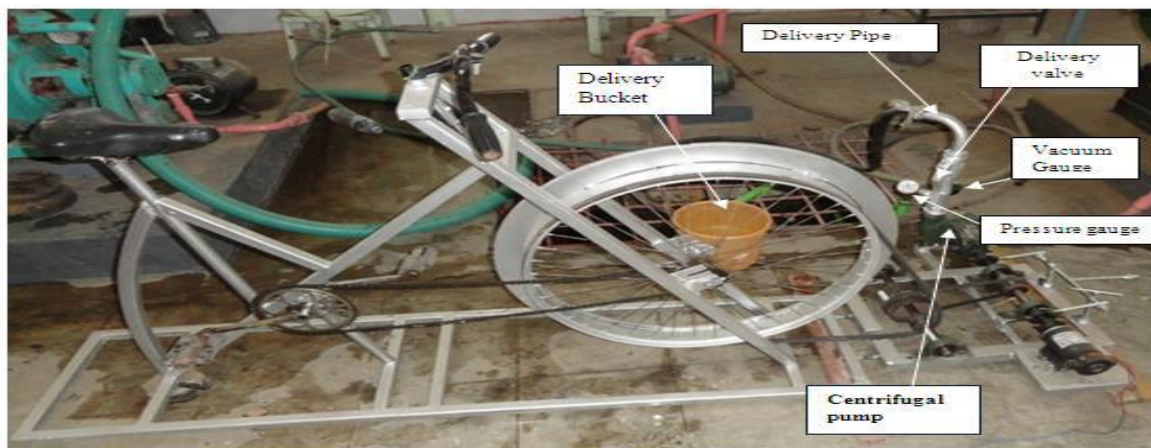


Figure 3: Actual setup of a Pedal Powered Multipurpose Machine

4. Wood Chipper [4]

V. M. Sonde et.al (2013) developed a generalized experimental data based model for wood chipper cutter using human powered flywheel motor. In this paper mathematical model had been developed in compact mode to reduce the time for experimentation generating optimum data. The experimental setup had been designed to measure processing torque, processing time and angular velocity at outlet using specially designed electronic kit. The indices of the mathematical model had been developed using regression analysis and sensitivity analysis.

5. Water distillation device [5]

Umesh Bokade et. al. (2013) have designed & developed a manually energized water distillation device. The designed model converts the dirty/saline water into pure water using the renewable source of energy (i.e. Human power). The energy stored in the flywheel is used to generate electricity by using the generator. This electricity is used for distillation of water in evaporator. The basic mode of the heat transfer involved is convection and the results are obtained by evaporation of the dirty/saline water and fetching it out as pure/drinkable water. The designed model produces 1.5 litres of pure water from 14 litres of dirty water in six hours. The efficiency of plant is 64.37%. It is also found that some of the most efficient & productive ways of operating the system i.e. the input pedalling rate is set in three stages, viz., 30-50 rpm, 50-70 rpm, 70-90 rpm. For 30-50 rpm the distillation rate of water observed was slow and found to be 25 minutes per 100 ml of pure water from 500 ml. of dirty water. Average time that subject can maintain the pedalling is 15 minutes. For 70-80 rpm the distillation rate of water was observed to be maximum.

6. Ice-cream making machine. [6]

R. B. Ramawat et.al. (2014) developed human powered ice-cream making equipment and evaluated its performance. The development of such machine was done to provide a new era in the ice-cream making technique, to design and develop the machine as efficient as possible and simple to build, to have relatively low maintenance, to have a low cost compact human powered machine and to fulfill the earning requirements of small sector businessmen. The total cost of the machine was found out to be Rs.17691. After field testing and performance evaluation of the machine it was concluded that the ice-cream making machine takes 15 minutes to produce 2kg of ice-cream in a steel drum of 30 cm diameter and 40 cm length rotating at 20-400 rpm. The capacity of the equipment was found out to be 8kg/hr. at the end of the research it was concluded that by providing the proposed solution for ice-cream making machine energized by human powered flywheel motor to the small sector businessmen it will definitely empower the approach of ice-cream making in rural areas. Also the model will be developed at a lower cost which will be affordable to the small sector businessmen. The fabricated model of the ice-cream making machine is shown in figure 4.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015



Figure 4: Fabricated model of ice-cream making machine

7. Utensils manufacturing [7]

Mohammed Shakebuddin et.al (2014) developed an experimental data based model for process of manufacturing utensils using HPFM as an energy source. This was carried out to generate data based model for human energized utensils manufacturing unit, to develop a machine which will use human power as an energy source, to provide an alternate source of power generation. The design was proposed to provide an opportunity for human powered system performance improvement. The method used for production of utensils in this experiment was spinning because of low capital investment, low tooling and energy costs, quick and inexpensive adaptation of tooling and methods to accommodate design changes, ability to carry out other operations like beading, profiling etc. in the same setup also any material can be cold formed by metal spinning. Figure 5 shows the human powered flywheel motor utensil making machine.

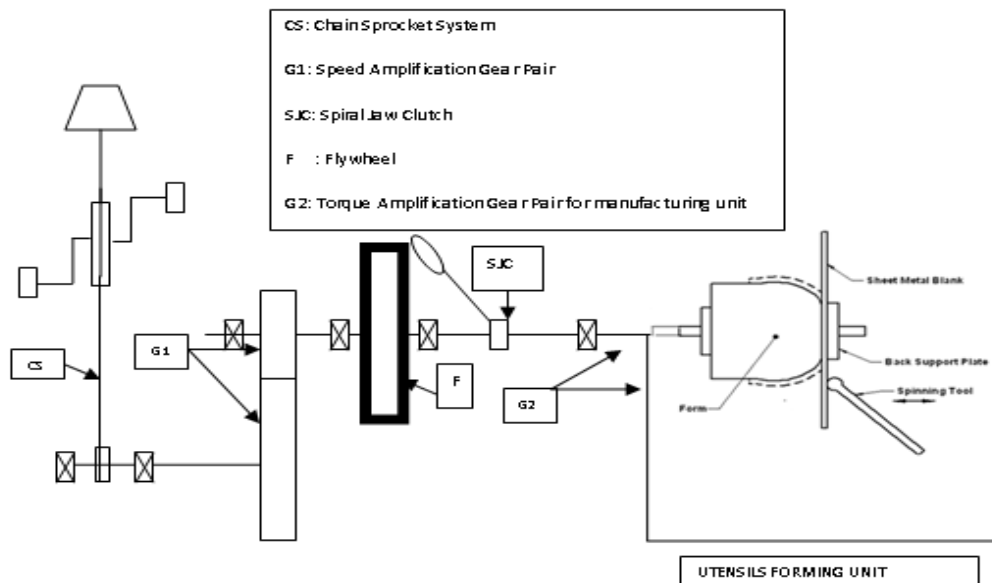


Figure 5: Human powered flywheel motor utensil making machine

8. Stirrup making machine [8]

Subhash N. Waghmare et.al (2014) had designed & developed the Stirrup making machine energized by HPFM. This set-up is used to bend the round bar. Stirrup is one of the essential element of reinforce cement concrete in civil construction. The stirrups are used for strengthening columns and beams, avoiding buckling of long slender column and avoiding sagging of horizontal beam. Traditionally stirrups are made on a wooden platform provided with pins and the rod is bent with the help of a lever. The force is applied on lever and the pin works as fulcrum point for bending the

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

rod. The present manual stirrup making activity indicates that the process suffers from various draw back like lack of accuracy and due to repetitive motion of hands; man is subject to internal injury to his body organs like carpal tunnel syndrome, spondylitis, musculo-skeletal disorder, etc. keeping these things in mind, they have designed and developed a machine for stirrup making by human power. Figure 6 shows the fabricated set up of stirrup making machine.



Figure 6: Fabricated set up for stirrup making machine

9. Nursery fertilizer mixer [9]

H.S. Bhatkulkar et.al (2015) developed and evaluated the performance of nursery fertilizer mixer using HPFM as source of energy. The paper presents the development, performance and experimental validation of a HPFM operated nursery fertilizer mixer to mix nursery fertilizers in proper proportion which is then used for plantation in small size farming. The machine was developed to establish data for low to medium capacity nursery fertilizer mixer energized by human power, to be partly useful as an aid to low/medium capacity farmer and to be an alternative to small scale businessmen to execute readymade nursery fertilizer business. The researchers concluded that, the mixing time is a function of available energy for mixing, resisting torque and average angular speed of the mixer shaft. From the results of experimentation, empirical models to predict the performance of the equipment was established and optimum values of various parameters were also derived.

10. Washing machine [10]

G. Bhatawadekar et.al (2015) designed and fabricated the pedal powered washing machine. This was undertaken to overcome the problem of electric supply in rural areas by setting up a manually operated washing machine incorporated with a simple cycling mechanism to run the washing machine. A washing machine is a machine designed to wash laundry such as clothing, towels & sheets. All washing machine work's by using the combination of mechanical energy, thermal energy and chemical energy. Mechanical energy was imparted to the clothes load by the rotation of the agitator (rotor) in top loader type of washing machine or by the tumbling action of the drum in front loader type. Thermal energy was supplied by the temperature of wash bath. The spin speed in this machine varied from 500 to 1600 rpm. Top and front views of the setup are shown in figure 7.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 11, November 2015

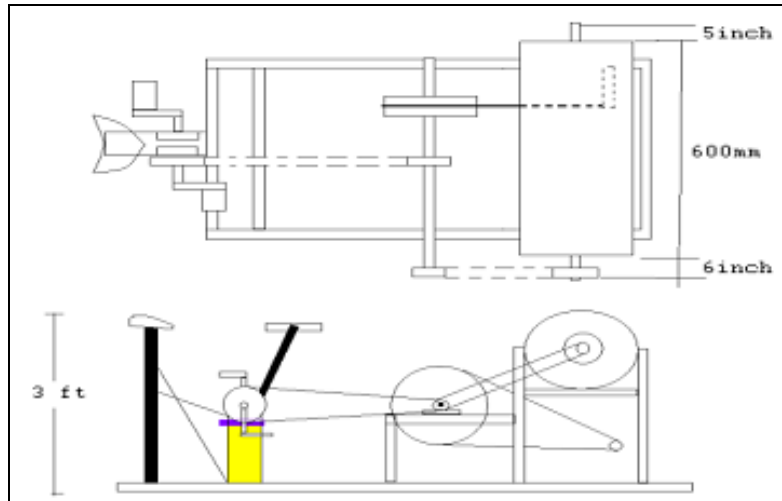


Figure 7: Experimental setup showing top view & front view

III.CONCLUSION

This paper discusses the applications of human powered flywheel motor driven process units such as fodder chopper, oil press, multi-purpose machine, wood chipper cutter, water distillation device, ice-cream making machine, utensils making machine, stirrup making machine, nursery fertilizer mixer and washing machine. Human powered flywheel motor is a promising energy source which can be used to energize various others process units requiring energy from 2-7hp. The above process units can be used in urban as well as majorly in rural areas.

REFERENCES

- [1] Zakiuddin K.S, Modak J.P. "Formulation of data based ANN model for the human powered fodder chopper", Vol. 15, No. 02, Journal of theoretical and applied information technology,79-85, 2010.
- [2] Dhale A.D, Modak J.P, "Formulation of Experimental Data Based model For oil press using human powered flywheel motor as energy source", AgricEngInt: CIGR Journal Vol. 14, No.3, 218-229, 2012
- [3] Bahale S.G, Awate A.U, Saharkar S.V, "Performance Analysis of Pedal Powered Multipurpose Machine" International Journal of Engineering Research & Technology (IJERT), Vol. 1, Issue 5, 1- 6, 2012.
- [4] Sonde M.V, Belkhonde P.N, Waghmare S.N, Undirwade S.K.: "An Experimental Approach to Formulate an Approximate Generalized Experimental Data Based Model for Wood Chipper Cutter Energized By HPFM", Vol 1, No. 02 International Journal of Recent Trends in Mechanical Engineering (IJRTME), 17-25 2013.
- [5] Bokade U, Zakiuddin S.K, Mehta G.D, "Design and Development of Manually Energized Water Distillation Device", International Journal of Mechanical Engineering and Robotics Research, Vol. 2, No. 1, 263-268, 2013
- [6] Ramawat R.B, Khope P.B, Choudhary P.S. "Design and Performance Evaluation of Pedal Operated Ice-cream Making Machine", Vol. 3 No. 4 International Journal of Engineering Research & Technology (IJERT), 1780-1783, April – 2014.
- [7] Shakebuddin.M, Khandelwal K.K, Langde A.M, Hussain H., "Experimental Data Based Model for Process of Manufacturing Utensils Using Human Powered Flywheel Motor as an Energy Source", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, 14-16, 2014.
- [8] Waghmare S.N, Sakhalde C.N, Singh M.P, "Design, Development and Fabrication of Stirrup Making Machine Energized by Human Powered Flywheel Motor", International Conference on Multidisciplinary Research & Practice, Vol. I, Issue VIII, 532-536, 2014
- [9] Bhatkulkar H.S, Modak J.P. "Development and Performance Evaluation of Nursery Fertilizer Mixer using Human Powered Flywheel Motor as Source of Energy", Volume: 02 Issue: 03, International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395 -0056, 793-797, 2015
- [10] Bhatawadekar G, Salman B, Chiplunkar N, Devrukhakar S, Singh A, "Design and Fabrication of Pedal Powered Washing Machine", International Journal of Engineering Research and General Science Volume 3, Issue 1, 1307-1311, 2015