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# DESIGN AND DEVELOPMENT OF THE HUMAN ENERGIZED OIL EXPELLER

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**Abstract: -** The pedal powered flywheel motor has been adopted for many designs of rural applications in the last two decades. In the recent past a pedal powered process machine has been developed for brick making, chaff cutter, water pump, blender, wood turning, clothes washing and drying and earthen pot making etc . The machine consist of human powered flywheel motor using a bicycle drive mechanism with speed increasing gearing and a flywheel, which drive the process unit through a spiral jaw clutch and torque increasing gearing [Gupta, J. K 1997]. The operator puts energy into the flywheel at a convenient power level for about one minute. After enough energy is stored, pedaling is stopped and the energy in the flywheel is made available to the process unit. Pedal power is the transfer of energy from a human source through the use of a foot pedal and crank system. Pedal powered machines could be a valuable backup solution to intermittent renewable energy sources like solar and wind. Human power is available 24 hours per day, is not affected by changes in the weather, is portable and can easily be stored for later use. This paper discusses about the simplistic design and development of pedal energized oil expeller machine. 'Human-scale' technology involved in these applications could be of great benefit to developing countries.

**Keywords:** Flywheel, Spiral Jaw clutch, Oil Expeller

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## INTRODUCTION

India is one of the largest producers of oil seeds in the world and Maharashtra is one of the major oil seed producing and edible oil producing state in India [3]. The oil expeller can produce oils extracted from a number of fruits, nuts and seeds for use in cooking and soap making or as an ingredient in other foods such as baked or fried goods. Extraction of oil from oil-bearing products could be done in two major ways a) Traditional Method b) Improved Methods. The traditional method is usually a manual process and involves preliminary processing and hand pressing. The improved method consists of chemical extraction and mechanical extrusion. Traditional oil expellers are simple mechanical devices that are hand/animal operated. Chemical extraction requires more capital expenditure, and refining the oil before use. There is also possibilities of toxicity from the solvent used and danger of fire explosion from the use of volatile organic solvent [4]. Although processing of oil-seeds, nuts, and fruits for oil production is achieved by mechanical extrusion method but the modern equipment and spare parts, degree of complexity of the equipment, maintenance, and the availability of power source constitute other major setbacks occur into it. Here the purpose of this research is to design and manufacture a suitable oil expeller's machine for all kind of seeds, energized by human powered flywheel motor as an energy source and consisting of a tandem drive mechanism for small scale industry.

## 2. Need For Manually Energized Oil Expeller:

The main objective to design and develop a machine, which uses the human powered flywheel motor as an energy source [5]; Human power is one such form of renewable energy that has been used historically to varying degrees but it was neglected during the periods when there was rapid use of fossil fuels. But due to very high prices of fossil fuels and hazardous environmental pollution from them, the human power again came in light as renewable energy source. In the context of the present condition in India and third world countries the Power shortage and exhaustion of coal, fuel reserves and unemployment, it is felt that "Manually energized oil expeller machine" for oil extrusion is very necessary. Traditional technologies usually have the advantage of requiring low investment but are labor intensive and time consuming. Some oil expellers is also operated by hand that causes strain to the body parts due to incorrect ergonomic posture, which will be eliminated by using this machine and mechanism. This machine is environment friendly i.e. non pollutant. It will bring Innovation & mechanization in agricultural engineering. Encourage rural development as wealth and self-employment jobs are generated in villages. Development of such an energy source which has tremendous utility in energizing many rural based process machines in places where reliability of availability of electric energy is much low also encourage animal husbandry by making oilcake available as best cattle feed. It increases milk production considerably.

**3. Concept of Manually Energized Oil Expeller.**

The average work rate of a man working continuously is equivalent to 0.13hp [6] .Therefore only continuous manufacturing process requiring less than 0.13 hp can be man powered. Any manufacturing process requiring more than 0.13 hp and which can be operated intermittently without affecting end product can also be human powered. Such human powered manufacturing process can be based on the following concept. In this processes a flywheel is used as a source of power. Manpower is used to energize the flywheel at an energy input rate, which is convenient for a man. After maximum possible energy is stored in flywheel it is supplied through suitable clutch and gearing system to a shaft, which operates process unit [7]; The flywheel will decelerate at a rate depends on load torque. Larger the resisting torque larger will be the deceleration. Thus theoretical a load torque of even infinite magnitude could be overturn by this man flywheel system. Oil Expeller Powered by Human Powered Flywheel Motor operates on the basic of above principle.

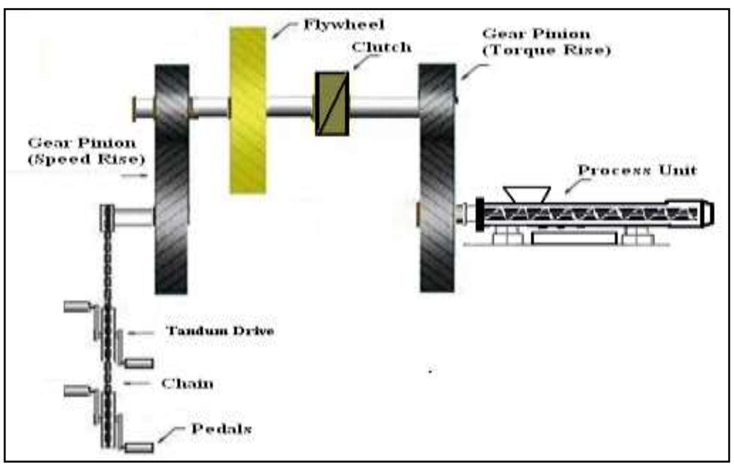


**Figure No.1 Concept of Human Powered Oil Expeller**

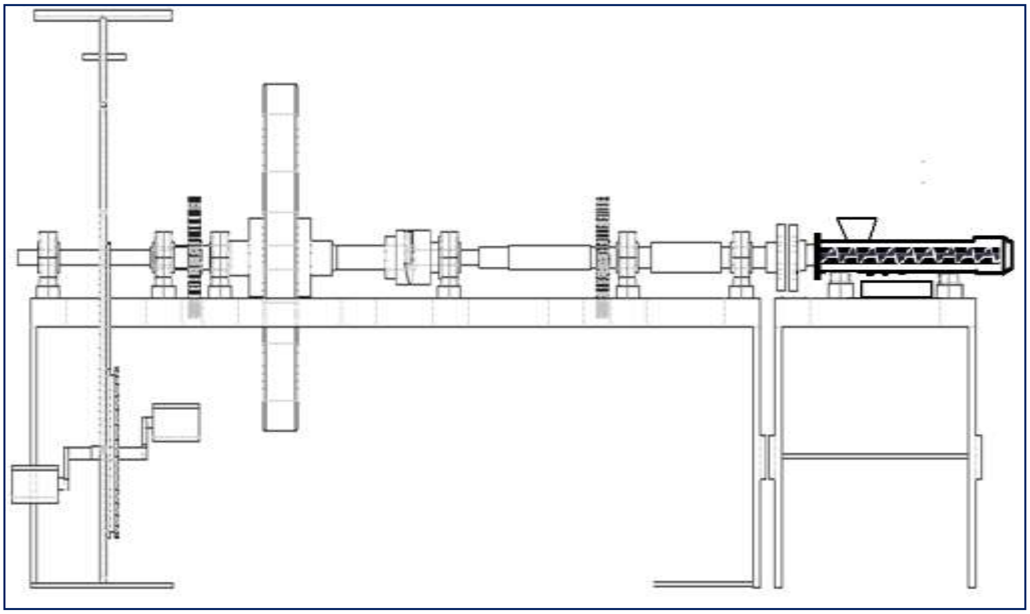

**Figure No.2 Oil Expeller Powered By Human Powered Flywheel Motor.**

**4. Working**

Essentially, the machine consists of three sub-systems: (1) the energy unit (2) transmission mechanism (3) the processing unit. The energy unit consists of a conventional bicycle mechanism, the transmission unit consists of a drive train; a chain drive mechanism running over a pair of speed-increasing gears and the process unit. The schematic arrangement of a human energized oil expeller machine is shown in Figure 1& 2.

The energy unit consists of a bicycle mechanism, a pair of speed-increasing gears G1 and a flywheel. The transmission consists of a spiral jaw clutch and the torque amplification gear pair G2. The suggested machine system uses human energy achieved by pedaling and stores this energy in a flywheel at an energy-input rate convenient to the peddler. After storing the maximum possible energy in the flywheel (pedaling time could be 1-2 minutes) the same can be made available for the actuation of any process unit (Extruder Unit) by making available the energy stored in the flywheel through a suitable clutch and torque-amplification if needed. Thus the flywheel will decelerate depending on the actual resisting torque offered by the process. It implies that the peddler does not pedal while the flywheel is supplying energy to the process unit. Upon engagement of the clutch there is a rapid transfer of momentum and kinetic energy between the energy unit and the process unit .The process unit input shaft is thus instantaneously accelerated and, after reaching the maximum speed, is subjected to deceleration. This deceleration is induced by the resistance offered on account of oil expellers.

The process unit consists of the gear pair G2 which is connected to the convener. The process unit consists of the gear pair G2 which is connected to power screw (i.e. screw shape tool used for crushing and squeezing of seeds). Because of which the power screw rotate in the drum and provide crushing and squeezing action take place.

**5. Dimensional Analysis.**

Dimensional analysis is the method of dimensions. [8] It is a mathematical technique used in research work for design and for conducting model tests. It deals with the dimensions of the physical quantities involved in the phenomenon. All physical values are measured by comparison, which is made fixed to an arbitrarily fixed value. Dimensional analysis can be used primarily as experimental tool to combine many experimental variables into one. The main purpose of this technique of is making experimentation shorter without the loss of control. Applying Releigh's method the dimensional equation for Extrusion Processing Time, Resistive Torque, Quantity of Oil Yield, and Speed of Extruder Shaft are formulated. [9]

**Table 1: Identification of Variables for Oil Expeller.**

| Sr. No. | Description | Symbols | Unit | $M^0L^0T^0$ | Dependent /Independent |
|---|---|---|---|---|---|
| 1 | Extrusion Processing time | $T_p$ | sec | T | Dependent |
| 2 | Resistive Torque | $T_r$ | N-mm | $ML^2T^{-2}$ | Dependent |
| 3 | Quantity of Oil Yield | $Q_y$ | kg | M | Dependent |
| 4 | Speed of extruder shaft during the process | $\omega_e$ | rad/ sec | $T^{-1}$ | Dependent |
| 5 | Minor dia. of power screw | $d_m$ | mm | L | Independent |
| 6 | Major dia. of power screw | $D_{m.}$ | mm | L | Independent |
| 7 | Length of power screw | $L_s$ | mm | L | Independent |
| 8 | Length of Barrel | $L_b$ | mm | L | Independent |
| 9 | Diameter of Barrel | $D_b$ | mm | L | Independent |

| | | | | | |
|---|---|---|---|---|---|
| **10** | Pitch of Helix | P | mm | L | Independent |
| **11** | Thickness of screw | $t_s$ | mm | L | Independent |
| **12** | Helix angle | Θ | Degree | $M^0L^0T^0$ | Independent |
| **13** | Average diameter of oil seed | $D_s$ | mm | L | Independent |
| **14** | Volume of the hopper | $V_h$ | $mm^3$ | $L^3$ | Independent |
| **15** | Young modulus of elasticity of Material (seeds) | $E_s$ | $N/mm^2$ | $ML^{-1}T^{-2}$ | Independent |
| **16** | Young modulus of elasticity of power screw shaft | $E_p$ | $N/mm^2$ | $ML^{-1}T^{-2}$ | Independent |
| **17** | Quantity of seeds admitted | $Q_s$ | kg | M | Independent |
| **18** | Kinetic Energy of flywheel | $K_f$ | N-mm | $ML^2T^{-2}$ | Independent |
| **19** | Angular speed of flywheel | $\omega_f$ | rad/ sec | $T^{-1}$ | Independent |
| **20** | Acceleration due to gravity | g | $mm/sec^2$ | $LT^{-2}$ | Independent |
| **21** | No. of screw shaft | *n* | | $M^0L^0T^0$ | Independent |
| **22** | Gear ratio | G | | $M^0L^0T^0$ | Independent |
| **23** | Time required to speed up the flywheel | $t_f$ | Sec | T | Independent |

M, L and T are the symbols for mass, length and time respectively. Applying Buckingham π theorem the dimensional equations for Extrusion Processing Time, Resistive Torque, Quantity of Oil Yield and Speed of Extruder Shaft during the process are formulated as under [10].

**Extrusion Processing Time ($T_p$)**

$$T_p\sqrt{\frac{g}{D_s}} = f_1\left\{\left(\frac{d_m}{D_s}\right)\left(\frac{D_m}{D_s}\right)\left(\frac{L_s}{D_s}\right)\left(\frac{L_b}{D_s}\right)\left(\frac{D_b}{D_s}\right)\left(\frac{P}{D_s}\right)\left(\frac{t_s}{D_s}\right)(\Theta)\left(\frac{V_h}{D_s^3}\right)\left(\frac{E_s}{E_p}\right)\left(\frac{g.Q_m}{E_p.D_s^2}\right)\left(\frac{K_f}{E_p.D_s^3}\right)\left(\omega_f\sqrt{\frac{D_s}{g}}\right)(n)(G)\left(t_f\sqrt{\frac{g}{D_s}}\right)\right\}$$

$$T_p\sqrt{\frac{g}{D_s}} = f_1\left\{\left[\left(\frac{d_m.D_m.L_S.L_b.D_b.P.t_s}{D_s^7}\right)\theta\right]\left(\frac{V_h}{D_s^3}\right)\left(\frac{E_s}{E_p}\right)\left(\frac{g.Q_m}{E_p.D_s^2}\right)\left(\frac{K_f}{E_p.D_s^3}\right)\left(\omega_f\sqrt{\frac{D_s}{g}}\right)(n)(G)\left(t_f\sqrt{\frac{g}{D_s}}\right)\right\}$$
..(5.21)

**Resistive Torque ($T_r$)**

$$\frac{T_r}{E_p.D_s^3} = f_1\left\{\left(\frac{d_m}{D_s}\right)\left(\frac{D_m}{D_s}\right)\left(\frac{L_s}{D_s}\right)\left(\frac{L_b}{D_s}\right)\left(\frac{D_b}{D_s}\right)\left(\frac{P}{D_s}\right)\left(\frac{t_s}{D_s}\right)(\Theta)\left(\frac{V_h}{D_s^3}\right)\left(\frac{E_s}{E_p}\right)\left(\frac{g.Q_m}{E_p.D_s^2}\right)\left(\frac{K_f}{E_p.D_s^3}\right)\left(\omega_f\sqrt{\frac{D_s}{g}}\right)(n)(G)\left(t_f\sqrt{\frac{g}{D_s}}\right)\right\}$$

$$\frac{T_r}{E_p.D_s^3} = f_1\left\{\left[\left(\frac{d_m.D_m.L_S.L_b.D_b.P.t_s}{D_s^7}\right)\theta\right]\left(\frac{V_h}{D_s^3}\right)\left(\frac{E_s}{E_p}\right)\left(\frac{g.Q_m}{E_p.D_s^2}\right)\left(\frac{K_f}{E_p.D_s^3}\right)\left(\omega_f\sqrt{\frac{D_s}{g}}\right)(n)(G)\left(t_f\sqrt{\frac{g}{D_s}}\right)\right\}$$
..(5.22)

**Quantity of Oil Yield ($Q_y$)**

$$\frac{g.Q_y}{E_p.D_s^2} = f_1\left\{\left(\frac{d_m}{D_s}\right)\left(\frac{D_m}{D_s}\right)\left(\frac{L_s}{D_s}\right)\left(\frac{L_b}{D_s}\right)\left(\frac{D_b}{D_s}\right)\left(\frac{P}{D_s}\right)\left(\frac{t_s}{D_s}\right)(\Theta)\left(\frac{V_h}{D_s^3}\right)\left(\frac{E_s}{E_p}\right)\left(\frac{g.Q_m}{E_p.D_s^2}\right)\left(\frac{K_f}{E_p.D_s^3}\right)\left(\omega_f\sqrt{\frac{D_s}{g}}\right)(n)(G)\left(t_f\sqrt{\frac{g}{D_s}}\right)\right\}$$

$$\frac{g.Q_y}{E_p.D_s^2} = f_1\left\{\left[\left(\frac{d_m.D_m.L_S.L_b.D_b.P.t_s}{D_s^7}\right)\theta\right]\left(\frac{V_h}{D_s^3}\right)\left(\frac{E_s}{E_p}\right)\left(\frac{g.Q_m}{E_p.D_s^2}\right)\left(\frac{K_f}{E_p.D_s^3}\right)\left(\omega_f\sqrt{\frac{D_s}{g}}\right)(n)(G)\left(t_f\sqrt{\frac{g}{D_s}}\right)\right\}$$
..(5.23)

**Speed of extruder during the process ($\omega_e$)**

$$\omega_e\sqrt{\frac{D_s}{g}} = f_1\left\{\left(\frac{d_m}{D_s}\right)\left(\frac{D_m}{D_s}\right)\left(\frac{L_S}{D_s}\right)\left(\frac{L_b}{D_s}\right)\left(\frac{D_b}{D_s}\right)\left(\frac{P}{D_s}\right)\left(\frac{t_s}{D_s}\right)(\Theta)\left(\frac{V_h}{{D_s}^3}\right)\left(\frac{E_s}{E_p}\right)\left(\frac{g.Q_m}{E_p.{D_s}^2}\right)\left(\frac{K_f}{E_p.{D_s}^3}\right)\left(\omega_f\sqrt{\frac{D_s}{g}}\right)(n)(G)\left(t_f\sqrt{\frac{g}{D_s}}\right)\right\}$$

$$\omega_e\sqrt{\frac{D_s}{g}} = f_1\left\{\left[\left(\frac{d_m.D_m.L_S.L_b.D_b.P.t_s}{{D_s}^7}\right)\theta\right]\left(\frac{V_h}{{D_s}^3}\right)\left(\frac{E_s}{E_p}\right)\left(\frac{g.Q_m}{E_p.{D_s}^2}\right)\left(\frac{K_f}{E_p.{D_s}^3}\right)\left(\omega_f\sqrt{\frac{D_s}{g}}\right)(n)(G)\left(t_f\sqrt{\frac{g}{D_s}}\right)\right\}$$
..(5.24)

## 6. RESULT AND DISCUSSIONS

Empirical models to predict the performance of the manually driven oil expeller machine to extrude the oil were established and optimum values of various parameters were arrived at on the basis of experiments involving the human energized oil expeller machine system. A new theory of oil expeller powered by human powered flywheel motor is proposed. Extrusion Processing time ($T_p$), Resistive Torque ($T_r$), Quantity of oil yield ($Q_y$), Speed of extruder during the process ($\omega_e$) are the function of all independent parameters.

This Flywheel motor is applied to brick making, low head water pumping and wood turning the performance is found to be functionally satisfactory and economically viable the wheel motor can be used as an energy source for process unit that need have continuous operation and have a upper limit of about 3h.p.

The pedal energized oil expeller machine was developed. The development of the Oil Expeller we can say that the design must be efficient and low in cost. The efficient use of human muscle power through pedal drive systems constitutes a useful alternative to other power sources for oil extrusion process. Future consideration of the 'human-scale' technology involved in these applications could be of great benefit to developing countries.

In designing the pedal powered oil expeller, the focus was on cheap, readily-available materials and we proposed a simplistic design that can deliver productive, efficient. This development will increase the productivity as well as efficient of the small medium business providing by self-employment jobs.

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