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. The production 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 support they 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: Jaggery Industry, 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. The Questionnaire and personal interviews had been conducted for data collection and conceptual thought behind this industry. In the survey, it was observed Jaggery plant owners are facing common problems, but the impacts of these Problems are different 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 for development 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

<table>
<thead>
<tr>
<th>Year</th>
<th>Quintals</th>
<th>Rates per Quintal in Rs.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Maximum</td>
</tr>
<tr>
<td>2005-06</td>
<td>6,85,704</td>
<td>5,555</td>
</tr>
<tr>
<td>2006-07</td>
<td>6,71,318</td>
<td>5,500</td>
</tr>
<tr>
<td>2007-08</td>
<td>8,01,049</td>
<td>3,511</td>
</tr>
<tr>
<td>2008-09</td>
<td>8,05,563</td>
<td>3,800</td>
</tr>
<tr>
<td>2009-10</td>
<td>8,17,659</td>
<td>4,840</td>
</tr>
<tr>
<td>2010-11</td>
<td>8,55,043</td>
<td>6,001</td>
</tr>
<tr>
<td>2011-12</td>
<td>7,70,256</td>
<td>7,001</td>
</tr>
<tr>
<td>2012-13</td>
<td>8,65,448</td>
<td>6,000</td>
</tr>
<tr>
<td>2013-14</td>
<td>7,65,264</td>
<td>5,500</td>
</tr>
<tr>
<td>2014-15</td>
<td>6,55,442</td>
<td>5,500</td>
</tr>
</tbody>
</table>

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 of sugarcane is required to make a single pan of Jaggery. A pan of Jaggery requirement depends upon the quality of cane and its sucrose content.

b. Boiling of juice

Extracted juice from the sugarcane is taken for boiling, juice is boiled in open 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 bagasse is used as fuel.

c. Purification of juice

The juice which is heated and boiled releases out many impurities that needs to be removed. Thus purification of juice is the main deciding factor for colour, texture, test and durability of Jaggery [1].
2. CONVENTIONAL SYSTEM AND AUTOMATION 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.

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).

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
3.2.2 Selection of Pump:
1R3E & 2R3E (Radial Piston Pump) by Polyhydrion 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 to mechanically 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, similar to 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>
<thead>
<tr>
<th>Sr. No.</th>
<th>Sugarcane (Kg)</th>
<th>Conventional m/c</th>
<th>Automatic m/c</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>1.5</td>
<td>2.3</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>3</td>
<td>4.5</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>30</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>1000</td>
<td>300</td>
<td>450</td>
</tr>
</tbody>
</table>

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

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

REFERENCES