

Study of Steam Operated Jaggery Making System

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Abstract— In rural India bagasse is used as fuel for production of jaggery. There is big loss of heat as well as ash from it may be mixed with product which reduces its purity. so we need to check clean and more efficient process for jaggery. We have iterative study for different modes of jaggery making pan which uses steam as heating element. Here we discussed about the pan with steam coil immersed in sugarcane juice. Its design and comparison with pan with baffles is made.

Key words: Jaggery, Sugarcane Juice

I. INTRODUCTION

Jaggery is natural, traditional, sweetener made from sugarcane juice. It consumes 20.36% of sugarcane grown in India [5]. Jaggery is product of cottage industries prone to production inconsistencies and inefficiencies, use of chemicals, poor hygiene and quality. In present system of jaggery making there are problems in crushing, filtration, heating, packing. Heating system affects quality, productivity & production cost so there is needed to improve heating system.

II. STUDY OF JAGGERY MAKING SYSTEM

In available 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 as

- 6% required in present temperature from 27^o to 99^o.
- 39% heat is required for removal of water in the form of steam.
- 0.1% to change liquid to solid jiggery

We have scope to reduce 55% heat losses due to bagasse system by the use of steam. 5.39% of heat of 45% heat from bagasse is required to remove water or steam from juice & we can reuse this steam for heating the juice.

The temperature(degree celcius) vs time (minutes) graph for jaggery making process is as shown in fig.1 within this process different additives to be added and ash with impurities is to be removed. This process is given in table 1.

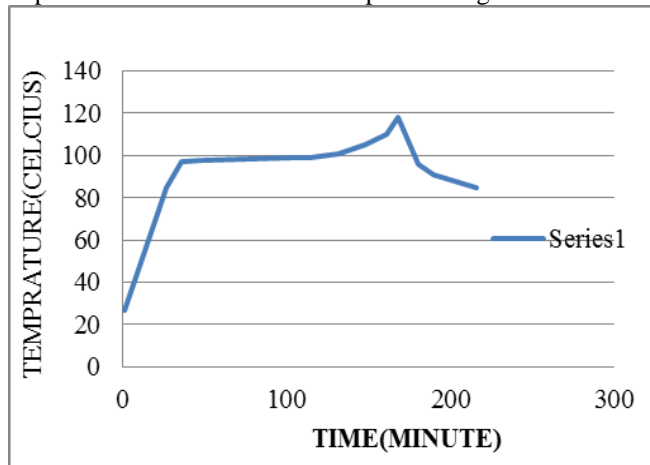


Fig. 1: Jaggery making from sugercane juice

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

Table 1: Time for each process and addition of additives and removal of ash

III. DESIGN OF PAN

Properties of steam:-

- Pressure of steam= 1.962 N/m²
- Temperature of steam= 120°C
- Specific enthalpy of steam =2201.6KJ/Kg

Properties of sugarcane juice:-

- Temperature range= 378k to 391k
- Thermal conductivity = 0.475 to 0.493 w/mk
- Density= 1044.5 to 1189.5 Kg/m³
- Specific heat at constant pressure = 3.67 KJ/Kg k

Process es	Temperatur e °C	Time in Minute	Total Mass Flow Rate in KJ	Stea m 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

Table 2: Calculation of mass flow rate of steam & energy requirement

Pan is designed on basis of total heat required to the system by considering parallel flow type of heat exchanger. It gives

U = Overall Heat Transfer Coefficient= 410

D= Diameter of Pan = 0.40 m

L= Length of Tube=3.18m

A = Area of Pan=0.126 m²

We take trail for jaggery making on this pan having coils of steam pipe. The readings of this trail are as follows-

Sr. no	Trial 1 st	
	Temp in °C	Time in min
1	45	5
2	60	10
3	80	15
4	87	20
5	90	30
6	92	40
7	95	50
8	97	60
9	97	75
10	98	80
11	100	85
12	104	90
13	110	100

Table 3: Trial in pan with steam coil



Fig. 2: Solid jaggery after trial in pan with steam coil

IV. COMPARISON OF TWO PANS

A. Pan with Baffles [1]

The steam operated jaggery making system have existing system in which pan with baffles is used as a heating chamber.

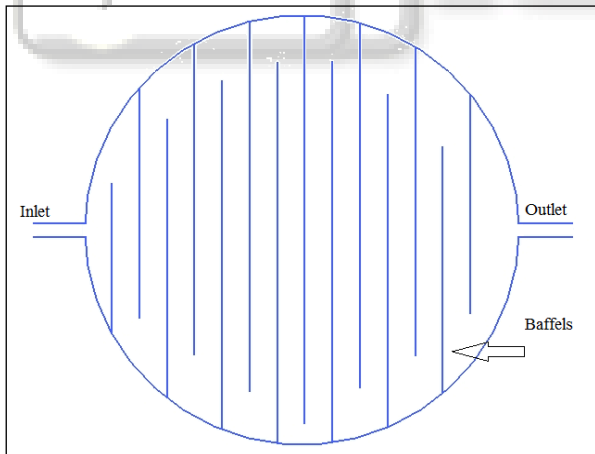


Fig. 3: Pan with Baffles

- No. of baffles are provided in pan due to steam gives heat to surface area of pan.
- Pressure drop in this pan is minimum.
- Cost is high due to use of baffles
- After flowing from baffles steam is condensed & gives it latent heat to pan
- This is also suitable for low volume of juice.

B. Pan with steam coil

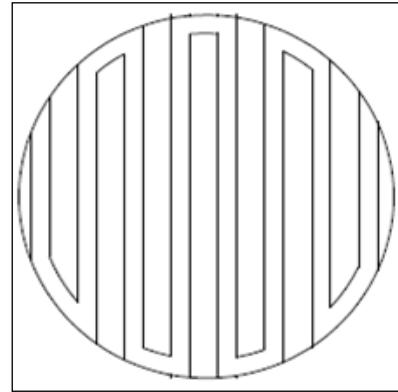


Fig. 4: Pan with steam coil



Fig. 5: Pan with steam coil setup

- Coils used in pan at that time temperature at starting are high after temperature is decreases.
- Pressure drop in pan is minimum than baffles attached to pan.
- Cost is less than pan with baffles.
- This is not suitable for low volume of juice.

V. CONCLUSION

- 1) We used steam instead of bagasse heating so that pollution of jaggery has controlled. And purity increased.
- 2) Steam operated jaggery making system have higher efficiency. Than conventional jaggery making plant.
- 3) There is a large scope of improvement in the performance of such plants by implementing better heat transfer systems and continuous loss of heat by leakages.
- 4) Flow control of steam should be maintain for proper heating of jaggery in jaggery making process.
- 5) Future scope: Use of multipan heating system for maximum utilisation of heat energy which will contribute to reduction of heat losses so that system will become more efficient.

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