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Mathematical modelling to improve thermic performances of jaggery by using solar panel for conserving energy

Kirti Bhushan Zare, Sapna Mohite and Sayali Ramtake
Dr. D.Y. Patil Institute of Engineering, Management and Research, Akurdi, Pune, MS, India
kaprekirti07@gmail.com

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Abstract

Jaggery is sweet juice produced from sugarcane to remove impurities and to get uniform mixture in hot open pan. Bagasse is used as a gas which produces combustion reaction. Due to the inefficient oxidation process, due to lack of energy resources, loss of energy occur and decrease the furnaces cost. In combustion processes energy is generated & used into evaporation. Solar pre-heater provided the proper reheat to increase the temperature, so the total heat needed to be prepared for net reduction of heat.

Keywords: Jaggery, solar panel, energy, sugar cane.

Introduction

The preamble is used in many places in India as a traditional made sweet place in the pan earth furnace. In India Jaggery is making over 2.5 million people[1]. The Bagasse used as fuel for different industries and provided clean development mechanisms (CDM).CDM reduces the CO_2 emission, which is implementing into developing countries. Bagasse can be interest under the CDN, because greenhouse gases have been emitted directly to remain sustainable in rural development. The process of simplifying each part of the Indian subcontinent is almost the same, but there is a difference between the designs of the seed made for the goats[2].

Spray drying chamber is not needed if dry tropical fluid is possible, because the background of the thesis is the ability to reduce the cost of an investment[3]. The main advantage of spray drying is that the particle size can be controlled by fluid molecules and spray drying involves the process of drying the spray dryer that the particle size can be controlled by circling the liquid and spray drying is faster than other dry methods. Dry bagasse is used as a fuel for production of heat[4].

Usually the spray dryer has a spray drying chamber, where the spray is dry and the equipment separated by one or more hurricane separator can make the equipment successful[5]. The formation of Jaggary is considered to be a small scale industry for many forms of rural India[6]. Provides employment to the unemployed rural people with their nearest capital investment[7]. Due to the efficiency of using less heat, fuel or fuel savings in this furnace are also not very common. Sugarcane fibers are excellent sources of raw materials for paper and pulp industries, which can be effectively converted into pith limbs and can be used as animal feed. So saving the bags can lead to the new way of creating additional revenue for the Jaggary markets[7-10].

Materials and methods

A solar heater is a device that can be used to obtain sunlight for processing in copper tubes (which is in circular shape and black color). Mainly Thermal panel, a tank for storing juice, equipment like copper tube that is used to transfer juice from the outlet from the inlet[11]. Solar preheated is the conversion of sunlight into heat for juice heating using solar thermal collector. It enable the substantial energy saving. Generally speaking, it is possible to heat 50 to 70 % of juice used in the jaggery making preparation.

Figure-1: Solar Preheater.

The solar heater absorbs light by means of glass which is used here and converts it into heat. As the glass absorbs the heat from sunlight the copper tubes which are arrange in circular fashion get heated and due to this phenomenon the sugar cane juice get heated. Sugarcane juice is crushed by using crusher and then sent to the solar heater for preheating.

Figure-2: Solar panel.

The temperature is raises up to 75-80^{0}C. Then after pre heating the juice in solar pre heater it sent to the open pan furnace which is placed on gas where continue measured of amount of fuel used is measured by weight machine. The measured quantity of additives like bhindi, calcium carbonate and phosphoric acid was added to sugarcane juice for maintaining the pH into furnaces[12]. Into the next stage water were removed the sugar cane juice up to its saturation/boiling temperature. Heat has been supplied to this stage for conversion of water to steam. After semisolid stage jaggary converted into the solid stage[13].

Figure-3: Temperature rising during preheating.

Figure-4: At the end of this stage the sugarcane juice has become rich in concentrated solid.

Figure-5: After Molasses.

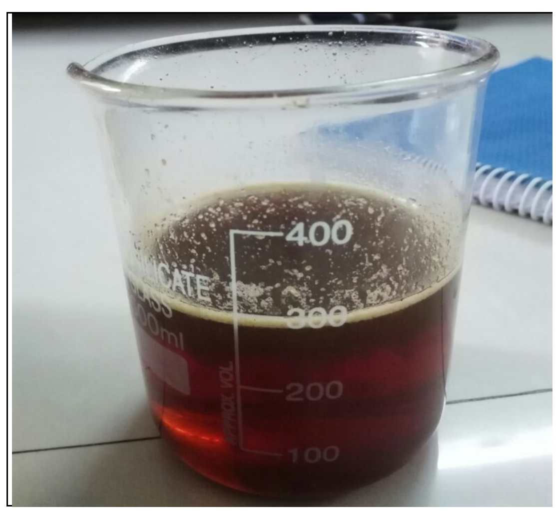

Figure-6: Liquid Jaggery.

Results and Discussion

Following table is showing time and temperature proportion with respective to molar weight.

Table-1: Time and temperature profile with respective to mole ratio.

Time (min)	Temperature (^oC)	Weight (gm)
0	28	9904.0
0.5	30	9903.5
1.22	35	9901.0
1.55	40	9899.5
2.48	45	9897.0
3.28	50	9896.0
3.33	55	9892.5
4.14	60	9889.0
5.11	65	9886.0
5.48	70	9883.5
6.38	75	9879.5
7.14	80	9874.0
9.03	85	9868.0
10.18	90	9857.5
11.11	95	9849.0
12	98	9835.0
14	98	9794.0
16	98	9739.0
20	98	9644.5

Calculation: For normal process:
Mass of Sugarcane juice = 2kg
Mass of jaggery produced = 0.4166kg
Mass of mud removed = 0.059kg
Mass of fuel used = (9904.0 – 8401.5) = 1.502kg
Initial temperature of juice = 28^0C
Final temperature of juice = 98^0C

Heat Energy Input = $m_f * C_f$
= $1.502*(46.1*10^6)$
= 69242.200 KJ

Required Energy for heating = $m_j*C_{pw}*(T_j-T_a)$
= 2*4.187*(98-28)
= 586.18 KJ

Water mass evaporated
Kg of jaggery produced=kg of juice–Mass of water evaporated – kg of mud
0.4166 = 2 - m_w – 0.059
m_w = 1.5244 kg

Total latent heat of vaporization = $m_w*{}_w$
= 1.5244 * 2256
= 3439.04 KJ

Heat of vaporization
= 586.18 + 3439.04
= 4025.22 KJ

For Modified Process: Juice is first preheated in solar heater and different runs are taken

For 1^{st} run
Juice is heated upto 40^0C
Initial temperature of the juice = 40^0C
Final temperature of the juice = 98^0C
Mass of fuel used = (9899.5 – 8401.5) = 1.498kg

Heat Energy Input = $m_f * C_f$
= $1.498*(46.1*10^6)$
= 69057.800 KJ

Energy required for = $m_j*C_{pw}*(T_j-T_a)$
= 2*4.187*(98-40)
= 485.692 KJ

Total heat of vaporization
= Heat energy required for heating the juice + Total latent heat of vaporization of water
= 485.692 + 3439.04
= 3924.72 KJ

Calculation: Number of the run has taken placed to check variation of heat with respective to temperature.

As we providing sugar cane inlet to solar heater sensible heat is going to increases. As we increases the inlet to panel sensible heat is increase rapidly.

Table-2: Experimentally Results.

Run No.	Fuel Used (kg)	Heat Energy Input (KJ)	Temperature difference (^{0}C)	Heat required for heating the juice (KJ)	Heat of Vaporization of water (KJ)	Total Heat of Evaporation (KJ)
1	1.498	69057.800	98 – 40 = 58	485.692	3439.04	3924.72
2	1.495	68942.550	98 – 45 = 53	443.822	3439.04	3882.862
3	1.494	68873.400	98 – 50 =48	401.952	3439.04	3840.992
4	1.491	68735.100	98 – 55 = 43	360.082	3439.04	3799.122
5	1.487	68573.750	98 – 60 = 38	318.212	3439.04	3757.252
6	1.484	68435.450	98 – 65 =33	276.342	3439.04	3715.38
7	1.482	68320.200	98 – 70 =28	234.472	3439.04	3673.512

Table-3: Sensible Heat Requirements.

Sugarcane inlet temperature (^{o}C)	Sensible heat required (KJ)
28	4025.22
40	3924.72
45	3882.862
50	3840.992
55	3799.122
60	3757.252
65	3715.38
70	3673.512

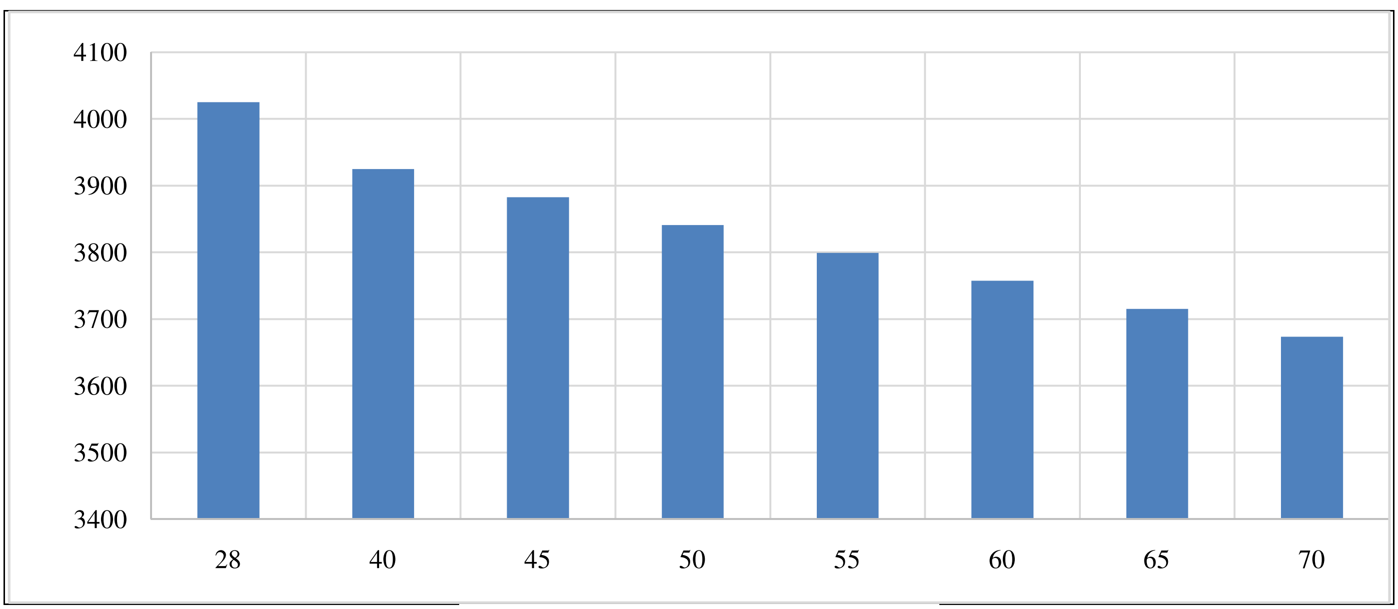

Figure-1: Sensible heat vs inlet temperature.

The value of sensible heat 33 required is changed from 4025.22 KJ to 3673.512 KJ as sugarcane inlet temperature to boiling pan changed from 28^0C to 70^0C. We defiantly save the energy by modified processes.

Conclusion

In combustion process for jaggery, dry bags are used as raw material the total energy produced is about 45% of the combustion process used to effectively make the jaggery, and the remaining 55% of the remaining leakage; ashes are destroyed and destroyed by the wall. For removing of moisture from the sugarcane juice requires about 39.22% energy Heat of approximately 6.08% is used as a sensible heat. Before boiling, it was found that around 351.708 Kg of heat has been saved.

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