Proposal for the Development of a Device to Load Bagasse at Sugar Industry

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Abstract- In all sugar industries the cane after processing is left with the waste product called "Bagasse". The Bagasse produced in the mills is used as a fuel to boilers and the generation of steam. The steam thus produced is expanded in turbines and the power is generated. The excess bagasse is then stored in an open area. Lot of human health hazards is taking place due to loading of bagasse. Nowadays, the industries are using the crane systems to load the bagasse into the tippers, which is a very slow task and causing more dust. The bucket conveyors are used to move bulk materials in a vertical or inclined path. Buckets are attached to a cable, chain, or belt. Buckets are automatically unloaded at the end of the conveyor run. The belt conveyor is used for transporting light- and medium-weight loads between operations, departments, levels, and buildings, providing considerable control over the orientation and placement of the load. The belt is roller or slider bed supported; the slider bed is used for small and irregularly shaped items.

Index Terms- Bagasse, Sugar industry, Sugar

I. INTRODUCTION

Indian sugar industry is the 2nd largest agro-industry with approximately 50 million sugarcane farmers and a large number of agricultural labourers (7.5% of the rural population) involved in sugarcane cultivation. In India, sugarcane is the key raw material, planted once a year during January to March. The production of sugar is spread across the country. Maharashtra, UttarPradesh, Karnataka, Tamil Nadu, Gujarat and Andhra Pradesh are the major sugar producing states in the country. Maharashtra and UP are the main cane producing states.

Bagasse: Bagasse is the material obtained after extraction of juice from sugarcane stalk.It is used as fuel in co-generation plant of sugar mills but is burnt directly in furnaces. Efficient burning of bagasse depends on its moisture content. Fresh bagasse normally contains 50% moisture.

Efficient burning of bagasse depends on itsmoisture content. Fresh bagasse normally contains 50% moisture and reductionof moisture improves upon its calorific value [1]. Calorific value of bagasse dried to half of itsinitial moisture content is about 10% higher [2]. Manohar [3] reported that wet mill bagasse has moisture 50%, fibre pith 47%, sugar 2.5% and mineral 0.5%. The composition of bagasse obtained from sugar mill is given in Table 1.

Table 1 Composition of Bagasse of Sugar Mill

Composition, %	Mill Bagasse
Fibre	43-52(Avg. 47.7)
Moisture	46-52(Avg. 50)
Soluble Solids	2-6 (Avg. 2.3)

A typical chemical analysis of bagasse might be (on a washed and dried basis) as mentioned below;

Bagasse is an extremely inhomogeneous material comprising around 30-40% of "pith" fiber, which is derived from the core of the plant and is mainly Parenchyma material, and "bast", "rind", or "stem" fiber, which comprises the balance and is largely derived from sclerenchyma material. These properties make bagasse particularly problematic for paper manufacture and have been the subject of a large body of literature.

Table 2 Chemical analysis of Bagasse

Cellulose	-	45-55 %
Hemi-cellulose	-	20-25 %
Lignin	-	18-24 %
Ash	-	01-04 %
Waxes	-	Less than 1 %

Bagasse can be used for various other forms, such as follows;

a) Fuel

Bagasse is often used as a primary fuel source for sugar mills; when burned in quantity, it produces sufficient heat energy to supply all the needs of a typical sugar mill, with energy to spare. To this end, a secondary use for this waste product is in cogeneration, the use of a fuel source to provide both heat energy used in the mill, and electricity, which is typically sold on to the consumer electricity grid.

The resulting CO_2 emissions are equal to the amount of CO_2 that the sugarcane plant absorbed from the atmosphere during its growing phase, which makes the process of cogeneration greenhouse gas-neutral. In many countries (such as Australia), sugar factories significantly contribute 'green' power to the electricity supply. Florida Crystals Corporation is one of America's largest sugar companies, owns and operates the largest biomass power plant in North America. The 140 MW facilities use bagasse and urban wood waste as fuel to generate enough energy to power its large milling and refining operations.

b) Paper

Paper production is the second-largest revenue stream from bagasse; the largest is electricity cogeneration. Using the by-products ofagricultural crops for paper production, rather than wood, does offset commercial forestry practices.

This is believed beneficial because the conversion of the rainforest to commercial tree stock and common forestry practices destroys a majority of the indigenous rainforest life forms. For example, the most common commercial tree stock for short fiber pulp for paper is eucalyptus, which is considered an invasive species due to compounds in the leaves that can be toxic in large quantities and because it is considered a fire hazard.

A secondary benefit of substituting agricultural by-products for commercial forestry practices is the reduction of the number of farmers following logging roads into the rainforest for the purpose of burning pristine rainforests to convert to farming. It is thought that bagasse has the added advantage over other forms of papermaking feedstock in that it requires fewer greenhouse gases to collect, compared to harvesting of wood chips, as thefibre has already been transported to the factory for extracting the sugar.

c) Boards

It can also be used for making boards resembling Plywood or Particle board, namely Bagasse board. It has wide usage for making partitions, furniture etc. It is an eco-friendly method as it does not involve any harmto the world's timber resources, un-like plywood. It is known as Bagasse Board and is considered a good substitute for plywood.

d) Controls

Mechanical collectors and wet scrubbers are commonly used to control particulate emissions from bagasse-fired boilers. Mechanical collectors may be installed in single cyclone, double cyclone, or multiple cyclone arrangements. The reported PM collection efficiency for mechanical collectors is 20 to 60 %. Due to the abrasive nature of bagasse fly ash, mechanical collector performance may deteriorate over time due to erosion if the system is not well maintained. Impingement scrubbers are in greater use due to their lower energy requirements and fewer operating and maintenance problems. Reported PM collection efficiencies for both scrubber types are 90% or greater.

Moisture test of Bagasse

Experimental procedure followed to determine the moisture content of the Bagasse in the laboratory;

1. Weighing out 100 gms of Bagasse material.
2. Dry it in oven at a temperature between 105 ºC to 110 ºC.
3. Cool it to room temperature.
4. Weight it again to find the loss.
5. The difference between the first and final weight of the sample will equal to the original moisture content.
6. Report the exact percentages of moisture determined.
7. Express moisture as percentage of moist sample.

II. PROBLEM DEFINITION

The sugar factories works in the season of October to march, during season lot of bagasse is collected and stored in an open place. Loading of Bagasse to the trolley has become a very difficult task due to dust coming out of it and it creating a lot of health hazards to human beings. Hence labors are unable to work it that environment. Hence a mechanical system must be developed for the loading of Bagasse.

III. PROPOSED WORK

The loading of bagasse is a very difficult task in sugar industries as it causes more dust while doing to trolley. Hence it is required to develop a new mechanism for loading bagasse in sugar industry. Hence we proposed a mechanical system for loading a bagasse by using bucket conveyors.The bucket assembly starts rotating and starts collecting the bagasse from heap. When the bucket reaches to the topmost position, the bagasse gets dumped into the hopper which then guides the bagasse towards the conveyor. Once the bagasse is conveyed onto the conveyor, it is then transported to the trolley. Engine is attached to the whole assembly so that the movement of the assembly can be made easier and it can also be moved to the place from where the bagasse is to be loaded.

Objectives

1. To suggest the development of an economic new mechanism for sugar industries in India to load the Bagasse to the trolley.
2. To be economical, consume less labor and lesser time than conventional methods.
3. To create a human hazardous free mechanism covering under safety norms.
4. To create a flexible and multipurpose mechanism.

Observations:

Percentage of moisture content
= (W1 - W2) / W1 X 100 = 50 %
Where,
W1 (gms) = Weight of Bagasse whose moisture is to be determined = 100 g.

W2 (gms) = Weight of Bagasse after drying = 50 g.

After performing the experiment finally the average moisture content in bagasse is found out to be 50%. Composition of Bagasse is shown below

Table 3 Composition of Bagasse

ITEM	BAGASSE (%)
Moisture	49.0
Fiber	48.7
Soluble Solids	2.3

IV. METHODOLOGY

The prototype mechanism works on 12 V DC power supply. When the power is switched on, the bucket assembly starts

rotating and starts collecting the bagasse from the heap. When the bucket reaches to the topmost position, the bagasse gets dumped into the hopper which then guides the bagasse towards the conveyor. Once the bagasse is conveyed onto the conveyor, it is then transported to the tippers and trucks.

Some of the design considerations made are:

1. Minimum ground clearance must be provided for the ease of movement of the buckets.
2. The slope and position of the hopper should be set so that the whole amount of bagasse that is collected goes onto the conveyor. An enclosure is suggested for the hopper so that the bagasse is not carried away by the wind.
3. The height of conveyor frame should be in proper alignment with the hopper and at the same time the other end of the frame should confirm to the height of the tippers and trucks for easier transportation.
4. The bucket assembly and the conveyor should be attached together with a common weld in order to maintain the constant distance between bucket assembly, hopper and conveyor. For this setup a driving mechanism is suggested so as to make the whole mechanism flexible to move and collect the bagasse.
5. The conveyor used here is roller conveyor in which the rollers are arranged in such an inclinedposition that the belt forms a "U" position by idlers so that the bagasse does not get carried away by any external influences.
6.

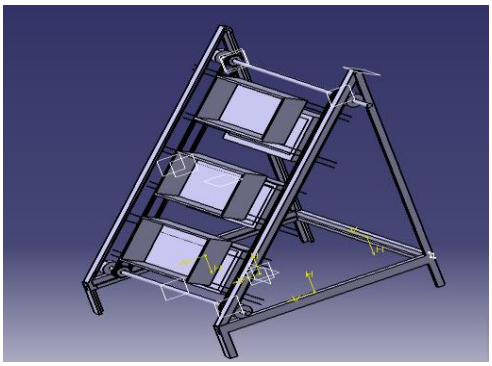

Fig 1 Isometric View after Final Assembly

V. MANUFACTURING OF COMPONENTS

Buckets: Bucket is the component used for loading the Bagasse in the sugar industry as it offers less resistance during collection of material because of less area of contact Presence of teeth and the slope provided makes it easier to collect the bagasse. Bulk production of these buckets is cost effective hence after a long market survey we preferred the material of bucket as stainless steel 302 grade.

Stainless steels are corrosion resistant steels, which are protected by the formation of a self-repairing passive oxide film. The resilience of this layer increases with chromium content and also with the addition of molybdenum. The presence of nickel encourages the formation of a crystalline structure called austenite, which aids ductility and formability. The standard stainless steel alloys used in plumbingapplications typically contain 17-18% chromium and 8-12% nickel.

The nominal width of bucket is 1.2m and length of bucket is 1,5m and depth is of 0.6m. the buckets are arranged with the teeth which helps to take the bagasse easily. The size of bucket helps to collect more bagasse and fill the trolley in a very faster rate.

Stainless Steel 302, as Bucket Material

SS302 is an austenitic Chromium-Nickel stainless steel offering the optimum combination of corrosion resistance, strength and ductility. These attributes make it a favorite for many mechanical switch components.

Advantages offered by Stainless Steel

- **Material Benefits**
  1. Stainless steel has a very low general corrosion rate in water and no corrosion allowance is required.
  2. Combiningcorrosionresistancewithhighstrength allows reduction in section diameter, wall thickness and weight, making it quick and easy to install.
  3. It is ductile and using the appropriate tooling is not difficult to bend andcut.

- **Environmental Benefits**
  1. Stainless steel can be used in all types of water.
  2. No heatis requiredtoformajointor agroove, reducingfirehazards.Thereforehotworkpermits arenotrequired.
  3. Stainlesssteelis fullyrecyclable.

- **Economic Benefits**
  1. The expected life time of a stainless steel system is morethan50years, longer than is typical for competingmaterials.
  2. Stainless steel requires no additional coating.
  3. No maintenance is required after installation, reducingsystemdowntime, replacement and maintenance costs over the life-cycle of the installation.
  4. Although initial costs may be higher than for competing materials, such as copper and plastic, the economic benefits of using stainless steel increase over time.
  5. At the end of its useful life, stainless steel is fully recyclable and retains a higher residual scrap value than ordinary steel.

Table 4 Nominal Composition

Chromium	18.2%	Silicon	5%
Nickel	85%	Carbon	0.06%
Manganese	1.6%	Iron	Balance

Table 5 Physical Properties

Density	= 0.284lbs.cu.in.
Melting Point (Approx.)	= 1400°C Electrical
Resistivity @ R.T.	= 72 Microhm·cm
Thermal Expansion	= 17.3x10-6/°C

Coefficient (0° to 100° C)	
Thermal Conductivity @100°C	= 16.3W/m·K
Magnetic Attraction	= None / Slight
Annealed Cold Rolled	---
Magnetic Permeability (Annealed: H=200 oersteds)	= 1.02 Max.

General Corrosion: ATI 302 austenitic steels provide useful resistance to corrosion on a wide range of moderately oxidizing to moderately reducing environments. The alloys are used widely in equipment and utensils for processing and handling of food, beverages and dairy products.

In addition, a large variety of applications involve household and industrial chemicals. The 18 to 19 percent chromium which these alloys contain provides resistance to oxidizing environments such as dilute nitric acid, as illustrated by data for ATI 302 below

Table 6 Data for ATI 302

% Nitric Acid	Temperature ^{0}F (^{0}C)	Corrosion Rate Mils/Yr (mm/a)
10	300 (149)	5.0 (0.13)
20	300 (149)	10.1 (0.25)
30	300 (149)	17.0 (0.43)

Table 7 Typical Mechanical Properties

Property	Annealed	Cold rolled
UltimateTensile Strength	100,000 PSI	210,000 PSI
YieldStrength(.2%Offset)	40,000 PSI	190,000 PSI
Elongation in 2”*	40 %	2 %
Modulus of Elasticity (Tension)	28x106 PSI	-
Poisson’s Ratio	0.29	-

*The measured elongation will be less as thickness decreases to .002”and less.

Belt Conveyors: A belt conveyor consists of two or more pulleys, with a continuous loop of material - the conveyor belt that rotates about them. One or both of the pulleys are powered, moving the belt and the material on the belt forward. The powered pulley is called the drive pulley while the unpowered pulley is called the idler. There are two main industrial classes of belt conveyors; those in general material handling such as those moving boxes along inside a factory and bulk material handling such as those used to transport industrial and agricultural materials, such as grain, coal, ores, etc. generally in outdoor locations.

The belt consists of one or more layers of material. They can be made out of rubber. Many belts in general material handling have two layers. An under layer of material to provide linear strength and shape called a carcass and an over layer called the cover. The carcass is often a woven fabric having a warp & weft. The most common carcass materials are polyester, nylon and cotton.

It is considered a labour saving system that allows large volumes to move rapidly through a process, allowing companies to ship or receive higher volumes with smaller storage space and with less labour expense.

Rubber conveyor belts are commonly used to convey items with irregular bottom surfaces, small items that would fall in between rollers (e.g. a sushi conveyor bar), or bags of product that would sag between rollers. Belt conveyors are generally fairly similar in construction consisting of a metal frame with rollers at either end of a flat metal bed. The belt is looped around each of the rollers and when one of the rollers is powered the belting slides across the solid metal frame bed, moving the product.

In heavy use applications the beds which the belting is pulled over are replaced with rollers. The rollers allow weight to be conveyed as they reduce the amount of friction generated from the heavier loading on the belting. Belt conveyors can now be manufactured with curved sections which use tapered rollers and curved belting to convey products around a corner.

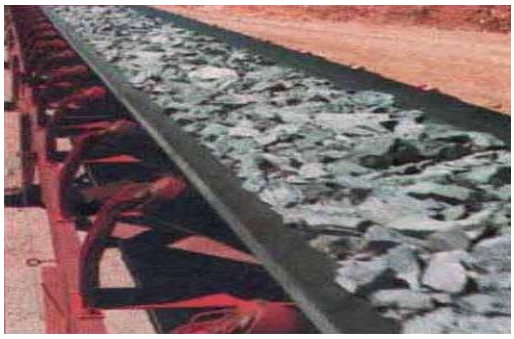

Fig 2 Belt Conveyor

In the Project, belt conveyor is used for the transportation of bagasse from the hopper to the trolley. The belt of conveyor is made up of top cover, end cover and carcass as explained earlier. Belt is also made of U-shape with the help of idlers as shown in above figure to prevent dropping of bagasse from belt.

Chain Conveyors: These conveyors generally have double or triple and sometimes multiple strands of roller chains running over fabricated frames and guides. They are used where positive transport of goods is required, and are often used in roller conveyors where a change of direction is required.

Chain conveyors utilize a powered continuous chain arrangement, carrying a series of single pendants. The chain arrangement is driven by an electric motor and the material suspended on the pendants is conveyed. Chain conveyors are used for moving products down an assembly line and/or around a manufacturing or warehousing facility.

Fig 3 Saltplus' Warlock Halflink' Chain

Chain conveyor is arranged with series of buckets. The buckets are welded with two cast iron bars to conveyor. Conveyor is provided power by electric motor because as electric power is generated in industry. When conveyor rotates buckets collects bagasse and dump to hopper.

Essential Properties Components

1. Flexibility
2. Transverse rigidity
3. Low mass per unit length
4. High strength
5. Simplicity and inexpensive
6. Longer life
7. Should not stretch under normal working stresses, (i.e. low relative elongation)
8. Wear resistant
9. Fire resistant

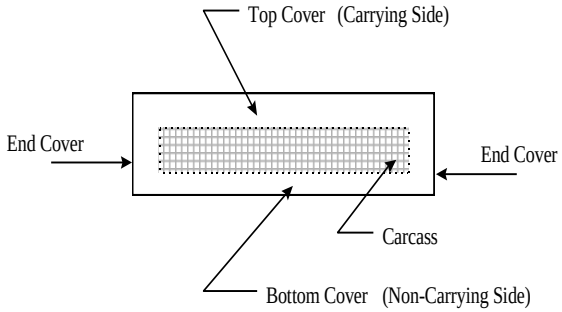

Fig 4 Construction of conveyor belt

Pulley

A pulley is a wheel on an axle that is designed to support movement of a cable or belt along its circumference. Pulleys are used in a variety of ways to lift loads, apply forces, and to transmit power. A belt and pulley system is characterized by two or more pulleys in common to a belt. This allows for mechanical power, torque, and speed to be transmitted across axles. If the pulleys are of differing diameters, a mechanical advantage is realized.

In the case of a drum-style pulley, without a groove or flanges, the pulley often is slightly convex to keep the flat belt centred. It is sometimes referred to as a crowned pulley. Though once widely used in factory line shafts, this type of pulley is still found driving the rotating brush in upright vacuum cleaners. Agricultural tractors built up to the early 1950s generally had a belt pulley. It had limited use as the tractor and equipment being powered needed to be stationary. It has thus been replaced by other mechanisms, such as power take-off and hydraulics.

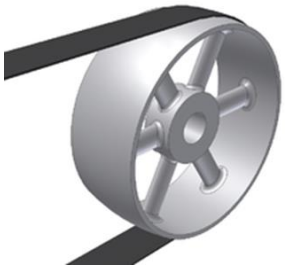

Fig 5 Flat belt on a Belt Pulley

Cast Iron Angular Plates

Angular plates are used to provide support to the whole assembly. Bucket conveyor systemis supported by the cast iron angular plates.

Fig 6 Cast Iron Angular Plates

VI. DISCUSSION AND CONCLUSION

Considering all the design parameters, real-time calculations, safety norms, cost efficiency, material life time and labour availability, it can be concluded that the Mechanism that is suggested is the most appropriate for conduction and transportation of bagasse. The sugar plant is bounded by a limitation of utilizing an excavator for 10 hrs. Per day; henceforth the use of this mechanism which can be fabricated at a onetime investment can serve the plant when needed, eliminating the cost expenses.

The mechanism is flexible in terms of motion due to the presence of a driving mechanism which makes it to collect the bagasse covering the whole plant area over which the bagasse is spread. By varying the size of the buckets, the amount of bagasse that can be collected can also be increased correspondingly. The total number of links present in the mechanism is considerably less making the maintenance cost of the mechanism lesser. By this, above suggested real time application will be best to suit the company requirements and prevents human labours from hazardous environment.

Real-time Calculations

Total no. of buckets	= 10
Amount of bagasse collected in one bucket	= 10 Kg
Amount of bagasse conveyed/cycle	= 100 kg

Amount of bagasse conveyed/min = 6.67 tons
Amount of bagasse conveyed/hour = 40.02 tons

The main advantage of the proposed machine is its flexibility. It can be used to lift and convey not only bagasse, but also the materials in other industries like Crusher industry, Grain industry. The whole system is attached to the driving mechanism where in the machine can be driven to the place where the produce is stored and ready to be conveyed/transported. The mechanism proposed serve as in ideal replacement ofJCB's in Sugar Industries, in terms of economic parameters attached to it.

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