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DESIGN AND DEVELOPMENT OF A GRAIN DRYER

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A substantial quantity of food grains deteriorates during storage after harvesting due to unawareness of the importance of crop drying. As high as 20% losses have been recorded during sun drying and storage. To avoid such a big loss a grain dryer has been designed which can save drying and storage losses. Drying of grains by this dryer is easy and time saving. Moisture removed by this dryer is proportional to the initial temperature of heat transfer medium (sand). Moreover, moisture removal rate by this dryer is maximum at 6.0 sand to grain mass ratio .

INTRODUCTION

A common feature of developing agriculture all over the world is the occurrence of losses in agricultural produce in one form or the other. There is a sizeable loss of grain every year due to storage of grain at higher moisture content (Brooker *et al.*, 1974). The main loss of the product after harvesting occurs during storage due to the fact that the freshly harvested crops are more susceptible to insect attack because of high moisture level.

Generally grain crops are harvested at moisture content levels ranging from 15 to 30% wet basis (w.b.). If the grains are not dried to about 12 to 13% moisture content level (w.b.), favourable conditions will be available for the development of molds and fungi during storage which will deteriorate the quality of the product (Noomhorm and Verma, 1986).

The traditional method of drying threshed grains in Pakistan is spreading the crop in sun shine. This method is only applicable in dry weather and requires sufficient dry area exposed to sun and more labour for spreading, stirring and collecting the grains. The results based on the work done at the University of Agriculture, Faisalabad (Chaudhry.1970) revealed that about 3.19% losses occur during floor drying of corn. Mphuru (1982) quoted an average of 20% post-harvest losses for most of the grains. This necessitates that proper measures be taken to reduce these losses to an acceptable level.

At present a few dryers using hot air as heat and moisture transfer medium have been reported in Pakistan. But the air drying has been described as an inefficient process (Foster, 1973). In view of the above mentioned facts, a prototype of simple grain dryer employing sand as heat transfer medium is designed and developed which is technically suitable and economically feasible.

MATERIALS AND METHODS

Design and development of dryer: The

machine (Fig.1) was fabricated from locally available material. A brief description of the major parts comprising the dryer is given below:

The main component of the dryer is a rotary cylinder 61 cm in diameter and 76 cm long, made of 15 gauge M.S. sheet. A helix made of 18 gauge M.S. sheet is welded inside the drum for conveying and mixing the hot sand and grain. The development of helix is shown in Fig. 2. A conical feeding end of the cylinder to facilitate the material to pour into the cylinder was designed and developed. The conical mouth of the cylinder has 30.5 cm diameter. At the exit end of the cylinder access ports were provided for discharging sand–grain mixture after the drying operation.

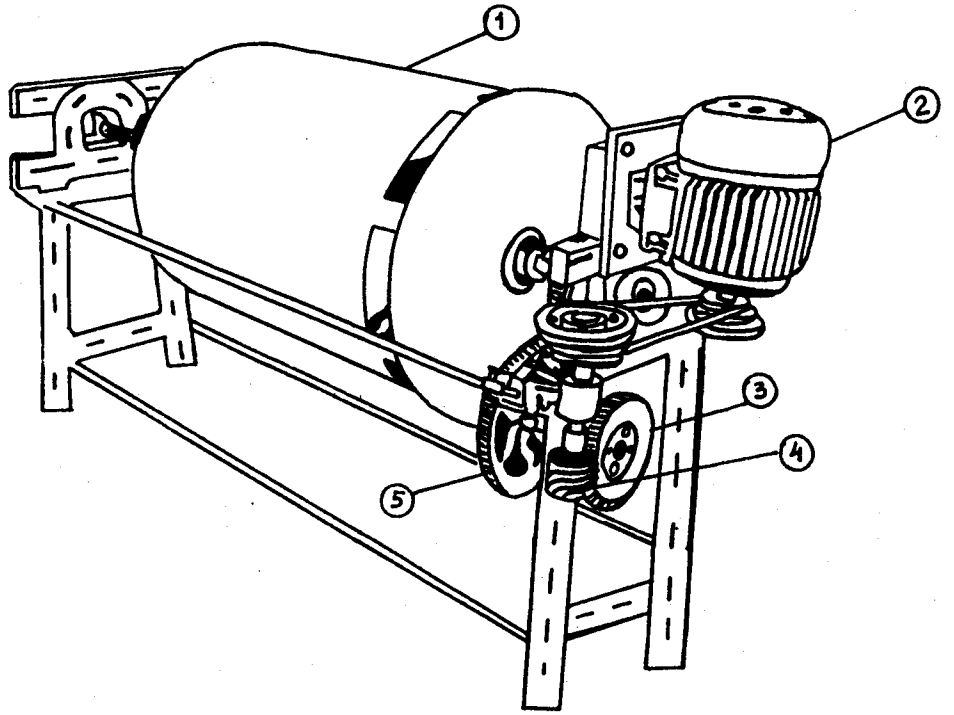

Fig. 1. An isometric view of grain dryer.

1. Electric motor
2. Iron stand
3. Spur gear
4. Worm wheel
5. Worm
6. Sieve
7. Gas meter
8. Sand heating pan

9 & 10. Step pulleys

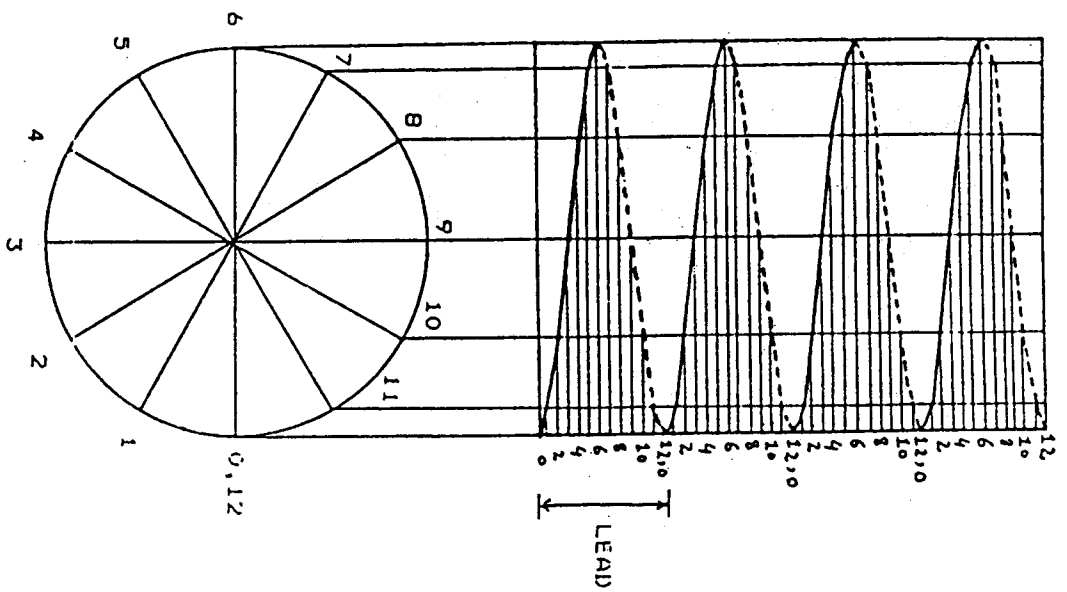

Fig. 2. Development of helix.

A cast iron stand was employed for mounting the drum, electric motor and other accessories. A rotating shaft 3.175 cm in diameter passing through the drying drum was supported by two UDC 206 ball bearings at its two ends. A 950 rpm, 1 HP electric motor was coupled to rotate the cylinder through matched pair of step pulleys and a V–belt.

Speed reduction mechanism: First reduction in speed was affected with the help of step pulleys having diameters of 5.40, 7.94 and 10.64 cm mounted on the shaft of the motor and 13.00, 14.48 and 7.96 cm diameter pulleys mounted on the shaft of the worm. A single thread worm having 10 mm pitch and a worm wheel having 44 teeth was used to obtain second reduction in speed. With these arrangements the rotational speeds of the cylinder could be adjusted at 11, 14, 18, 23 and 28 revolutions per minute. Two cast iron spur gears, each having 104 teeth and 9 mm pitch were used to transmit drive from the worm wheel to the drying cylinder. These gears provided positive power transmission system.

Operation: Two men, one for pouring the hot sand and the grains into the drum and the other for sieving and handling the dried grains were required to operate this machine. The required quantity of sand was heated to the desired temperature. As soon as the desired temperature of sand was reached, it was transferred quickly into rotating drum. A temperature drop during transfer of hot sand into the drum was compensated by heating the sand little higher than the required drying temperature.

After the heated sand was transferred to the cylinder, a

weighed sample of grains, according to sand grain ratio, was poured quickly into the cylinder to move the mixture of grains and the hot sand within the rotating cylinder towards the exit end. As soon as the mixture of sand and grains was delivered by the dryer, grains were separated from sand by sieving process.

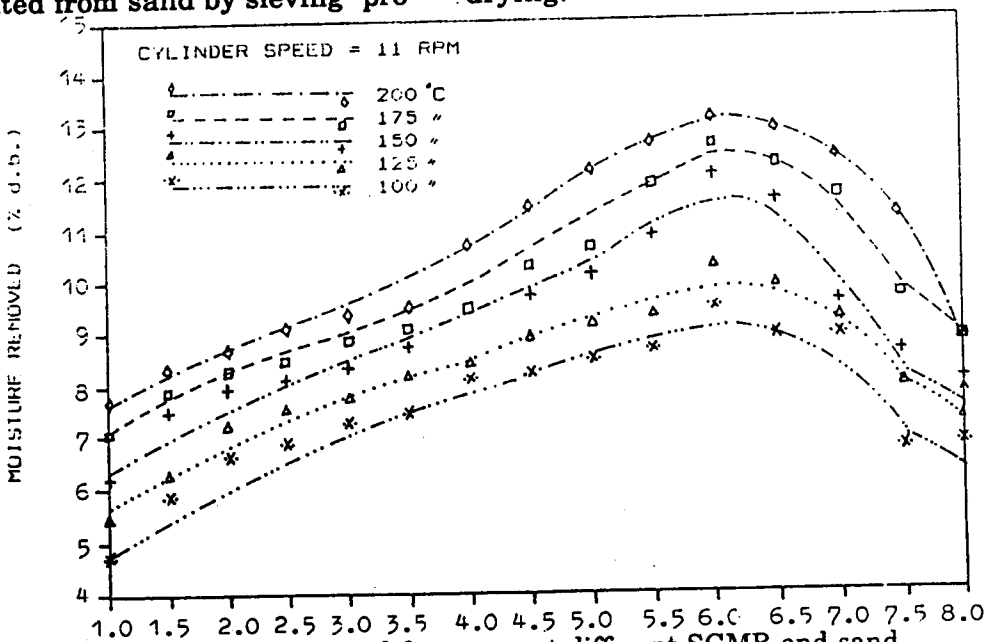

Fig. 3. Percent moisture removed from corn at different SGMR and sand temperatures.

RESULTS

Some of the results obtained in this study are shown in Fig. 3. It was found that percent moisture removed was proportional to the initial sand temperature. Moreover, the reduction in moisture content of grain increased upto a 6.0 sand to grain mass ratio (SGMR) and a decreasing trend was shown when SGMR was higher than 6.0.

Drying of grains by this dryer was found easy and time saving. Drying by a traditional method requires a large open space for spreading the grains for sun drying, causes grain losses and needs more time for achieving the desired moisture level of grains for storage. The grain dryer developed in this study offers attractive features to alleviate the problems faced in sun–drying.

REFERENCES

Brooker,D.B., F.W. Bakker-Arkema and C.W. Hall. 1974. Drying Cereal Grains (Second Printing). The AVI Publishing Company, Inc., Westport, Conn., USA.

Chaudhry, M.A. 1970. Food Grain Losses at Farm Level in Pakistan. Vol. I. Dept. of Agri. Marketing. Faculty of Agri. Economics and Rural Sociology, Univ. of Agri., Faisalabad, Pakistan.

Foster, G.H. 1973. Heated air grain

drying. *In*: Grain Storage: Part of a System. The AVI Publishing Co., Westport, Conn., USA.

Mphuru, N.A. 1982. On–farm handling, processing and storage of food grains in Africa. Published by The African Regional Centre for Technology, Dakar.

Noomhorm, A. and L.R. Verma. 1986. Generalized single layer rice drying models. Trans. of the ASAE. 29 (2): 587–591.