Environment & Ecology 27 (1A) : 316—319, 2009
 ISSN 0970-0420

Evaluation of Multipan Furnace over Traditional Pan Furnaces Used for Jaggery Production in Mandya District of Karnataka

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Abstract

Sugarcane is one of the main crops of Cauvery Command Area of Mandya district and 60% of which is used for jaggery production. The jaggery making units use different types of furnaces varying from single pan to multi pan furnace systems mainly, depending upon quantity of cane to be crushed and capacity of initial investment by the farmers. The quantity of fuel consumption, use of skilled manpower and rate of jaggery production vary with the type of furnaces used. Among the furnaces, multipan furnace proved better in conserving fuel energy, quickness in boiling and quality end product. However, the initial investment, quantity of cane required for crushing, non-availability of skilled laborers to handle the processing operation are some of the factors which affected large scale adoption of multipan furnace, in spite of its proven advantages. Fabrication of boiling pan with a proper gauge material and design plays an important role in minimizing fuel consumption, quickness in boiling of juice and to obtain quality product.
Key words : Multipan furnace, Jaggery production, Traditional Pan.

Sugarcane is one of the main crops of Cauvery Command Area of Mandya district and 60% of which is used for jaggery production (1). Traditionally jaggery is made from sugarcane juice using different types of furnaces namely single, double, triple and multipan furnace. The fuel required for juice boiling, the manpower required for processing of juice and maintaining hygienic conditions in and around the jaggery units vary from the type of furnaces used (2). Multipan furnace system of jaggery making is an advanced technology for efficient utilization of heat energy generated by fuel, quickness in juice boiling and concentration and hence quality jaggery production. Though this technology is popular in states like UP, Bihar and Maharashtra, but it is not popular in Karnataka in spite of its proven merits in respect of saving of fuel energy and higher production rate with better quality end products. Therefore, evaluation study of multipan furnace over traditional pan furnaces used for jaggery production was conducted in Mandya district of Karnataka.

Methods

The multipan furnaces over traditional pan furnaces were evaluated for their performance with respect to saving of fuel, time, labor and quantity of jaggery produced over traditional practice of jaggery making using single, double and triple pan furnaces used in the study area and information on production details were elicited using pre-tested questionnaire by visiting individual units (three units of each type).

The weight of the fuel (bagasse) and moisture content of the fuel were recorded in subsequent processing and averaged. Similarly quantity of juice added initially, followed by other pans was measured

Table 1. Performance of single pan furnace (golden yellow jaggery). MC–Moisture content, T_1 – Initial temperature of pan, T_2 – Final temperature of pan.

Pan No	Quantity of juice used (l)	Quantity of fuel fed (kg)	MC of fuel fed (%)	Ash content of fuel (%)	Temp of juice (C) T_1	Temp of juice (C) T_2	Time taken min	Yield of jaggery kg
1	571.5	426.67	7	3.8	27.97	119.33	213.33	100

Table 2. Performance of double pan furnace (golden yellow jaggery). MC– Moisture content, T_1– Initial temperature of pan, T_2 – Final temperature of pan.

Pan No	Quantity of juice used (l)	Quantity of fuel fed (kg)	MC of fuel fed (%)	Ash content of fuel (%)	Temp of juice (C) T_1	T_2	Time taken (min)	Yield of jaggery (kg)
1	515	407.5	6.9	2.88	28.12	75.25	132.5	90
2	98				75.5	117.88	117.5	

in liters and averaged, the temperature in different pan furnaces was also recorded using digital thermometer in each and every operation of jaggery processing and at the weight of the fresh jaggery is also recorded and the survey was conducted in four villages of Mandya district in Karnataka.

Results and Discussion

The single, double, triple and multipan furnaces were selected to study the performance of the individual furnace with respect to fuel consumption, cost of production and quality of jaggery produced. The evaluation was done for production of golden yellow color, brown color and dark color jaggery. The results of the study are presented in Tables 1 to 4.

In single pan system of jaggery making, about 571.5 liters of juice crushed mechanically was conveyed to the pan, where boiling takes place for clarification and concentration of juice. In this system all the operations like adding of additives for adjustment of pH, removal of scum and concentration of juice are done simultaneously in single pan. Table 1 shows that the total operation in single pan furnace system starting from adding of juice to removal of concentrated syrup from the pan took nearly three hours 33 minutes at a temperature of 119 C. About 426.5 kg of bagasse containing 7% moisture content on dry weight basis was used to boil the juice.

When the temperature of juice is about 105 C the juice started frothing and from this time onwards the fire is to be regulated to prevent caramelization of the sugar. When temperature starts rising (above 110 C), syrup needs to be stirred constantly to prevent charring and spilling over the sides of the pan. At this stage about 50 ml of groundnut oil is added to pan to prevent frothing to a certain extent and to facilitate easy flow of jaggery syrup from pan to cooling trough. After cooling, syrup is poured into moulds to get desired shape. Final yield of the jaggery will be about 100 kg for boiling of 517.5 liters of fresh juice. The fuel consumption in this system for producing 100 kg of jaggery is comparatively higher as compared to multi pan furnace system. The probable reason may be more time required for boiling of juice and inefficient performance of furnace constructed. Similar observations were made by Parthasarathy and Lakshmikanthan (3) they reported that single pan furnace not only consume more time to produce jaggery but also affected quality of jaggery to a considerable extent.

In double pan furnace system, crushed cane juice is directly conveyed to Pan No. 1, where partial boiling of juice takes place and major scum is removed manually. Later partially boiled juice is transferred to Pan No. 2 where clarificants are added for adjustment of pH, color and for early concentration of juice, which will take place at an average temperature of about 118C.

Table 3. Performance evaluation of triple pan furnace (golden yellow jaggery). MC–Moisture content, T_1 – Initial temperature of pan, T_2 – Final temperature of pan.

Pan No	Quantity of juice used (l)	Quantity of fuel fed (kg)	MC of fuel fed (%)	Ash content of fuel (%)	Temp of juice (C) T_1	T_2	Time taken (min)	Yield of jaggery (kg)
1	572				30.25	91.78	72.3	
2	410	275	6.95	3.8	91.95	96.2	72.3	100
3	106				96.35	118.08	72.3	

Table 4. Performance evaluation of multi pan furnace (golden yellow jaggery). MC–Moisture content, T_1 – Initial temperature of pan, T_2 – Final temperature of pan.

Pan No	Quantity of juice used (l)	Quantity of fuel fed (kg)	MC of fuel fed (%)	Ash content of fuel (%)	Temp of juice (C) T_1	T_2	Time taken (min)	Yield of jaggery (kg)
1	572				28.25	86.86	57.41	
2	450	201.66	7.06	2.8	87.625	97.59	57.41	100
3	300				97.29	100.24	57.41	
4	105				100.4	117.8	57.41	

About 70 to 80% of the juice added to Pan No. 1 is evaporated and the rest of about 98 liters out of 515 liters added to the Pan No. 1 is shifted to the Pan No. 2, where further clarification and concentration of juice takes place at an average temperature of about 118 C. In this system, total time taken for production of jaggery starting from adding of cane juice to Pan No. 1 and removal of concentrated syrup from Pan No. 2 took nearly one hour 57 minutes. Table 2 reveals that on an average 407.5 kg of bagasse containing 6.9% moisture is used for boiling juice. Further, 90 kgs of golden yellow color jaggery is obtained by adding 515 liters of juice in double pan furnace system. As compared to single pan furnace system, the fuel consumption in double pan system is comparatively less. This may be due to lesser time taken for boiling, effective utilization of heat energy among the two pans to hasten the process of juice boiling and improved method of furnace construction. The observations made in this study are in conformity with the observation made by Parthasarathy and Lakshmikanthan (3).

In triple pan furnace system the juice in Pan No. 1 is shifted to Pan No. 2 and Pan No. 3 for clarification and concentration. Table 3 reveals that initially 572 liters of juice is added to Pan No. 1 and reduced to 106 liters, when it reached Pan No. 3. The total time taken to complete the process in three pans took one hour 12 minutes. Further, 275 kg of bagasse containing 6.9% moisture is used to boil the juice in all the three pans.

The fuel consumption in triple pan system is comparatively less as compared to that of double pan and single pan systems, this is because of lesser time required to complete the process, effective utilization of heat energy in all the three pans, improved design of furnace and construction. The jaggery obtained from triple pan furnace is of good quality with desired color. Similar observations are made by Shivaramu et al. (4).

In multipan furnace system cane juice crushed mechanically is conveyed to Pan No. 1, where partial boiling of juice and removal of scum takes place. There after the juice is shifted from Pan No. 1 to Pan No. 2, 3 and 4 for further clarification and concentration. Table 4 shows that initially 572 liters of juice is added to the pan No. 1 and over boiling, the juice quantity is reduced to about 105 liters when it reached to pan No.4. The experiments are repeated 12 times and the data were averaged. The data revealed that about 202 kg of bagasse containing 7.06% moisture was used to boil the juice in all the four pans. Altogether the operation took about 57 minutes and 41 seconds.

As compared to double and triple pan furnace system the average fuel consumption is less and time taken to complete the process is comparatively less in multipan furnace system for boiling same quantity of juice to obtain same quantity of jaggery. The reason for consuming less fuel and quick processing in this system is due to effective utilization of heat energy produced by burning fuel without any wastage. Since the boiling of juice takes place simultaneously in all the four pans, there will be effective removal of scum and quick boiling of juice which helped to obtain good quality with desired color in a short time.

Conclusion

I can be concluded that adoption of multipan system is found to be useful to obtain high quality jaggery with less fuel consumption and reduced time to complete the process and cost of production of jaggery. Though the initial investment for installation of multipan furnace systems are costlier. Because of more time for boiling of juice, more will be the oppor-

tunity time for the juice to warm and float its scum and effective clarification.

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