

DESIGN AND FABRICATION OF SPICES PROCESSING MACHINE

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Abstract:- The paper is about fabrication of spices crusher. Spices has been a part of the human diet in the world since at least 7500 BC. Spices are very important and essential for adding and enhancing flavor, taste and scent in preparation of food. They are also useful in preparation of certain medicine. India is the largest producer, consumer and exporter of spices Andhra Pradesh, Gujarat, Orissa, Rajasthan are major states producing varieties of spices. Crushing of spices is an important activity in rural areas both for self- sustenance as well as source of subsidiary income to small farmers & agricultural labors. India is the largest producer and consumer of spices with a production of around 36.68 lakh tones. As of today, in the rural household, throughout the country the rural people use pounding method for crushing. Spices are essential ingredients adding taste and flavor in food preparation. With changing of human life style and especially with changes of food habits and increase of income level, the use of powdered spices has increased. Spices powder can be made from this project using some mechanical Arrangement. This mechanical arrangement incorporates chain sprocket, gear box and grinding rods. Chain drives are normally used when power or motion or both of them are to be transferred over a short distance. Our main objective is to crush the spices and get it in to powder by using electric power supply.

Introduction

A spice is a seed, fruit, root, bark or other plant substance primarily used for flavoring, coloring or preserving food. Spices are distinguish from herbs, which are leaves, flowers, or stems of plant used for flavoring or as a garnish. Many spices have antimicrobial properties. This may explain why spices are more commonly used in warmer climates, which have more infectious disease and why the use of spices is prominent in meat, which is particularly susceptible to spoiling. Spices are sometimes used in medicine, religious rituals, cosmetics or perfume production.

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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 chilli powder, turmeric powder, Cumin powder, Coriander powder and mix spices 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.

Storage of spices and problems associated with the storage

After processing, the spices were immediately sold or stored by using various techniques. For 75% of processors interviewed, the non-processed spices are sun dried twice or three times a week for long period conservation (two years) or dried with electric drier (1.2%) to avoid the attack by mould. The storage of fresh spices (chili, ginger, onion, and garlic) by the cool is practiced by 5% of the processors. The maximum storage duration of the spices kept in cool conditions is 10 days according to 80% of the processors who practiced this technique. Thus, the moisture level for most spices should be reduced to below 11% in order to prevent the proliferation of microorganisms. According to the European Spice Association, the moisture content in spices after drying is very decisive for the microbial proliferation (Yogendrarajah, 2014; Tulu et al., 2014).

In summary, the duration of the storage of spices is a function of the storage methods used (refrigeration, drying, packaging). From the survey data, it appeared that the products that did not last longer in storage were those stored with the cool (that is, at most 7 days for chili). In contrast, the dried products last longer and can be stored during two years as mentioned by 86% of the processors. The survey also showed that the major storage problems faced by the processors were the rotting of fresh SAH (cited by 65.3% of the respondents), the attack by mould related to the no ground dried products pointed out by 63.3% and powder products mentioned by 26% of the interviewees. The presence of dead maggots (38.2%) of processors, the loss of weight (18.1%) and aroma (9.98%) during the storage were also reported for dried products in general and the ground ones in particular. In addition, the attack by mould during the storage period can lead to the production of aflatoxins as reported by Set and Erkmen (2010). Other major problems observed were the general unhygienic conditions of the processing sites and the processing material leading to the contamination of the product.

Problem Identification:

- MARKET PROSPECT

India is the world's biggest exporter of spices. There is good scope for domestic market for this commodity in processed form. The market for export of spices is encouraged in processed form as it will bring more value addition to the unit price of whole spices. The demand for spice powder is increasing day by day with the changing attitude as well as improvement in purchasing power of the people. The products find good market in the urban areas of the country particularly within the state itself.

Market Promotion plays a vital role for the generation of the potential customers therefore, application of marketing strategies are recommended. Marketing plan of the proposed project may include good quality maintenance, promotional campaign like offering special discounts, referrals, advertisement and tying up with buying houses.

PROCESS DETAILS:

(i) Washing: First of all, the spices are washed with water under high pressure to remove impurities.

(ii) Peeling & Cutting to Small Pieces: Some spices require peeling and cutting to small pieces. Such spices are peeled with hand knives.

(iii) Drying: Spices are spread on the floor to provide sun drying. At times, mechanical dryers are also used. Tray type dryer is most suitable.

(iv) Grinding/ Pulverising: Spices are grinded in dry form.

(v) Mixing: After all the above operations, various spices for different purposes are mixed together.

(vi) Packaging: At the end, spices powder are packaged in automatic form, fill and sealing machine.

(vii) Transportation and Marketing: Thereafter, the products are transported and supplied to the bulk purchasers.

SMALL-SCALE SPICE PROCESSING:

Correct harvesting time

It is not possible to produce a high quality spice from low quality, inferior material. Harvesting spices at the correct point of maturity is the key to producing good quality products. Quite frequently spices are harvested when they are immature and before the flavour and aroma compounds have fully developed. This results in spices with an inferior taste and aroma. Early harvesting is usually through fear of the crop being stolen or because the farmer requires money urgently. Every effort should be made to wait until the spices are fully mature before harvesting.

Cleaning

Spice crops are quite often contaminated by dust, dirt, pesticides, insects, animal hair and droppings and a range of microbes. The crop must be cleaned before processing. The first stage is to remove dust and dirt using a winnowing basket. This can be made locally from bamboo, palm or other leaves. Someone used to this work can remove the dust, dirt and stones quickly and efficiently (eg they could clean 100kg of pepper in an eight-hour day). Small machines are available for cleaning but they are rarely cost effective. After winnowing the crop should be washed in clean, potable water. Washing should be quick so that the spice is not soaked in water as this reduces the quality. The washing water must be changed regularly to prevent recontamination of spices by dirty water. It is essential that clean water is used as spices are not heat treated later on during processing. Dirty water introduces more bacteria, many of which cause food poisoning.

Drying

This is by far the most important part of processing to ensure good quality spices. Inadequately dried produce will lead to mould growth. The sale value of mouldy spices can be less than 50% of the normal value. In addition, the growth of food poisoning bacteria on some spices is a real danger if proper washing and drying is not carried out. Spices contain volatile oils that are adversely affected by high temperatures. Therefore the temperature of drying must be tightly controlled to ensure a high quality dried product. Most small-scale processors dry the crop by spreading it in the sun. This is another opportunity for the crop to become contaminated. All efforts should be made to ensure that the crop is dried in a clean place, away from animals, insects and birds.

WORKING PRINCIPLE

Spices Processing Machine is Designed to Operate on electrical 0.5 HP single phase motor for smooth operation of spice processing by using Chain and Sprocket Mechanism and the Power for the Crusher operation is taken from an 1440 rpm electrical motor. It is designed to use a single phase motor for the crusher operation as the power required for crushing the spices. The machine has been constructed in such a way that it can be operated by electric supply. The drive unit consists of an electrical motor of 0.5Hp a gear box having ratio of 30:1, this electrical motor is used to provide reciprocating motion to the hammering rod. Power supply of 230volt AC is used to drive this motor with 1440 rpm which is further reduced by gear box which is connected to another shaft with the help of sprocket and chain mechanism for smooth operation. In this machine the power of motor is transferred by using of chain drive is made to avoid slippage problem.

CHAIN DRIVE

Chain Drive mechanism constitutes two sprockets, one is called driver and the other is called driven, and a chain. Chain itself constitutes various links and each link is formed by joining roller, plates and pin.

The most former of all machine elements were the Chain Drives. Chains normally have lesser weight as compared to their counterparts such as gear drives or belt drives. Slip might occur on belt and rope drives, but chains are used to prevent slipping. Many stiff links are used to make chain; these links are connected through pin joints to allow required flexibility for rolling around the driven and driving wheels. Special profile teeth are protruded on these wheels. Teeth met matching recesses present in chain links. Therefore, chain and sprocket are restricted to proceed together in the absence of slip with hone velocity ratio. When power and motion are to be transferred over a short distance between the shafts, chains are used. For example, in rolling mills, motor cycles, conveyors etc.

Advantages of Chain Drive over Belt or Rope Drive

1. In chain drive slip is zero so exact velocity ration occur.
2. Chain drive is used for short as well as for long distance.
3. Transmission efficiency is as high as 98 percent.
4. One chain could transfer motion to several shafts.
5. More power is transfer.
6. Chain drive might be used in adverse atmospheric and temperature conditions.
7. Mostly metal chains are used, hence in width very less space is occupied as compared to rope or belt drive.
8. Chain drive is positive drive.
9. Unlike belt drives, angular velocity remains constant in chain drives
10. It allows high speed ratio of 8 to 10 in one single step
11. Highly efficient, chain drives give the advantage of more power compared to belts
12. They can operate even in wet conditions.
13. Chain drives do not deteriorate due to sunlight, oil, grease, or age
14. Lower load on shaft than belt drives.

Disadvantages

1. Production cost is high.
2. Maintenance and accurate mounting is required.
3. Excessive stretching could cause variation in velocity.

Gear box

The gear box is the second element of the power train in an automobile. It is used to change the speed and torque of vehicle according to variety of road and load condition. A gear box changes the engine speed into torque when climbing hills and when the vehicle required. Sometimes it is known as torque converter.

A gear box can either change the direction a rotary motion is being transmitted, or it can change the speed of that motion, changing speed for torque.

Why gear box is required

Most modern gearboxes are used to increase torque while reducing the speed of a prime mover output shaft (e.g. a motor crankshaft). This means that the output shaft of a gearbox rotates at a slower rate than the input shaft, and this reduction in speed produces a mechanical advantage, increasing torque.



Some of spices are in powder form



Front view of machine

Design calculations

The design proceeded from two known values, one is motor RPM i.e. driver's RPM, and second is Driven speed in RPM. from this two-values velocity ration can be calculated. The determination of number of teeth for smaller sprocket is the most important step in the design. It is due to the number of teeth on a sprocket played vital role in adjusting or determining the performance of drive system. Numbers of teeth have direct effect on efficiency of system, with lesser number of teeth the system become noisier and by increasing the number of teeth centrifugal and frictional forces can be reduced along with reduction in shocks.

$$\text{Velocity ratio} = \frac{N_1}{N_2} = \frac{T_2}{T_1}$$

N_1 = number of revolutions per minute (R.P.M) of smaller sprocket

N_2 = number of revolutions per minute (R.P.M) of larger sprocket

T_1 = number of teeth on the larger sprocket

T_2 = number of teeth on the smaller sprocket

Calculation for Shaft

$$\text{Velocity ratio} = \frac{N_1}{N_2} = \frac{T_2}{T_1}$$

$$\frac{40}{N_2} = \frac{15}{23}$$

$$N_2 = \frac{40}{15} \times 23$$

$$N_2 = 61.333 \text{ rpm}$$

Power Supply = 0.5 hp

Design power $(P)_d = (P)_R \times k_1$

$$= 0.5 \times 1.7$$

$$(P)_d = 0.85 \text{ kw}$$

Design torque, $T_d = \frac{60 \times P \times k_1}{2\pi N}$

$$= \frac{60 \times 0.85 \times 100 \times 1.7}{2\pi \times 61.33}$$

$$T_d = 22.499 \text{ N-m}$$

$\tau = 175$from data book.

Maximum stress,

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

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

$$d = \frac{16 \times 22.499 \times 1000}{\pi \times 175}$$

$$d = 18.708 \text{ mm}$$

Therefore selecting the shaft of 19 mm.

Calculation for chain and sprocket

The chains were used to transmit motion and power from one shaft to another because the distance between the centers of the shafts was short. Chain drive gave high transmission efficiency as no slippage took place. The chains were made up of rigid links which were hinged together in order to provide the necessary flexibility for warping around the driving and driven wheels. The wheels had projecting teeth and fit into the corresponding recesses, in the links of the chain. The wheels and the chain were thus constrained to move together without slipping.

Design of chain and sprockets:

P = Pitch of the sprocket

d = Diameter of the pitch circle, and

T = Number of teeth on the sprocket.

$$P = d \sin(360^\circ / 2T)$$

$$P = 60 \times \sin(360^\circ / 2 \times 15)$$

$$P = 12.4 \text{ mm}$$

The exact length of the chain (L) was determined as:

$$L = \left\{ \frac{P(T_1 + T_2)}{2} + 2X + \left[\frac{P}{2} \csc\left(\frac{180^\circ}{T_1}\right) - \frac{P}{2} \csc\left(\frac{180^\circ}{T_2}\right) \right] / \kappa \right\}$$

T1 = Number of teeth on the larger sprocket,

T2 = Number of teeth on the smaller sprocket

X = Centre distance between sprockets

Motor side chain length:

$$L = \{12.4 \times (15+23)/2 + 2 \times 450 + [p/2 \operatorname{cosec}(180/23) - p/2 \operatorname{cosec}(180/15)]/450\}$$

$$L = 1135.63 \text{ mm}$$

CONCLUSION

Design and fabrication of spices processing machine was interesting in itself, as it required new and different approaches to solve the problem from those which were used for fabrication of machine. It was better to use existing technology to improve the performance of machine by using chain drive. Chain drives were better suited in this application as they offered zero slip and occupied less space as compared to belt drive and gear drive. Its transmission efficiency is as high as 98 percent. During design & fabrication phase it was considered that smallest possible design was designed which could be easily manufactured from local market.

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