Design and Fabrication of Multipurpose Pedal Operated Crusher Machine

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Abstract— Our main objective is to grind the chili and convert it into chili powder using manual power. The project starts with the chain and sprocket mechanism. Bicycle is provided to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a rod. The pinion gear in sprocket mechanism provides the rotary motion to rod. This rod incorporates a spur gear of 110 teeth connected with pinion gear of 20 teeth to provide the maximum rotary motion to another rod. This gives rotation motion to fly wheel of approx. 10kg. According to law of motion the fly wheel will rotates with high speed comparatively the force provided to sprocket mechanism because the weight and momentum of the fly wheel is more. This rod ends with the clutch for the transmission of power (and therefore usually motion) from one component (the driving member) to another (the driven member) when engaged, but can be disengaged. This clutch when engaged provides motion to another pinion gear which is in contact with spur gear. The rod connected with the spur gear provides rotary motion to cams which is a mechanical linkage used especially in transforming rotary motion into linear motion or vice-versa. It is often a part of a cylinder shaft that strikes a lever at one or more points on its circular path. This cam is used to deliver pulses of power to a steam hammer. This cylindrical hammer moves up and down and helps to crush the chilly.

Keywords: Chili Crusher, Gear Drive, Cam and Follower Mechanism, Sprocket Mechanism

I. INTRODUCTION

A. Introduction As of today, in the rural household, throughout the country the rural people use pounding method for crushing. In this traditional method a wooden mortar having one or more shallow pockets for keeping the paddy and one or two rural women folk pound the paddy by means of round long wooden log of 5ft-6ft called pestle. In this traditional method the mortar is at times made of stone also. However, for both mortar and pestle the rural folk cut down trees thereby depleting the natural wealth. There being millions of rural households in the Country, large amount of wood is thus regularly consumed by the rural folk, which destroys trees thus upsetting ecological balance. Spices are essential ingredients adding taste and flavoring in food preparations. India is the largest producer and consumer of spices with a production of around 36.68 lakh tones. India is also the largest producer of chilli in world contributing 25% of the total world production. India spices are of the finest quality. Today the demand for it has considerably increased from all the countries. This work aims at production of ground spices especially chilli in consumer packs. This work mainly would involve production of chili powder, tamarind powder, Jeera powder, Dhania powder and mix spice powder. Spices are integral part of Indian food (India has come to be known as "land of spices") both as a component of daily food items as well as part of pickles, sauces & chutneys etc. With changing of life style and especially with changes of food habits and increase of income level, the use of powdered spices has increased. Of late, the market for ready mix of spices has grown significantly. Export market for Indian spices is also growing- it was Rs. 2025 crore during 2000-01.Thus the market is huge with potential for quality producer. Numbers of brands have appeared in the market such as Sona, MDH, Ashok Masala, Sunrise etc. besides these, some of local brand are also there in the market. In addition there are numbers of small units producing powdered spices, both in loose as well as packet formed. The consumption of spices in a household of five members, in the north eastern region is estimated at 100 gm. per person per month i.e. 6.0 kg per household per year. Of this share of, powdered spice may be taken at 50% i.e. 3.0 kg per household per year. In north eastern states powdered spices are used mainly in urban and semi urban areas and it may be conservatively assumed that 70% of the urban population uses powdered spices. Chili crushing is an important activity in rural areas both for self- sustenance as well as source of subsidiary income to small farmers & agricultural laborers. Community is in need of a better technology, requiring less manual power and mechanical troubles as well as economy. Hence to make the existing techniques more user-friendly, and for these more intensive studies are to be carried. The present scenario of the power crises & limited natural resources urge engineers to harvest energy from non-traditional sources & it should be eco- friendly. Many such efforts are being made to avoid the use of environmentally hazardous fossil fuels. Apart from all other energy resources, the main source of energy i.e. human energy has been completely overlooked. Human bodies have the capacity to generate significant amounts of energy; however, most of this energy is dissipated in the form of mechanical energy and heat. There are two important Considerations when using human energy: the technical feasibility of harvesting energy from human activity, and the economic viability of such a device to use this energy. This work emphasis is to utilize human energy during normal or routine work carried by them & its reproduction with the help of energy generation device that converts mechanical human energy dissipated by pedaling. Present work is aimed at testing of a functional prototype and the determination of the conditions necessary for the device to be economically feasible. A lot of stress is being given in conducting practical, which have relevance to the industry. During the course of development of the setup a lot of infrastructural facilities and expertise will be developed. This can be used for design of better practical work. Research work on other aspects of this project like enhancing human power and ergonomics design of pedaling

technique etc. may also be carried out. The work starts with the chain and sprocket mechanism. Bicycle is provided to transmit rotary motion between two shafts where gears are unsuitable or to impart linear motion to a rod. The pinion gear in sprocket mechanism provides the rotary motion to rod. This rod incorporates a spur gear of 110 teeth connected with pinion gear of 20 teeth to provide the maximum rotary motion to another rod. This gives rotation motion to fly wheel of approx. 12 kg. According to law of motion the fly wheel will rotates with high speed comparatively the force provided to sprocket mechanism because the weight and momentum of the fly wheel is more. This rod ends with the clutch for the transmission of power (and therefore usually motion) from one component (the driving member) to another (the driven member) when engaged, but can be disengaged. This clutch when engaged provides motion to another pinion gear which is in contact with spur gear. The rod connected with the spur gear provides rotary motion to cams which is a mechanical linkage used especially in transforming rotary motion into linear motion or vice-versa. It is often a part of a cylinder shaft that strikes a lever at one or more points on its circular path. This cam is used to deliver pulses of power to a steam hammer. This cylindrical hammer moves up and down and helps to crush the chili.

A. Objectives

The concept of utilization of kinetic energy is completely new one and so far very little work has been carried out on this topic. It has a totally new idea to work on. The main aim of this project is to crush the chilly into fine powder. In addition to that, the available kinetic energy is used to drive centrifugal pump to lift the water which otherwise requires either electricity or diesel engine, but the present innovation works on pedaling. This is a non-polluting and thus environment friendly device. Again the available kinetic energy is used to produce electricity and to glow LED light as the work is mainly focused for remote areas where the villages are facing power cut off daily for several hours.

II. LITERATURE REVIEW

A. Drying

This is by far the most important stage of the process. If the chilies are not fully dried or if they take a long time to dry, they will be prone to mould growth and spoilage. The sale value of moldy chili can be less than 50% the normal value. In extreme cases the whole crop can be lost. The choice of dryer will depend on the 6climate at the time of harvest and the Intended end use of the chilies. For home use of the dried chilies, it is preferable to use the cheapest method available, which is sun drying. However, sun drying is really only practical in dry climates with plenty of sunshine. In humid climates drying will take too long, during which time the chillies have the potential to spoil.

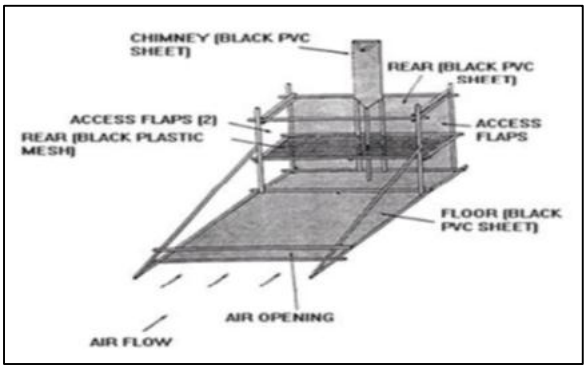

Fig. 1:

If a solar dryer is available, it is advantageous to use it as the drying process will be speeded up and the end result will be a higher quality dried chilli. Artificial dryers are only an option if there is a guaranteed market for the dried chillies. The Practical Action technical briefs on drying give a good overview of the principles and practicalities of drying and good advice on the choice of dryer.

B. Drying During the Dry Season

During the dry season, sun drying is usually adequate to dry the produce. The simplest and cheapest method is to lay the produce on mats in the sun. However, there are problems associated with this method. Dust and dirt are blown onto the crop and unexpected rain storms can re-wet the crop. To improve the cleanliness of the process, the drying chillies should be covered with a light gauze or muslin sheet which keeps away the insects and dust. To help maintain a good red color, the chillies should be dried in the shade, not in direct bright sunlight. Alternatively, a solar dryer can be used. The simplest type of solar dryer is the cabinet solar dryer, see Figure 1, which can be constructed out of locally available materials (e.g. bamboo, coir fiber or nylon weave). For larger units (over 30kg/day) an 'Excel Solar Dryer' could be used, see Figure 2. However, the construction costs are greater and a full financial evaluation should be made to ensure that a higher income from better quality spices can justify the additional expense.

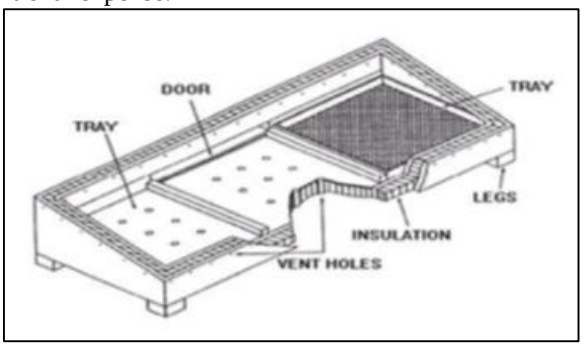

Fig. 2:

C. Drying during the Wet Season

During the wet season or times of high humidity, which often coincides with the harvest of the spices, a solar dryer or sun drying cannot be used effectively. An artificial dryer which uses a cheap energy source is necessary. This may be a wood or husk burning dryer or a combined wood burning and solar dryer. The technical brief on drying of foods contains more information on artificial dryers.

D. Over Drying

Care needs to be taken to prevent over drying of the chillies. A dryer operator will soon learn how to assess the moisture content of the chillies by hand. The final moisture content should be 10% wet basis.

E. Grading

In some cases the dried chillies need to be graded, e.g. to gain a premium price for high quality packaged products. Chillies are graded by color and size – the brighter the color red the better. Grading is carried out by hand.

F. Grinding

Dried chillies can either be sold whole or ground into a powder. Grinding is one way of adding value to the product, but it must be done carefully to avoid problems and losses of material. A whole, intact product can be easily assessed for quality whereas a ground product is more difficult. Some consumers do not like to buy ground spices for fear that they have been adulterated. This fear can be overcome by producing a consistently high quality product and gaining the confidence of customers. Ground spices also lose their flavor and pungency much more quickly than whole spices. Therefore, grinding the chillies reduces their shelf life and potentially means that you may suffer from higher losses as you will have to discard any ground spice that does not sell. It is essential that the ground powder is well packaged in moisture proof bags to prevent it taking up moisture. You really should only grind spices if you have an assured market with a rapid turnover for the product. Basically there are two types of grinder – manual and mechanical. Whichever type you opt for, it must be placed in a separate and well-ventilated room because of the dust that it creates.

G. Manual Grinding Mills

There are many manual grinders that could be used to grind chilli (see equipment suppliers below). An experienced operator can grind about 20kg in an eight hour day. However, this is hard and boring work. A treadle or bicycle could easily be attached to the grinder which will make the work easier. With this system one person could grind about 30kg in one day. Consumer research should be carried out to find out the fineness of grinding that the consumer wants. The grinding mills then need to be set so that they produce the desired ground product. For small-scale production, (up to 100kg/day) a series of these grinders is all that is needed. For larger scale production units, a mechanical grinder would be required.

H. Mechanical Grinding Mills

There are a range of mills - horizontal plate, vertical plate or hammer mills - that are suitable for grinding chillies. The choice of mill depends on what is available in your particular area and the price of the mill.

III. DESCRIPTION OF CHILLI CRUSHER MACHINE

A. Working of Mechanism

As we provide motion with the help of paddle, a chain socket arrangement which is mounted on the shaft will rotate and because of that motion our gear shaft1 will also rotate in clockwise direction which is connected to the Shaft1.As the Gear 1 rotates in clockwise direction, the gear2 which is attached to the shaft 02 will also rotate in anti-clockwise direction with respect to that our flywheel and gear 3 will also rotate in same direction. As Gear 3 rotates in anti-clockwise direction, the Gear 4 which is completely meshed will rotate in clockwise direction which is attached to the shaft S3. As the shaft 3 rotates in clockwise direction with respect to that CAM will also rotate we had provided CAM and FOLLOWER arrangement for lifting of punching rod. It converts rotary motion into reciprocating motion.

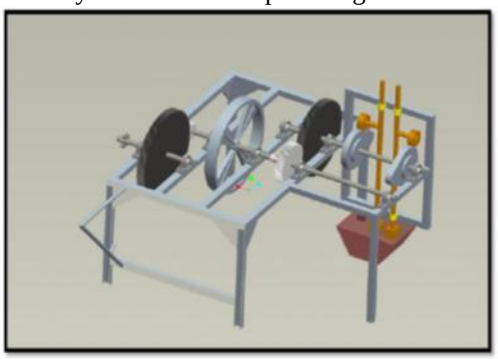

Fig. 3: Basic Components in Chilly Crusher Machine

B. Basic Components in Chili Crusher Machine

A machine element for the connection and disconnection of shafts in equipment drives. If both shafts to be connected can be stopped or made to move relatively slowly, a positive-type mechanical clutch may be used. If an initially stationary shaft is to be driven by a moving shaft, friction surfaces must be interposed to absorb the relative slippage until the speeds are the same. Interference of the interlocking portions prevents engagement at high speeds; at low speeds, if connection occurs, shock loads are transmitted to the shafting. Positive clutches may be of the square jaw type (Fig. 4) with two or more jaws of square section meshing together in the opposing clutches, or the spiral jaw type, a modification of the square-jaw clutch that permits more convenient engagement and provides a more gradual movement of the mating faces toward each other.

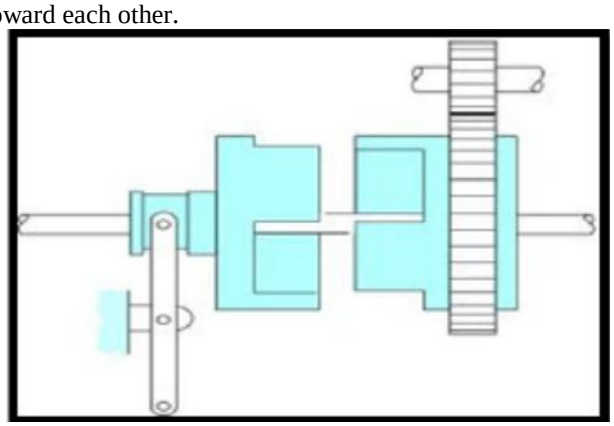

Fig. 4: Basic Components in Chili Crusher Machine

C. Cam & Follower

A cam is a rotating or sliding piece in a mechanical linkage used especially in transforming rotary motion into linear motion or vice-versa. It is often a part of a rotating wheel (e.g. an eccentric wheel) or shaft (e.g. a cylinder with an irregular shape) that strikes a lever at one or more points on its circular

path. The cam can be a simple tooth, as is used to deliver pulses of power to a steam hammer, for example, or an eccentric disc or other shape that produces a smooth reciprocating (back and forth) motion in the follower, which is a lever making contact with the cam.

D. Flywheel

A flywheel is a rotating mechanical device that is used to store rotational energy. Flywheels have a significant moment of inertia and thus resist changes in rotational speed. The amount of energy stored in a flywheel is proportional to the square of its rotational speed. Energy is transferred to a flywheel by applying torque to it, thereby increasing its rotational speed, and hence its stored energy. Conversely, a flywheel releases stored energy by applying torque to a mechanical load, thereby decreasing its rotational speed.

E. Spur Gears

Spur gears are used to transmit rotary motion between parallel shafts. They are usually. Cylindrical is shape and the teeth are straight and parallel to the axis of rotation. In a pair of gears, the larger is often called the GEAR and, the smaller one is called the PINION.

F. Bearing

Cast iron pillow block bearing unit with 2 holes for attachment bolts, re lubricatable (JIS Standard). A bearing is a machine element that constrains relative motion and reduces friction between moving parts to only the desired motion. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Many bearings also facilitate the desired motion as much as possible, such as by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.

IV. DESIGN CALCULATIONS

A. Design of Shaft

Assume,

Ns_1 = 40 rpm (paddle speed by human)

Teeth of large sprocket, $T_1 = 40$

Teeth of small sprocket, $T_2 = 18$

$$\frac{N_{s1}}{N_{s2}} = \frac{T_2}{T_1}$$

$$\frac{40}{N_{s2}} = \frac{18}{40}$$

$$N_{s2} = 88.88 \text{ rpm}$$

$N_{s1} = N_{s2} = 88.88$ rpm ..... (Shaft 1)

Teeth of gear 1, $G_1 = 110$

Teeth of gear 2, $G_2 = 20$

$$\frac{N_1}{N_2} = \frac{G_2}{G_1}$$

$$\frac{88.88}{N_2} = \frac{20}{110}$$

N_2= 486.75 rpm ..... (Shaft 2)

Teeth of gear 3, $G_3 = 40$

Teeth of gear 4, $G_4 = 85$

$$\frac{N_2}{N_3} = \frac{G_4}{G_3}$$

$$\frac{486.75}{N_3} = \frac{95}{40}$$

N_3= 229.05 rpm ..... (Shaft 2)

Assume, Power = 5 kW

We use 5 kw because a normal human being can produce upto 5kW power.

N = 88.88 rpm

$P = \frac{2\pi NT}{60}$

$$5 \times 10^3 = \frac{2 \times 3.14 \times 100 \times T}{60}$$

$$T = \frac{60 \times 5 \times 10\text{^}3}{2 \times 3.14 \times 88.88}$$

T = 537.20 N-m

Shear Stress = 175 N/mm_2

Max. Stress,

$$T = \frac{\pi}{16} \times \tau \times d^3$$

$$d^3 = \frac{537.2 \times 10^3 \times 16}{3.14 \times 175}$$

$$d_3 = 25 \text{ mm}$$

Therefore, selecting shaft diameter of 25 mm

B. Design of Cam

Accent,

$V_o = \frac{\pi \times \omega \times N}{20}$ ..... {1}

$$\omega = \frac{2 \times 3.14 \times N230}{60}$$

$$\omega = 24 \text{ rad/sec}$$

{1}→ $V_o = \frac{3.14 \times 24 \times 0.0042}{2 \times 1.57}$

V_o = 1 m/sec

V. CONCLUSIONS

- Times saving is much more in machine operated by motor as compared to our pedal operated machine but there is no need of electricity. Only human power is needed.
- Cost of labor is nil.
- No use of electricity.
- Useful for village people where villagers are facing power cut off daily for several hours.
- Cost of our equipment is 50% less compared to cost of traditional machine in use.

REFERENCES

[1] Food and Fertilizer Technology Centre (FFTC) Taipei, Taiwan ROC.
[2] Zakiuddin Syed Kazi, J.P. Modak (2010): Design and Development of Human Energized Chaff Cutter, New York Science Journal, PP. 104-108.
[3] Design data book, B.D. Shiwalkar, 3rd edition.
[4] A textbook of machine design, R.S Khurmi & J.K Gupta, S.Chand publication.

