The current situation of grain drying in China

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Abstract

Drying is an important technology widely used in the processing of such products as grain, food and other agricultural materials. In recent years, the drying industry in China is in a fast developing period and the amount of grain dryers is increasing every year. The grain drying technology is also improving. In this paper the present situation of grain drying technology and grain drying equipment is presented. The type, structure and characteristics of most widely used grain dryers are described. Some recommendations for further development are given.

Introduction

With the development of rural economy in China, grain drying techniques have come to a stage of rapid development. According to the statistics, there are about 30 grain dryer factories and companies in the North-East part of China alone. These factories and companies manufacture about thirty models of different grain dryers. Some foreign manufacturers are also establishing joint ventures in China and making profits from the Chinese market. The 21st century will witness an even faster growth in grain drying industry in China.

Characteristics of Grain Dryer Development In China

In the past, grain drying equipment were used mainly in State farms and large grain elevators. The capacity of such grain drying equipment was fairly large. In recent years, grain drying technology developed rapidly with the increasing demand of agriculture machinery. Some outdated dryers were already obsolete. Advanced and up-to-date drying technologies are developing. For example in North-East China there are about 100 grain drying centers established, combining drying, storage and transportation in one unit. The overall drying capacity reaches 40,000 tons per day. In the mean time, small grain dryers begin to appear in the market. Some villages, farms and small elevators, even individual farmers begin to buy their own dryers and dry their grain. Since small capacity dryers are much cheaper and more beneficial to farmers, a series of small enterprises start to produce such dryers. Almost all types of grain dryers can be found in China such as: cross flow dryer, concurrent flow dryer, mixed flow dryer, recirculating dryer, low temperature grain drying bin, movable and also vibro-fluidized bed dryers. Most of these dryers are now in production with standard models. Their capacity ranges from 2.5 ton/hr to 50 tons/hr with 5% moisture extraction. Instead of oil burner, most of Chinese dryers use coal-fired furnace as the main heat source. Indirect heating is used to avoid grain contamination.

The fundamental research and theoretical study on grain drying are carried out mainly in Research Institutes and Universities as Beijing Agriculture Engineering University (BAEU), North East Agriculture University, South China Agriculture University, Wuxi College of Light Industry and Chinese Academy of Agricultural Machinery Science (CAAMS). The fundamental researches focus mainly on thin layer drying models, heat and mass transfer in grain kernels, modeling and simulation of grain dryers, energy and efficiency aspects of grain dryer, new drying technology and automatic control of grain dryers.

At BAEU, simulation of different dryers was investigated continuously. A comprehensive grain drying simulation program has been developed. Four types of grain dryer can be simulated, i.e. cross flow dryer, concurrent flow dryer, fixed-bed and reversible air flow dryer. Drying of five kinds of grain i.e. corn, wheat, rice, soybean, sorghum could be predicted by using this program so that optimum drying parameters may be selected and dryer performance can be analyzed. North East Agricultural University is pursuing a research on drying technology called mixing of dried and wet grain or grain recirculating dryer. Moisture transfer between wet and dry grain was investigated by means of radio-active substance.

Different grain drying technologies were studied at Chinese Agriculture Universities, such as concurrent flow and counter flow dryers combined high-low temperature grain dryer. Some optimized results have been obtained. In addition some new drying technology like spouted bed drying, vibro-fluidized bed drying, pulsed fluidized bed drying, impinging stream drying and superheated steam drying were also studied.
Main Types of Grain Dryers

Cross flow dryer

In cross flow grain dryer, wet grain flows downward between two perforated screens. Heated air penetrate the grain column crosswise. The upper part of grain column is drying zone and the lower part is cooling zone. The features of cross flow dryer are simple in construction and high in drying rate. But the moisture difference in the grain is large and the energy consumption is high. In order to improve grain quality out of cross flow dryer, various measures were undertaken such as usage of grain diverter, application of differential speed mechanism, and reverse of hot air. The cross flow dryer is widely used in State farms of North East China. Based on the dryer research achievements, a 5HL-model cross flow grain dryer was developed and manufactured by Hong Xing Long Machinery Factory. This type of dryer has won popularity in North-East China with total installations of over 130. In 1990 a new cross flow dryer of TZ-series was developed and manufactured by Tie Lung Machinery Factory. The capacity of this dryer can be 5, 10, 15 tones per hour with moisture reduction being 8%.

Mixed flow dryer

In mixed flow dryer, many inverted V-shaped air ducts are located inside the dryer. One row is inlet air duct and the other is exhaust air duct. When the grain moves downward by gravity it is subjected to hot air drying treatment. The advantages of mixed flow dryer are high drying capacity, uniform drying and low air resistance. No screen is used in the dryer therefore it could be used to dry small seeds, such as rape seeds. Since early 1950, mixed flow grain dryers have been used in State farms. But it was built with concrete. In 1987 Metallic mixed flow dryer Model 5HZ was manufactured by Bahaun Machinery Factory at Healongjiang province. Nowadays there are at least 8 factories in China manufacturing mixed flow dryers, with models including 5HZ, 5HTD, and HW 5HM. About 400 mixed flow grain dryers were produced in recent years.

The mixed flow dryer 5HG-45 developed by BAEU worths mentioning for it’s new structure. It is characterized by it’s variable row space and installation of pre-cleaner and post cleaner. The quality of corn dried by this dryer is excellent. The detailed characteristic features of this dryer are as follows:

1) Energy saving. The specific heat consumption of this dryer is 4000 KJ/kg water
2) Higher drying rate. The drying intensity is 49 kg water/m³
3) Lower operating cost. The operating cost of this dryer is only 0.01 Yuan RMB per kg of dried grain.
4) Less investment. The area for installation of this dryer is 50 m² only.

Concurrent flow dryer

Concurrent-flow dryer is a new grain drying technology developed in recent years. It usually consists of several drying stages. Between drying stages a tempering section was introduced. The main features of this dryer are that high drying air temperature may be used and thus high drying rate may be obtained. The grain moves vertically downward through the dryer, while heated air is introduced into the moving grain at one or two stages along the grain column. The wet grain and drying air travel through the drying section in the same direction. The moisture extraction is uniform for good grain quality. It is an energy efficient dryer with lower specific heat consumption.

Many factories such as Hai Cheng, Bei Fang, Wu Xi and Dong Guang are now manufacturing concurrent flow dryers. There are 2-stages, 3-stages concurrent-flow dryers in China. The concept of concurrent flow drying with counter flow cooling has proven to be superior in quality control, fuel efficiency and pollution prevention to other types of dryer. It permits the utilization of high drying air temperature up to 200°C depending on the grain type, meanwhile maintains a low kernel temperature. This is resulted from the high evaporation rate in the first few centimeters at the grain inlet part. Low energy requirement, high fuel efficiency, large capacity and good quality of grain are the main features of concurrent flow dryers.

Recirculating batch dryer

Two types of recirculating dryer are manufactured in China. One is the rectangular shaped recirculating dryer HZ-3.2 which has the following features:

1) Low air temperature with large airflow rate.
2) Thin layer grain bed with multi-passageway for grain.
3) Drying and tempering alternatively cycled.

This kind of dryer may be used for drying seeds and rice. The other type is a round cylindrical shaped recirculating dryer with vertical auger in the middle of the drying bin. A dryer of Model 5HZP-6 is manufactured by Nanha Farm Machinery Factory and Model CHGXY manufactured in Xing Jiang Province.

Low temperature in-storage drying bin

Bins either round or square are used. Ventilation from the bottom via a false floor of perforated metal is the most common configuration. There are three advantages of this drying system: multi-purpose use of the floor, ability to cope with the output of combine harvester, and lower capital...
Grain recirculation dryer (Mixing of wet and dried grain technology)

In 1986, a commercial dryer called grain recirculation dryer was developed in North-East Agriculture College. It is a new grain drying technology. In this dryer part of the dried grain is recirculated and mixed with the wet grain. It can handle grain at any initial moisture content in one pass with excellent energy efficiency and good quality. It may save 30% energy compared with conventional dryer of the same size. The new dryer has a capacity of up to 45 tons/hr. Two types of drying section may be used, i.e., the concurrent flow and mixed flow drying section.

Main Problems

1) The main drawback of Chinese dryer lies in the low level of manufacturing skills and technology. Some dryer manufacturing factories are poorly equipped. Therefore, quality of dryer parts can not meet the requirement of large scale production. The service life of dryers is short and reliability is fairly low.

2) Too many dryer models and different type of dryers are manufactured. Some dryers were put into production without passing test or technical evaluation. Therefore, performance and quality of dryer can not be guaranteed. Such situations cause damages to the end users.

3) Most of Chinese dryers operates without automatic control systems due to the lack of suitable sensors for online measurement of grain moisture content. Therefore, the output grain moisture can not be controlled accurately causing overdrying or underdrying of grain. The quality of dried grain is poor. Sometimes there are losses of grain.

4) Low reliability and short service life of the coal-fired furnace. Owing to the limited amount of oil in China, the main fuel used for grain dryer is coal. Significant progress has been made in developing indirect heating coal fired furnace. The operating cost is reduced compared with oil burner, but the thermal efficiency is less. The service life of the coal furnace is short. The heat exchanger and furnace are made in one unit, the air flow resistance is therefore increased. There are a lot of research works required to improve the construction of the coal furnace.

Suggestions

To overcome the problems in dryer design and production, following suggestions are made on further development of grain drying.

1) Improvement and modification of present drying technology and equipment for an optimized drying operation. Great attention should not only be paid on reducing cost, increasing dryer efficiency and improving dryer performance but also on the quality of dried product.

2) In addition to the development of new drying technology, emphasis should be put on the improvement of manufacturing technology, such as improving anti-corrosive reliability and durability, increasing wear proofing ability of drying equipment.

3) Research Institute and University should concentrate their effort on the basic research of grain drying in such areas as: heat and mass transfer within kernels, grain quality prediction, grain drying simulation and drying theory of different agricultural materials.

4) Some key technical problems, concerning grain drying, must be solved by joint effort of research institute and dryer manufacturing companies. These include the reliability of coal fired furnace, drying of high moisture corn in cold weather (frozen weather), online measurement of grain moisture content and automatic control of grain dryers.

References

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