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Design and analysis of bagasse dryer for boiler

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Abstract- The process of manufacturing crystal sugar requires steam. By installing co-generation systems, the sugar industry now produces Electricity far in excess of their captive requirement & sells the surplus power to the grid. Mill wet bagasse contains about 50% moisture. The calorific value of mill wet bagasse is 2280 kcal/kg. Use of driers to reduce the moisture content in bagasse before it is burnt, is regarded as a simple energy conservation measure. This bagasse drying system can also use the waste heat from the boiler flue gases for its partial heat requirement.

Keywords- Bagasse, Boiler, Dryer, Flue gas.

I.INTRODUCTION

Bagasse, the fibrous material, is one of the main by-products of cane sugar manufacturing plant, which is obtained after the sugar juice is leached out of sugarcane. It has moisture content of around 48% to 51% as it leaves the milling process. Bagasse drying is a matter of keen interest to the sugar industry, due to its utilization as fuel in boilers. Bagasse has a Gross Calorific Value of 9456 KJ/kg at 50% moisture and 12386kJ/kg at 35% moisture content (DinenGoshk 2003; Jorge Barroso et al, 2003). This shows drying bagasse before firing in the boilers could save considerable amount of fuel. Drying of moist objects is a complicated process, which is described as reduction of product moisture to the required dryness values at a definite process. All units the product to reach the drying values at the definite process consist of heating and dehumidification, which is described as the drying system.

II.LITERATURE REVIEW

Between 1910 and 1970 only a small number of papers were published and even few industrial applications were reported. The reason for the lack of interest in the bagasse drying during this period was low cost of fossil fuel. Due to energy crisis in the 1970’s effort have been concentrated in further reducing the bagasse moisture by drying with waste heat from flue gases. So that decreasing the stack particulate and CO (Carbon monoxide) emission and boiler efficiency increased from about 65% to 70%.

Professor Kerr was the first one that studied drying of the sugarcane bagasse using the exit gases in 1910. The dryer made in steel was 1.2m x 1.8m cross-section and 6.0m high. It was a countercurrent contact with deflectors to promote better gas – solid contact. He work with three rotary drum type dryers of maximum capacity to operate with existing boiler based on flue gases temperature 218’c. These three dryers processed all the bagasse production by daily grinding rate of 8000 Tons of cane and lower the moisture content from 54% to 46%. (w.b).

Kinoshita (1991) published four systems using boiler flue gas to dry bagasse installed in Hawdi. Three of the four installations were rotary dryers and the other; a flash dryer.Correia (1983) described the use of a pneumatic transport dryer. This dryer was developed in the Santo Antonio factory, in Alagoas, Brazil. He reported in increase in steam production of 16% by drying the bagasse from 52% to 40%.Massarani and Valenca (1981 and 1983) studied intensively the drying of bagasse in moving bed dryer. They developed a study from laboratory scale to pilot one. The pilot installation was composed a dryer of 0.40 x 0.50 x 2 m.

Nebra and Macedo (1989) published industrial equipment. This dryer was a flash dryer type could work with 25 ton bagasse/hr. That is the biggest flash dryer reported until now Arrascaeta et al. (1987) got a patent of a baggase dryer that elutriates the bagasse, spreading the particles in different sizes. This dryer could work with 7 tons/hr. It was designed, constructed and then operated from 1983 to 1985. It was fluidized and pneumatic conceptions.

Augustingky (2004) described the installation of two pneumatic dryers at Brazilian sugar industries in 1984 and in 2004.Salermo and

Santana (1986) worked with a dryer composed of a fluidized bed, a pneumatic duct and a cyclone. It is important that they used the cyclone to separate the phases. This system worked with 10 ton/hr of 47% moisture content (w.b) bagasse.

Cardenas et al. (1994) described a pneumatic dryer in an industrial size. They studied the energetic and exegetic efficiencies of a boiler – dryer system. They concluded that the use of a dryer improve the boiler efficiency. The researchers from school of Mechanical Engineering and school of Chemical Engineering from state University of Campinas (UNICAMP) have been working with drying of agricultural residues like sugarcane bagasse in cyclone (Silva and Nebra, 1997, Correa et al., 2004). A review of drying in cyclone that includes the works of this group is presented at Nebra et al. (2000).

Barbosa(1992) studied the Kinetics of sugarcane bagasse drying in a flash dryer. He observed that major part of moisture reduction occurred in the acceleration zone. Alarcon and justiz (1993) also worked with pneumatic dryer. The dryer reduced moisture content from 50% to 30% (w.b) and separated particles with different sizes. The biggest particles were used as raw material to paper and pharmacy industries and the smaller ones were burned. This is a solution for countries like Cuba that do not have energetic sources.

III.BAGASSE DRYING METHODS

Drying generally refers to the removal of moisture from a solid by evaporation. Based on the mode of heat transfer, bagasse dryers can be classified into two types.

1) Indirect or non-contact Dryers. 2) Direct or contact Dryers.

1. Indirect Dryers

They are also called as non-adiabatic units, where the heat transfer medium is separated from the product to be dried by a metal wall. In the case of drying of bagasse, the heat transfer is only through conduction and forced convection. No radiative heat transfer takes place because of lower temperature levels of operation. The indirect drying method can be tried for bagasse with low pressure steam (3atm or less) by adopting large tube bundles, inside a large bin. Typically the bagasse moisture can be reduced from 50% to 45%. A dryer handling 90t.p.h through put of wet bagasse at 50% initial moisture can be dried to around 86t.p.h of bagasse at 45% outlet moisture with around 4t.p.h of evaporated moisture. The dryer would consume around 6.3 tons of low pressure steam. Even after discounting for the energy of steam used and the electrical power required for the drive of dryer motor, there can be significant energy economy because of increased boiler efficiency and increased boiler steam output. The increase in boiler efficiency and the increase in steam to bagasse ratio are because of lower moisture content in bagasse.

2. Direct Dryers

Direct dryers or adiabatic or contact type dryers, transfer heat by direct contact of the product with the hot gases. The gas transfers sensible heat to provide the heat of vaporization of the moisture present in the solid. Since the moisture content in bagasse is quite high, it is possible to obtain the benefit of non-luminous radiation heat transfer.

IV.METHODOLOGY

The dryer unit consists of rectangle type in construction (2m x 2m x 9 m). Inside the dryer has a spreader, it is placed just below the hopper. There is a uniform gap is maintained between the spreader and the wall of the dryer along the four sides. Through the gap, the bagasse is freely flow into the dryer. An opening is made on one side of the dryer just below the spreader at the vapor space. A duct or pipe line is connected with the opening of the dryer at one end and the other end is connected with the dust collector (called as cyclone separator). A curved plate is welded with the dryer just above the opening of the dryer. So that it prevents the falling of bagasse in front of the opening from the spreader, when it flows into the dryer. If the curved plated is not provided in the dryer, the falling of the bagasse in front of the opening are sucked into the dust collector by the draft, which is created by the exhaust fan. A level controller is placed at a distance of 2m from the top of the dryer to maintain the level constantly. The first flue gas distributor is placed at a distance of 0.5m below the level controller.

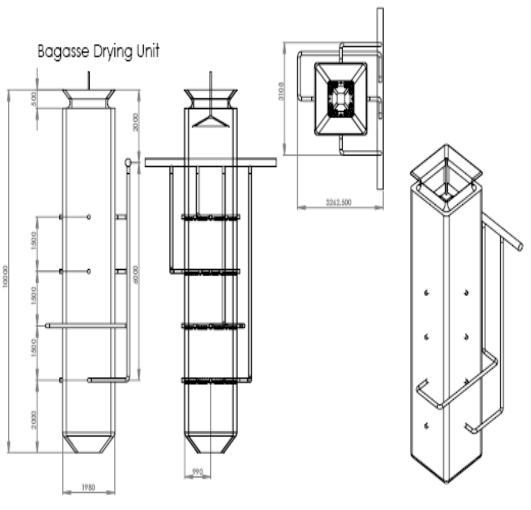

Fig. 1 Bagasse Dryer Unit

The second, third, and fourth distributors are placed at a distance of 1.5m apart consecutively and uniformly. An opening is provided at the bottom of the dryer. This opening is varied in space between the top and bottom. The top side is larger in dimension and the bottom side is smaller in dimension. The height of the bottom opening is 0.5m. This opening of the dryer is connected with the drum feeder, and the feeder is used to deliver the moisture reduced bagasse into the boiler through screw conveyor.

The flue gas pipe is circular shape in construction. The hot flue gas suction is taken near the inlet of the chimney. A blower is used to discharge the hot flue gas with the required mass and velocity into the distributors. The hot flue gases in the distributors are comes out through the nozzle at a high velocity of jet. This high velocity jet of gases impinges into the bagasse at the bottom and two sides of the distributors and flows counter currently upward. Due to this, mixing of flue gas and moisture bagasse is takes place and thus the flue gases absorb moisture from the bagasse. This process can be takes place throughout all the distributors, when bagasse flows into the dryer. Hence the mixture of flue gases and water vapor are collected in the vapor space of the dryer due to the draft. This draft is created by the blower, which is placed after the dust collector. The accumulation of mixture of flue gas and water vapor are sucked into the dust collector. The dust collector splits the solid particles, if any presents in the mixture of gases and settles down at the bottom. The dust free mixture of flue gas and vapor are sent to the chimney by the blower or exhaust fan. Drum feeder is a device used to discharge the moisture reduced bagasse from the dryer into the boiler at constant feed rate. The capacity of drum feeder is to be designed as 10 Tph and the mass of bagasse feeding is 166 kg/min, for the 85 Tph of steam production boilers. The drum feeder has a rotating drum inside. The periphery of the drum is fixed with knife edged pieces. The drum feeder is driven by using VFD (Variable Frequency Drive) motor. So the rotation of the drum could be able to control at infinitely variable speed.

V.RESULT

In bagasse drying unit below 30°C is feeded into drum. Flue gas of ≤ 450°C is passed into the unit. Output of bagasse is 120°C to 140°C is obtained which is fed into the boiler with greater efficiency.

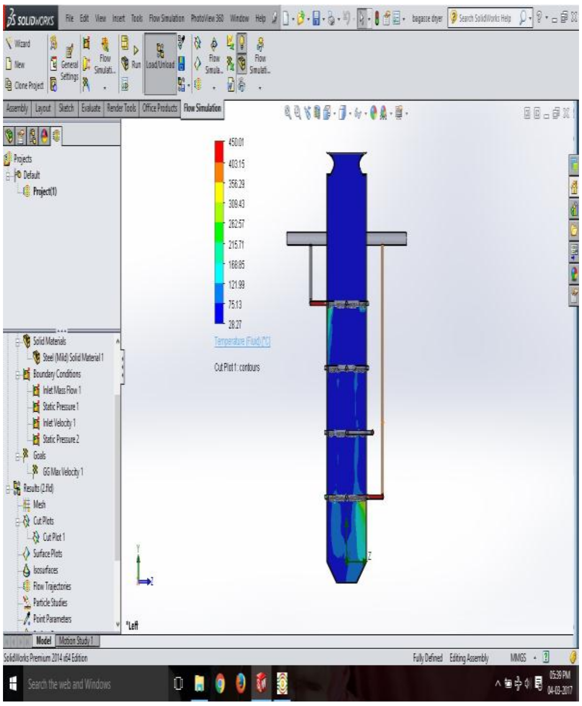

Fig. 2 Analysis of Bagasse Dryer

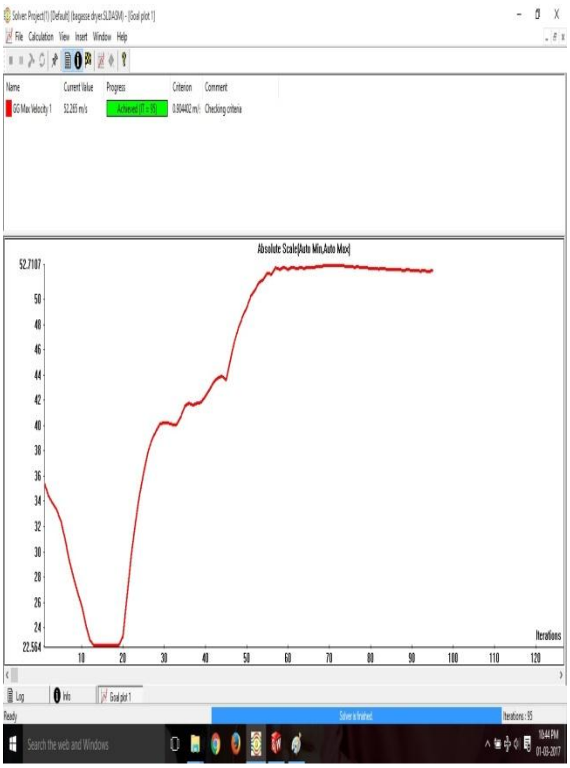

Fig. 3 Graph of Bagasse Dryer Unit

VI.CONCLUSION

Many types of dryers are available for drying the bagasse. They are complex in design and external driving force is required for making the bagasse to flow into the dryer. But in our design, the vertical type dryer which is simple in design and does not require any external power to force the bagasse. This is an economical and robust design maintenance is less for the effective performance of the dryer. This dryer is a self-cleaning one, which will prevent self-clogging, and it ensures the long life to run without stopped.

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