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Design and Fabrication of Small Scale Sugarcane Juice Extraction Using Solar Power

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ABSTRACT— The main objective in this paper is to design and manufacture a machine that is able extract sugarcane juice automatically with maximum juice extraction efficiency using solar power. An extracting machine was designed and fabricated. The materials use for the design and fabrication of the sugarcane juice extractor was locally sourced, Stainless steel Plate, Rollers, stainless square pipe, gears, chain, bearing, electric motor, reduction gear, bolt, and nut were bought-out materials were used. In the design, stainless steel material was used to avoid contamination of the extracted juice. The machine was designed to extract juice from the sugarcane and it is powered by an electric motor which is run by solar power. Solar power is obtained stored into the rechargeable battery through charging circuit. This paper consist of current sensor which uses to measure the current ,voltage and battery percentage of battery and which is connected to the Arduino UNO microcontroller to display the values on LCD module.
Keywords— Rollers, stainless square pipe, gears, chain, bearing, electric motor, rechargeable battery, Arduino UNO microcontroller, LCD module.

I. INTRODUCTION

The currently available sugarcane juice extractors require high energy and are application of more sophisticated mill driven mechanically. Some of the available cane crushers are of high capacity mainly for industrial applications. These are out of reach of small scale and rural farmers that are presently involved in processing of cane juice into ethanol, brown sugar and other related products at small scale level. The problems associated with processing of sugarcane include small size of farms and farm fragmentation as a result of land ownership by inheritance. In addition to the above problems using the same carriage capacity/medium, it will further reduce production cost to transport extracted sugarcane juice from the farm to the factory for refining into sugar than transporting harvested sugarcane to the factory for processing. This is because the extracted juices from a trailer load of sugarcane many not be up to 30% of a trailer load of juice.

Several methods of juice extraction were in used. These methods included boiling the cane to extract the juice, use of wooden presses and application of more sophisticated mills driven mechanically or by bullocks (Okogie, 1980). The high power requirements during processing of sugarcane constitute the major constrain in the development of small scale sugar processing plants. The average power distributions for a medium size sugar factory powered by electricity or steam turbine at crushing rate of 170 tons/hour. The development of a small scale sugarcane juice extractor was therefore to meet the needs of the small scale farmers who cannot avoid high capacity and complex cane crushers. The main objectives of this study were to design and construct a simple mechanical device for extraction of sugarcane juice. The functional performance and economics of operation of the machine were evaluated.

II. LITERATURE REVIEW

The development of sugarcane machines has been started hundreds of years back in many countries. The Trapiche is a traditional wooden roller used by people of Panama and Columbia to extract sugarcane juice, the trapiche is a Spanish word. “sugarcane crusher”. It is varying in size which is made up of wood. It has two rollers that are vertically placed and held by a wooden frame. (Rika, 2010).

A conventional machine is a simple machine consists of several gears, rollers, and lever attached on a cast-iron chassis body. Most conventional machines are made up of cast iron material which is strong and durable. These machines were made by a simple mechanism of rolling and crushing (Kulkarni, 2005). Crushing a sugar cane requires strong force due to its strong and hard characteristics. Juice extractor machines were built mostly focused on the mechanical of the machine. The efficiency of the machine depends on the mechanical system that has been

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designed on the machine. The performance of a pilotscale screw-press conveyor was tested for dewatering capabilities and power consumption. The un-optimized equipment decreased megasse moisture from 96 to 89 %. Olaoye, J. O. (2011), developed a sugarcane juice extractor for small scale industries. The designed is a simple mechanical device for the extraction of sugarcane juice. The output capacities of 10.50, 12.00 and 14.25 kg/hr were obtained at operating speeds of 0.25, 0.3 and 0.36 m/s. The extraction efficiency of the machine ranged between 40 and 61 % at operating speeds of 0.25 and 0.36 m/s. Design is to be implemented into reality through manufacturing assembly with good aesthetic. Then performance of machine is checked and compared with the other machines also confirmed that all objectives are satisfied. The human involvement in system operation is reduced when the system is actually working. The sugarcane juice extractor can be replaced by conventional cane juicers in juice bars cafes, restaurants, hotels etc. and the for the power we have solar panels here.

III. MATERIALS AND METHOD

The extractor machine consists of gears, crushing rollers, rollers, coupling, fixtures, metal frames and gear engines. The following are the various parts of the extractor of sugar cane juice:

A. The Crushing Unit/ Roller

The crush unit consists of three rollers, one big roller and two tiny rollers. The wide roller with a diameter of 100 mm and the longer, mild steel and the two wide rolls of 77 mm with a length of 300 mm and a mild roller of steel. The diameter of the rollers is 300 mm. These rollers are made of mild steel due to their resistance to compression. The mild steel bars have been coated by a lath machine and become aggressive, forming a rib-like structure. These provisions ensure that, unless removed, slipping in the case of plain crushing rollers occurring during feeding with sugar cane will be reduced to minimal.

B. Gears

The top-mounted roller controls the movement of two bottom-mounted rollers. The roller gears are 23 teeth mesh, which means that the three rollers depend on each other. The two other rollers move at the same speed as the top roller shaft, but in the same direction. The transmission is carried through the gear motor to two more rollers. The dental gear decreases the transmission rate to the broken roller so that the transmission torque on every roller increases. This increases the crushed strength of the roller surface.

C. Power Source

The electric gear engine is 2 hp. The input is connected with the input. The engine speed is reduced to 1:55 of the speed reducer from the engine, which is 1440rpm. The gear motor speed is 26.2 rpm for this power source.

D. The Machine Frame

This part consists mainly of the mild steel angle bars. Two flat shaped "H" profiles are made from mild steel. This is mounted on an angle bar stand ; the engine is placed on top of the stand.

E. Arduino UNO Microcontrollers

The Arduino Uno is a microcontroller board which has ATmega328 from the AVR family. There are 14 digital input/output pins, 6 Analog pins and 16MHz ceramic resonator. USB connection, power jack and also a reset button is used. Its software is supported by a number of libraries that makes the programming easier.

F. Solar Panel

Electrons (negatively charged) are knocked loose from their atoms, allowing them to flow through the material to produce electricity. Due to the special composition of solar cells, only allow the electrons to move in a single direction. The complementary positive charges that are also created (like bubbles) are called holes and flow in the direction opposite of the electrons in a silicon solar panel. An array of solar panels converts solar energy into a usable amount of direct current (DC) electricity. Solar powered electrical generation relies on heat engines and photovoltaic.

The machine was mounted on a table made from square stainless pipes and angle bar, with the electric motor and reduction gear mounted on the base, the designed roller was assembling and coupled with the shaft in the crushing chamber and the pinion gears were used on both sides of the rollers to connect to a chain drive.

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IV. DESIGN AND ANALYSIS

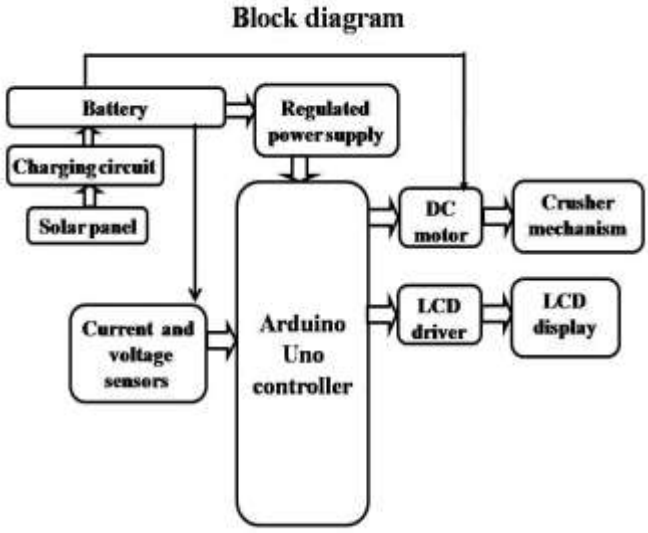

Fig 1. Block diagram

Power Selection for Motor

The required power for the electric motor was calculated 4.0 hp motor of 3300 rpm was chosen.

Motor ratings:

Output Power: 350W.
Supply Voltage: 24/36V DC
Speed: 2750 RPM
No load speed: 3300RPM
Full load Current: ≤19.20A
No load Current: ≤2.5A

The output capacity and extraction efficiency of the extractor were evaluated using Equations 7, 8 and 9 as described by Jenkins (1966), Hugot and Jenkins (1960), Rein et al. (2007) and Meade (1977).

(Weight of extracted juice / Total weight of Sugarcane)*100

Total Weight of stalks (Sugarcane) is given by (mass of shredded stalks – a mass of dry bagasse)

= 0.84 x 100 = 83.7 %

Capacity (Throughput) of Machine was based on the ability of the machine to extract sugarcane juice of duration of time per kilogram weight of the Sugarcane.

Fig 2. Detailed and Exploded Design of Sugarcane Juice Extracting Machine

A. Arduino IDE Compiler:

This instructable adds to any of the Arduino on a Breadboard instructables.

1. We need a microcontroller with a pre-loaded Bootloader, or must load your own
2. Not all ATmega328's are equal (A bootloader, very simply, is a programme that sits on the chip and manages the upload of your sketches onto the chip)

V. CONCLUSION

The machine was designed to extract juice from the sugarcane and it is powered by an electric

motor which is run by solar power. • Solar power is obtained stored into the rechargeable battery through charging circuit..This paper consist of current sensor which uses to measure the current, voltage and battery percentage of battery and which is connected to the Arduino UNO microcontroller to display the values on LCD module. Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced IC's with the help of growing technology, the project has been successfully implemented.

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