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DESIGN AND DEVELOPMENT OF STEAM OPERATED JAGGERY MAKING SYSTEM

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Abstract:*In India jaggery industry is one of the most essential parts of the industries. In every part process of jaggery making is same but there is design of plants. In jaggerymaking process heating method is important. In this paper proposed system to improve the production rate,increase the quality of jaggery. This proposed model is designed to control the process of manufacturing jaggery product. In this system first we have developed pan with is having heating from base with baffles. but cost of this system increases. Hence previous design is changed. therefore we have made new proposed design. The improved system and previous system are compared on the basis of bagasse consumption, reduce pollution and increase quality of jaggery*

Keywords:*Jaggery, Pan jaggery making unit, Steam, Sugarcane juice,*

I INTRODUCTION

Jaggery is natural, traditional, sweetener made by concentration of sugarcane juice. It containsall minerals and vitamins present in sugar cane juice and that is called as healthiest sugar in the world. it is rich in important minerals like salts:2.8gm/100gm, whereas only 300mg/kg is obtained in refined sugar.Jaggery is rich in important minerals like calcium 40-100mg, magnesium 70-90 mg, potassium 1056mg, sodium 19-30mg, iron 10-13mg,zinc 0.2-0.4mg,Vitamin A-3.8 mg, Vitamin B1-0.01mg,vitamin C-7 mg, Vitamin D2-6.50mg, protein 280mg/100gm of Jaggery. This micronutrients present in the Jaggeryposses antitoxic and anti carcinogenic property,

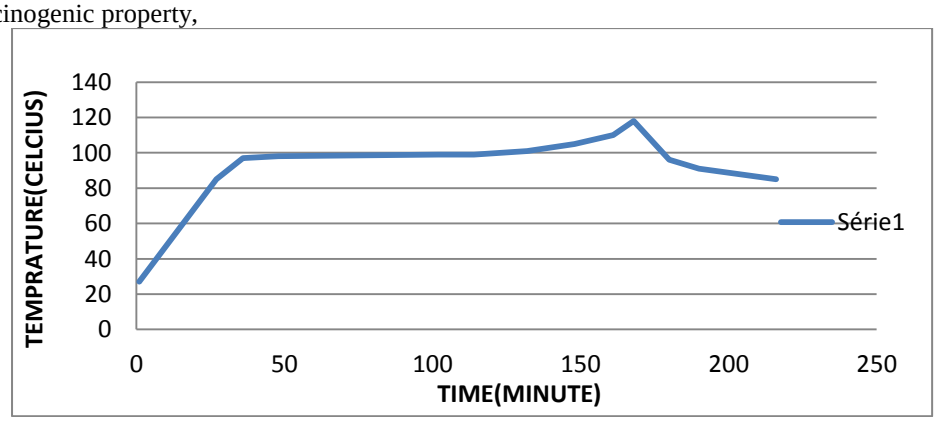

Fig: **General temperature in jaggery making process**

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Temperature	Time span	Add additives
27-85	27 min	Bhendi powder
85-97	9 min	First ash(Dhormali)
85-97	12 min	Use of acid
98-99	54 min	Boiling of syrup
99-101	12 min	Second ash(sonmali)
101-105	16 min	Splitting of syrup
105-118	20 min	Solid jaggery

I
n required heating system bagasse is used. This system requires heating chamber & 45% heat is required for making jaggery. Out of 45% heat from bagasse is used to 39% heat is required for removal of water in the form of steam,6% required in present temperature from $99^0$to 118^0,0.1% to change liquid to solid jaggery. We have scope to reduce 55% heat losses from bagasse by the use of steam, 39% of heat is required to remove water or steam from juice & we can reuse this steam for heating the juice.

II CASE 1: DESIGN OF PAN

In this system of pan hot steam entered from the inlet and flows through the baffles in the zigzag way. Numbers of baffles are provided in the pan due that steam gives heat to the surface of the pan. After flowing from the baffles steam is condensed and gives its latent heat to pan. Condensed steam is flows from outlet. Pressure drop in this pan is a minimum. Energy losses are less. Easy to design. Cost is a minimum. It maintains the required temperature. Heat at the inlet of pan is more due that collection of ash is easy.

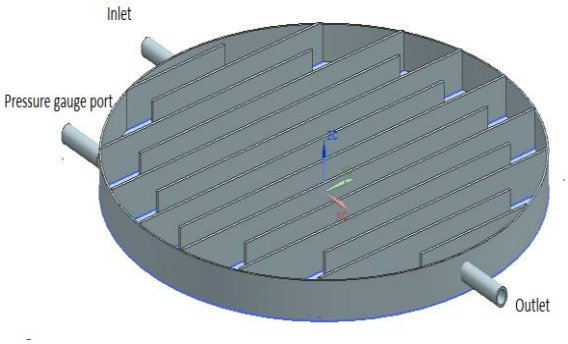

Fig: Steam chamber

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SR No	Heating System	LPG gas	Bagasse	Steam	
				using Bagasse	using electricity
1	Mass required	0.2 Kg	2 Kg	3.82 Kg	3.82 Kg
2	Energy required	8500KJ	12256 KJ	9805 KJ	8528KJ
3	Time required	1:50 hrs	2:40 hrs	1:42 hrs	1:42 hrs
4	Cost (Rs)	18	2.71	2.17	16.52
5	Quality	Good	Good	Best	Best
6	Safety	Good	Less	Good	Good

Fig: comparison of various system

Case 2:Proposed design

Calculation of mass flow rate of steam & energy requirement:-

Properties of steam:-

1. Pressure of steam= 1.962 N/m^2
2. Temperature of steam= 120℃
3. Specific enthalpy of steam =2201.6KJ/Kg

Properties of sugarcane juice:-

1. Temperature range= 378k to 391k
2. Thermal conductivity = 0.475 to 0.493 w/mk
3. Density= 1044.5 to 1189.5 Kg/m^3
4. Specific heat at constant pressure = 3.67 KJ/Kg k

Formulae:

Q =$m_{jC_p}\Delta T$

Q=Rate of heat transfer

m_j=Mass of juice.

C_p=Specific heat juice.

ΔT=Temperature difference.

ms=$\frac{m_{jC_p}\Delta T}{\Delta h}$

ms=mass of steam.

m_j=Mass of juice.

C_p=Specific heat juice.

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ΔT=Temperature difference.

Δh=Change in enthalpy.

Processes	Temperature℃	Time in Minute	Total Mass Flow Rate in KJ	Steam Flow Rate in Kg	Steam Flow Rate per Hour Kg/hr
1	27-85	27	851.44	0.387	0.86
2	85-97	9	158.54	0.071	0.4733
3	85-97	12	689.26	0.0305	1.525
4	98-99	54	2720.37	1.20	1.33
5	99-101	12	1142.91	0.50	2.5
6	101-105	16	1376.17	0.60	2.28
7	105-118	20	1498.80	0.66	1.98
Total	-	148	8437.49	3.723	10.9483

Iteration table:

Sr no	U	D	A	L	ho	hi
1 Iteration	250	0.51	0.20	5.20	0.019	0.0141
2 Iteration	300	0.46	0.17	4.34	0.024	0.0174
3 Iteration	350	0.43	0.14	3.71	0.027	0.019
4 Iteration	400	0.40	0.129	3.25	0.031	0.023
5 Iteration	410	0.40	0.126	3.18	0.031	0.023

Calculating area of pan,

Q_{max} = 1500 KJ

$\frac{1500\times10^3}{75\times60}$ = 333.3

Q = UAθ_m

Where, consider 5th iteration

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U = 410

$\theta_m = \left(\frac{15-2}{l_n\frac{15}{2}}\right) = 6.45$

$333.33 = 410 \times A \times 6.45$

$A = 0.1260\ m^2$

$A = \pi DL$

$0.1260 = \pi \times 0.0126 \times L$

L = 3.18mA = $\frac{\pi}{4} \times D^2$, D = $\sqrt{\frac{4\times0.1260}{\pi}}$

D = 0.40m

Fig: new design pan

III CONCLUSION:

The steam operated system is used instead of bagasse system. If the bagasse system is used, more pollution produced. There are also pressure drop and energy losses created. The pan having heating from with baffle, so area of pan increases at that time pressure and temperature low at base of baffle. Therefore cost of this system increases so it need to improve. Hence we have designed new pan system.

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