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Design & Manufacturing of Automation system for Jaggery Plant

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Abstract –*Jaggery industry has been considered as one of the small scale and cottage industry in India. Theproduction of Jaggery ranges between five million tons to seven million tons. Because of these plants are designed and fabricated on the basis of age old expertise without any technical supportthey suffer low profit or loss. In traditional method feeding of sugarcane is done by labour manually and Crushing is done by Three roller pan system.Current efficiency of Jaggery Plant is near about 50-60%. Cost of Operation in feeding is high and Juice extraction from crushing is not efficient. "Skilled labour" is also one of the major problem of Jaggery Plant other problems include* low profit,transportation, high raw material cost*. To overcome Labour Problems and reduce Labour cost Automation in jaggery Plant is Necessary.*

Key Words**: **JaggeryIndustry, Problems, Efficiency of Plant, Automation

1. INTRODUCTION

Jaggery is one kind sweetener used in most of parts of India.The survey was conducted on 25 random units of Jaggery manufacturing units of themajor clusters of Kolhapur district.7 Villages were selected, they were Balinge, Padali Khurd, Kodoli, Kotoli, Khupire, Nandgaon, Kavane, During the survey, manufacturers were asked questions regarding the Production of Sugarcane, Production of Jaggery cost of production, marketing channels, major-barriers to Jaggery industry and any kind of supports from government or private bodies. TheQuestionnaire and personal interviews had been conducted for data collection andconceptual thought behind this industry. In the survey, it was observed Jaggery plant owners are facing common problems, but the impacts of these Problems aredifferent for each. The major problems which were identified are low profit,transportation, high raw material cost, and lack of Research & Development. But out of this low profit is the major problem of Jaggery plant units.If they have their own transportation, they get more profit.The reason identified that due to lack of unity and of inter-competition, the plant owners are not ready to form any association, cooperative or society fordevelopment of transportation and R&D. Now a days Labour Problem is also big issue because of this number of Running Plant in Kolhapur decreases to 250 from 1000 in last 4 years. Also demand of High pay from labors reduces profit of Plant and this effect Jaggery market very badly.

From Table-4 which was data of Production of Jaggery from 2005- 06 to 2014-15,
Production of Jaggery decreasing per year and it decreases around 25% from 2012-13 to 2014-15.

Table -1: Production and rates of Jaggery in Kolhapur

Year	Quintals	Rates per Quintal in Rs.	
		Maximum	Average
2005-06	6,85,704	5,555	1,850
2006-07	6,71,318	5,500	1,550
2007-08	8,01,049	3,511	1,200
2008-09	8,05,563	3,800	2,200
2009-10	8,17,659	4,840	3,200
2010-11	8,55,043	6,001	2,500
2011-12	7,70,256	7,001	2,800
2012-13	8,65,448	6,000	3,200
2013-14	7,65,264	5,500	3,000
2014-15	6,55,442	5,500	2,900

1.1 Stages of Jaggery making

Sugarcane cutting and transportation are the two steps before extracting juice from sugarcane. The steps in Jaggery making are as follows: -

a. Extraction of juice from sugarcane
By using cane crusher which driven by oil engine or electric motors. About 1.5 or 2 tons ofsugarcane is required to make a single pan of Jaggery. A pan of Jaggery requirement dependsupon the quality of cane and its sucrose content.

b. Boiling of juice
Extracted juice from the sugarcane is taken for boiling, juice is boiled inopen pans. These pans are made up of iron sheets and are of 230 to 280 cms of diameter and about 50 cm deep. Generally, the baggasse is used as afuel.

c. Purification of juice
The juice which is heated and boiled releases out many impurities that needs to beremoved. Thus purification of juice is the main deciding factor for colour, texture, test anddurability of Jaggery [1].

d. Concentration of juice

Next step after purification of juice is concentration of juice which is boiled at thestriking point of temperature that
normally ranges between 11.80°c to 12.30 °c.

2. CONVENTIONAL SYSTEM AND AUTOMATION SYSTEM

Fig-1: Three Roller Conventional crushing system

A conventional Jaggery crushing system contain three rollers as shown in fig. First sugarcane is inserted into two inclined parallel rollers and Crushing is depends on distance between these two rollers and it's upto 50-60% efficient. Also 3 Labors needed for feeding and placing sugarcane in front of this system. To save no. of labors and increase efficiency to 80-90% we automate feeding system by using Hydraulic System.

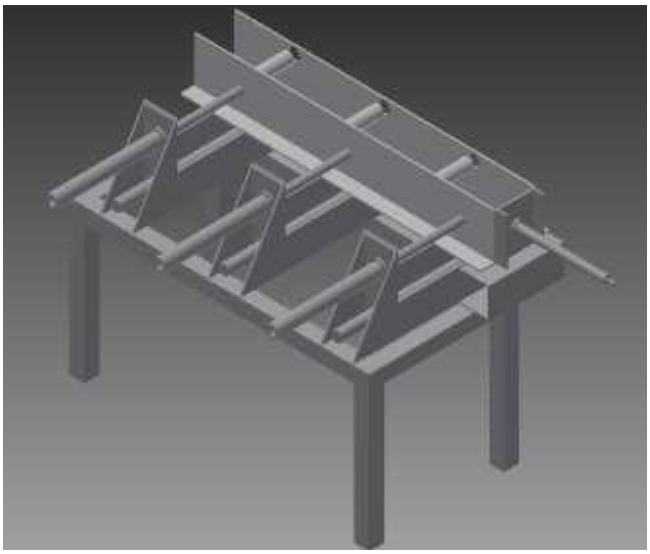

Fig-2: Design of Automation Sugarcane Feeding System

In improve automation system The sugarcanes are kept in between moving and fixed plate. The moving plate is attached to cylinder which can exert pressure on it. As the volume of sugarcane is not uniformly distributed over area
of bed, the guide-ways are provided to avoid the chances of bending the moving plate. The large amount of pressure is applied on sugarcane it gets squashed so that the volume of sugarcane is reduced. That is why in conventional system it can be feed by more number of sugarcane. The juice is extracted by these process is filtered and collected by the tray is fitted in bottom of the system.

3. SUGARCANE FEEDING SYSTEM

3.1 Design of Machine

Results after Sugarcane Compression testing are:

Pressure on One Sugarcane needed to break sugarcane
= 45 psi = 3.0393 bar
(By considering size of sugarcane as Length = 8 feet and average diameter = 1 inch).[2]

Depending on This pressure we select sizes of
a.) Side Plate(Quantity 2):2337mm*305mm*12mm
b.) Pushing Plate: 254mm*305mm*12mm
c.) Base of machine: 2540*762*585

Selection of Cylinder:

a) Main Cylinder (Quantity 3): Diameter=85 mm, Length=610mm, Ram Diameter=50 mm
b) Pushing Cylinder: Diameter=50mm, Length = 725 mm

Size of Tank:

60cm x 60 cm x 50 cm (Depending upon Flow Rate of oil in pipes & Cylinders). We need at least 150 litres oil in tank for operating Hydraulic circuit.

Material Used

Most of the Part of Machine are made up of Mild steel and Parts having connection with Sugarcane Juice are made up of SS Steel.

3.2 Design of Machine

3.2.1 Design of Hydraulic Circuit

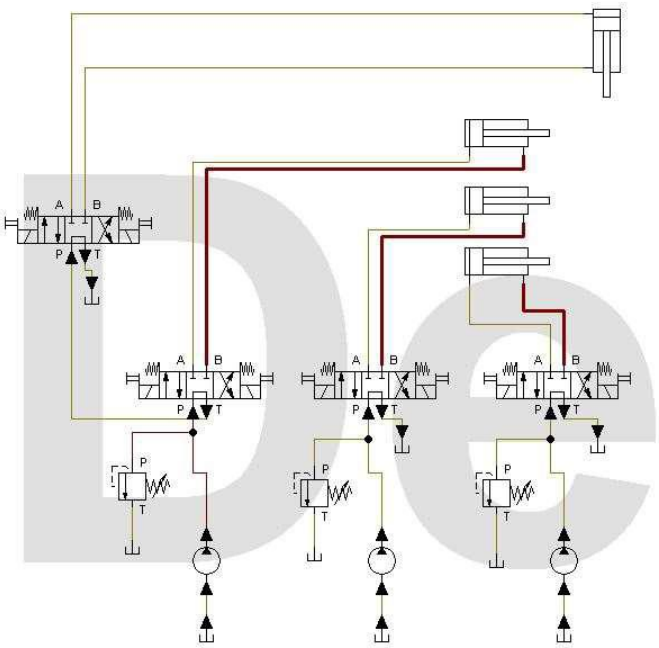

Fig-3: Hydraulic Circuit of Machine [2]

3.2.2 Selection of Pump:
1R3E & 2R3E (Radial Piston Pump) by Polyhydron Pvt. Ltd. Has been selected for Pumping oil from tank. [3]

3.2.3 Direction Control Valve:
4-port, spool type, solenoid operated, directional control valves with wet armature AC coils and wide variety of spool types with spring centered and spring-offsetarrangements.

3.2.4 Relief Valve:
Size:10, Threaded Cartridge,100 bar capacity. [3]

3.3 Selection of Electric Components

3.3.1 Power Supply

Power supply used in this project is to convert AC supply to constant 24V DC supply. Power supplies are categorized in various ways, including by functional features.

3.3.2 Sequential Timer PT380

For our system we need sequential timer. This timer used to operate solenoids of solenoidoperated DCV at required time to run cycle. By using knowledge of Programming we entered the program for our system, Programs for our system

3.3.3 Relay

A relay is an electrically operated switch. Many relays use an electromagnet tomechanically operate a switch, but other operating principles are also used, such as solid-state
relays.

3.3.4 Contactor

A contactor is an electrically controlled switch used for switching a power circuit, similarto a relay except with higher current ratings. A contactor is controlled by a circuit which has a much lower power level than the switched circuit

4. Final Setup of Machine and Testing

While performing a real environment test on the fabricated system designed in project. We obtained following experimental results. As this process of sugarcane feeding involves large amount of feed, hence the results obtained are considered on mass scale.

Table -2: Result and Comparison between both

Sr. No.	Sugarcane (Kg)	Conventional m/c	Automatic m/c
1	5	1.5	2.3
2	10	3	4.5
3	100	30	45
4	1000	300	450

Fig-4: Final Setup along with Conventional Machine

5. Results & Conclusion

In this project an accessory is provided to conventional sugarcane feeding system.

Automatic sugarcane feeding system results in increasing production rate of jaggery. This process not requires labour to feed manually instead it can be automatically feed. This process works faster as compare to manual feeding. As the process is fast it saves time and money.

Table -3: Comparison between both Setup

Sr. No.	Factor	Conventional	Automation
1	No of Labors	8	4
2	Labor Cost (Per Day)	3200	1600
3	Efficiency	55~60%	~75%
4	Profit (Per day for 8 tons sugarcane	12,000	15,000

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[2] Design of Machine Elements by V.B. Bhandari
[3] Design of Hydraulic Circuit by using FluidSIM
[4] Catalogue of Polyhydron Pvt. Ltd.