

RESEARCH AND DEVELOPMENT REFINED SUGAR DRYERS IN SUGAR-CANE MILLS OF VIETNAM

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1. FOREWORD

The main products of Vietnamese sugar-cane mills are refined sugar (RS) and crude sugar (yellow sugar-cane(YS)). The rate between RS and YS depends on constituent syrup, syrup floating equipment, syrup boil processing, additional bleach chemistries, crystalline time and syrup separating centrifugal procedure. Normally the YS rate is about 30 % and RS rate is about 70%

A popular sugar- cane mill can produce the yellow crystalline product only for selling. In fact, consumption capacity of the YS is very less so that most of popular mills get the yellow crystalline back for the boil process again or accumulation to sell for poor farmers. Normally, the moisture of crude sugar-cane is 3,5 %, so it is not necessary for drying while the moisture of refined sugar-cane (RS) which get out the A centrifugal is 0,5% -1,5 %. Basing on recent classification, if the moisture of sugar-cane is under 0,06 %, it will be classified as the super class. Similarly, the moisture of first class is under 0,07% and the second class is under 1,2%).

The final product should dry to meet the standard moisture before packing for storage, transportation, and consumption. Because of this, it is necessary for the sugar-mills to equip dryer for drying.

1. White crystalline sugar-cane drying processing

The drying process can split in to three period

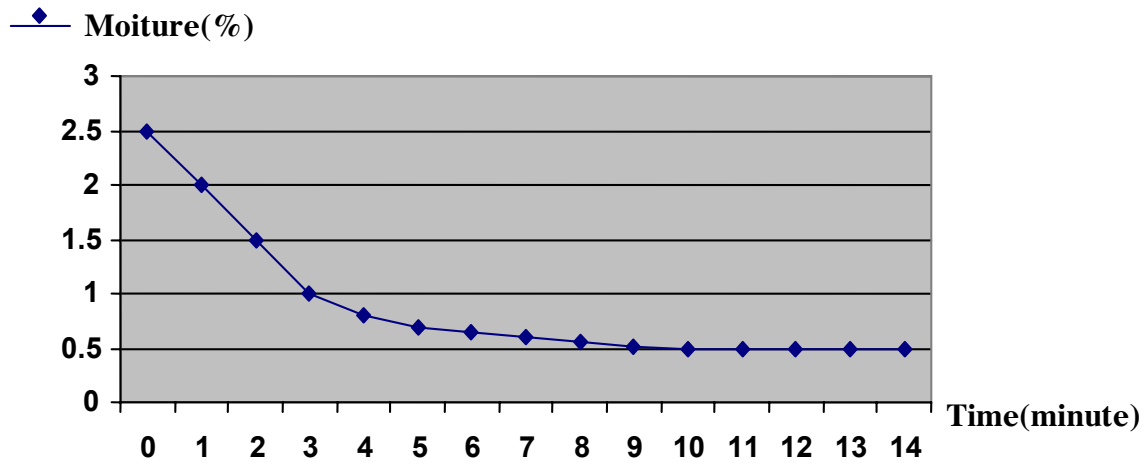
- The first stage is the constant rate period (surface evapotranspiration)

formidable evapotranspiration strength between hot air and moisture on the crystalline surfaces. Hot air receives moisture from sugar-cane crystalline continually. The drying rate of this stage is highest than other.

- The second stage is the falling rate period (moisture diffuse stage)

The crystalline surface of sugar-cane is dried, evapotranspiration is slow down, then moisture from inside of crystalline is diffuse to out side and continuous evapotranspiration. The pressure of hot air is nearly equal evaporating moisture pressure of crystalline sugar-cane. The drying rate is slow down in the end of the second stage.

- The third stage is equilibrium moisture content (EMC)



The equilibrium moisture content is defined as the moisture content of crystalline after it has been exposed for a long period of time on a particular environment with relative humidity and temperature. At the period of time the vapor pressure of sugar-cane is equal to the vapor of the hot air. The evapotranspiration process is nearly stop.

The drying process for refined sugar-cane is on the curved line of figure 1.

3. Analysing the main factors influence drying rate

3.1. The drying layer thickness and sizes of crystalline.

The large layer thickness and small crystalline size are influenced diffuse moisture from inside to outside. Evapotranspiration and drying rate decrease continuously

3.2. Moisture rate of crystalline.

The trouble A centrifugal machines or low experience operation technician get out low products, moisture rate of crystalline is higher or undurable. Normally moisture standard of sugar-cane is 0,7 to 1,5% after running out the A centrifugal machine. Besides moisture of sugar-cane depend on the breed crystalline size during crystalline process.

3.3. Moisture of hot air

The higher the hot air temperature is, the lower the relative moisture is and the faster the evapotranspiration of refined sugar-cane is. In fact, the sugar-cane drying is as same as the cereal drying. The drying temperature is limited for each kind of grain product. Example paddy, the drying temperature for merchandise is under 60 °C and for seed is under 40 °C.

The hot air temperature for sugar-cane drying is under 80 °C. If it is over 100 °C, the natural white colour of sugar-cane is changed to the yellow. The quality of final product get bad so it will effect to price of RS.

3.4. Kind of dryer

Kind of dryer is one of factors that decides to drying rate and final product quality. The different dryer get out different drying rate and quality.

4. Research and development refined sugar-cane dryers in Vietnam

Some of the requirements for Vietnamese sugar-cane dryer are simple structure, easy operation and maintenance, and low power consumption. Specially It is synchronous with the production assembly line and using heat of drying from sugar-cane processing.

4.1 The rotary drum dryer

The drum dryer is common for chemistry production plants. The drum dryer is simple structure, It consist of a cylinder which is set slanting 3° - 5° . Flights is set in side the cylinder. The flat flight with no lip in the feed end, flight with 45-deg. lip Flights in the middle with 90-deg and to showering the sugar-cane grain through the hot air stream during passage though the cylinder. The flights design is changed along the dryer length with spiral form. The inlet head and the breeching get fastened each terminal of the cylinder. Specially the heat transfer is supplied at the outlet of product. The feed chute, exhaust tube and cyclone separator are attached the inlet head of dryer. The drum is

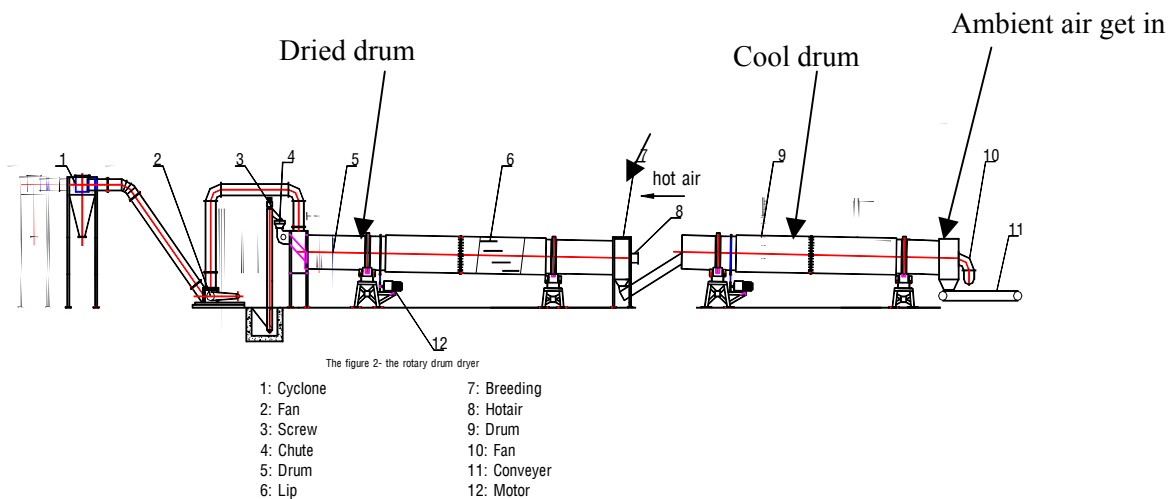


Figure 2: The rotary drum dryer

revolute about 3 to 5 rpm, sugar-cane is oppositely moved with hot air direction during drying and the pressure in side is required from (-)25 to (-)50 mm Hg. The structure of the rotary drum dryer is the figure 2.

The first advantage of the rotary drum dryer is controlled time to retain sugar cane in the cylinder so that sugar-cane moisture obtains requirement easily.

During drying, sugar-cane is blended strongly, crystalline grain is broken or abraded much. Grains is not beautiful, the colors is dark. There is so much pieces of sugar-cane is born during dying, people should separate pieces by the screen and broke them to reproduction. The rotary drum dryer has developed in sugar-cane mills such as Kien Giang, Thoi Binh-Ca Mau, Quang Nam, Quang Ngai, Phan Rang, and Bien Hoa- Tay Ninh sugar-cane mills.

4.2 Vibrative dryer

The structure of Vibrative dryer is based on the vibrative conveyor. It consist of a frame of vibrative conveyor is divided in to two chambres by separated plates. The top chamber contains sugar-cane and the under chamber contains drying air. At the under chamber is separated two parts, The first one contains hot air, the other one is received ambient to cool sugar-cane after drying. There is a cone hat to cover on the conveyor and connect with the exhaust tube and cyclone separator. Hot air is supplied by the U tube heat transfer is attaches the frond of dryer. The principle of the Vibrative dryer is described figure 3.

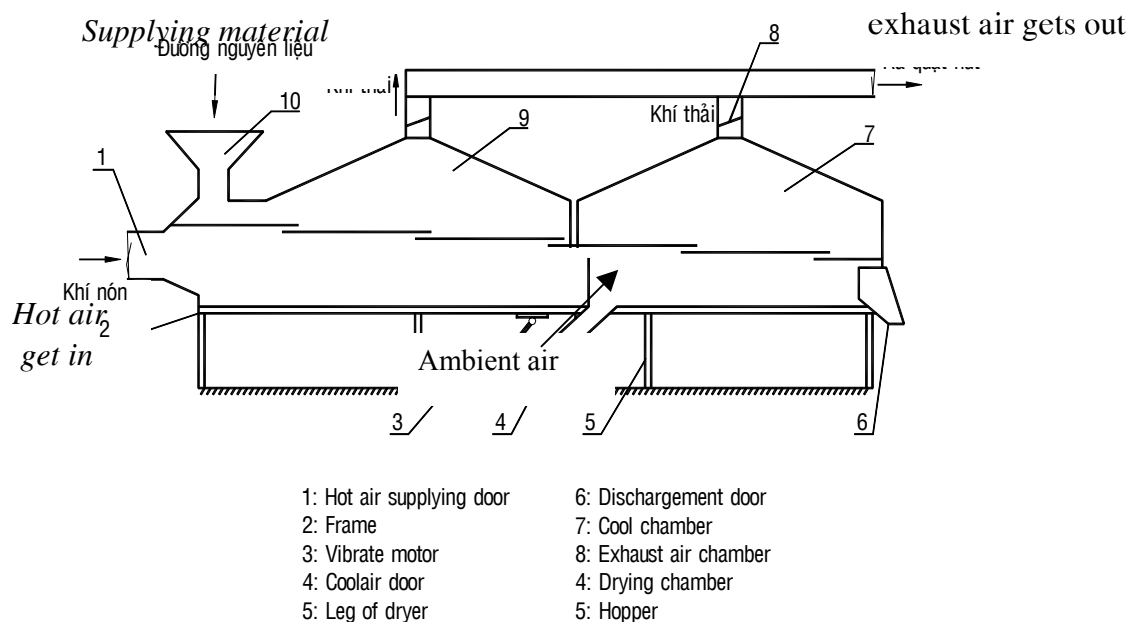


Figure 3: The vibrative dryer

Agricultural engineering investment & consultant company (AGRINCO) belongs to the Vietnam Ministry of Agriculture & Rural Development has researched and developed most of sugar-cane mills which were supplied and transferred by China such as Daclac, Tri An, Ben tre, ViThanh, TraVinh, and SocTrang sugar-cane mills. The dryer is designed and modified from the vibrative conveyor, which is used transportation the finished products from the A,B centrifugal machines.

On drying, refined sugar-cane is both to keeps in touch with heat from the separated plates and to receives hot air from step gates of separated plates directly. Refined sugar-cane is moved along the conveyor during vibration.

Humidity air evaporates of refined sugar-cane and Sugar powder are get out through exhaust tube.

The dryer is designed and modified on the vibrative conveyor so that its investment is low. The broken crystalline grain rate is lower than the rotary drum dryer, the colour and grain size of sugar-cane is more beautiful and whiter.

4.3. The fluidized dryer

The fluidized dryer is also designed and reformed on the vibrative conveyor of the sugar mill. The dryer consist of three chambers.

- The first one is received and distributed material sugar regularly on the wideness of conveyor.
- The second one is fluidized dryer. It includes two chambers which is separated by a screen with many holes that their size are super small. Material sugar is on the screen, hot air is under screen. The hot air chamber has three curve separated walls to distribute hot air regularly during drying.
- The last one is cool chamber. Its structure is alike the drying chamber. This chamber is received ambient to cool dried sugar.

All other parts of the fluidized dryer is like the vibrative dryer such as heat mass transfer, exhaust air chamber, sucked fan, and cyclone separator.

The principle described the figure 4.

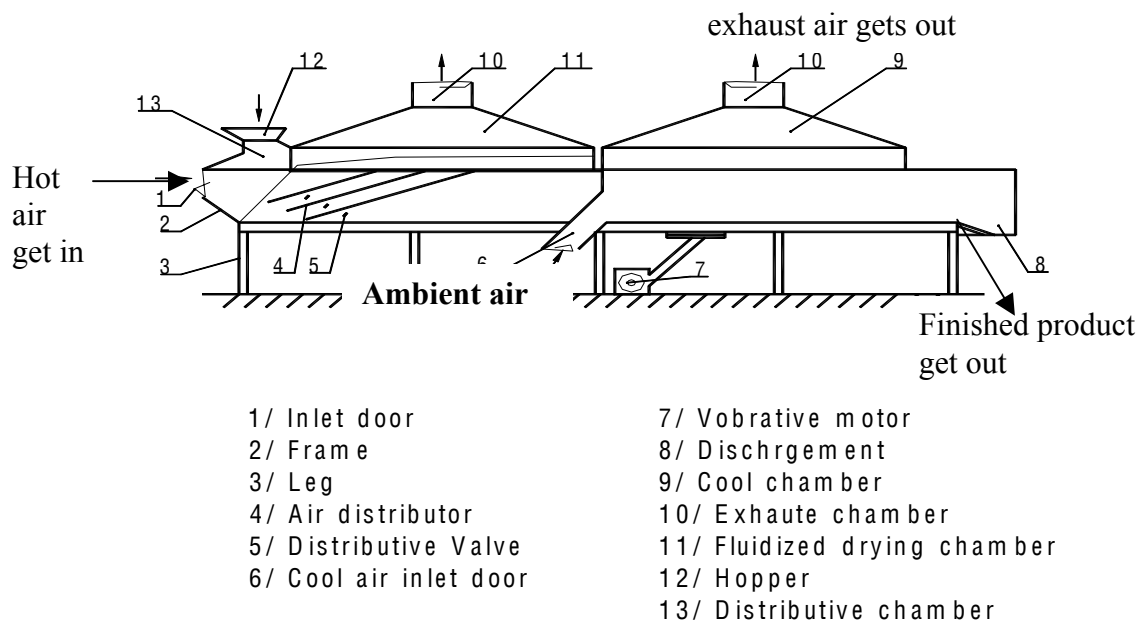


Figure4: Fluidized dryer

During drying, material sugar is moved little by little from the first chamber to the second chamber. Hot air is adjusted by the air valves of the flow heading part with its pressure is from 1100 Pa to 1120 Pa, pressure of exhaust air is (-) 1400Pa and gas velocity of fluidity is from 0,2 to 3m per second. Hot air (gas) goes through super small leaks of the screen. The layer of sugar is fluidized state and the frame of dryer is vibrating continuously. At this time drying sugar layer is float on the screen and moved to the terminal chamber. The surface evapotranspiration of sugar grain and humidity transfer to hot air is fast and strongly to equilibrium state at the end of the drying chamber. Dried white sugar-cane

continues to move in a cool air flow of the cool chamber to cool to stored temperature. Exception screen material and manufactured technique is specially and complexly, the rest parts of the fluidized dryer is manufactured simply

Because of sugar-cane is moved and floated during drying, sugar-cane grain is get in touch with screen seldom so that crystals is not broken, the colour of sugar-cane is white and beautiful.

Comparison the other drying principle for sugar-cane, investment of the fluidized dryer is higher, the structure and operation technique is more complicated so that the technician should have good skill. The fluidized dryer is manufactured and transfed in the Binh Dinh and Test & line- Nghe An sugar mills.

5. The auxiliary components

Tube heat transfer and cyclone separator are the two auxiliary components of the sugar-cane dryer.

5.1. U tube heat mass exchanger

Almost sugar mills are using steam to supply heat for sugar-cane processing so that energy for drying is get on from the heat mass transfer equipment. the U type heat exchanger is designed to sugar-cane dryer. Because drying air temperature is under 90°C so that the thickness of tube is 3mm and the stationary tube sheet is about 14 to 17 mm. The heat exchange area is 36m^2 , and capacity of the blower fan is $16\ 000\text{m}^3$ per hour, pressure 1500Pa

5.2 The Cyclone separator

There is a cyclone separator that is joined to the dryer for collect sugar powder during drying. People can design and choose one of two kind of cyclone separator. The wet cyclone separator is better than dried cyclone while it collects sugar dust. However the manufactured material is better and maintenance should be permanently. Operating cost of wet cyclone is higher than dried cyclone. In fact AGRINCO designed and manufactured dried cyclone to equip for sugar cane dryers. The dried cyclone is more simple and cheap price.

6. Conclusion and discussion

- It is necessary to dry refined sugar to standard moisture before packing in weather condition of Vietnam. In fact some sugar mills of Vietnam has not yet to pay attention this problem. They use ambient to dryer sugar on the way transportation from the A Centrifugal machine position to the separated Screen position (the temperature of product at the A centrifugal machine is under 80°C). Actually, sugar moisture is decreased little. This sugar-cane drying process is as cope with customers temporarily.

- The vibrative dryer is more advantage than the others. Its investment is lower. Exception the heat transfer should be equipped newly, In Chinese sugar mills, people can reform and supplement some auxiliary parts only.
- Do not pack finished product when its temperature is high.
- Do not store the crude sugar-cane and the dried white sugar in a storage
- Do not load over 25 bags of product on a column

The storage should be ventilated, the temperature is under 38⁰C and relative air humidity is about 70 %

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