

Distillation for Liquor Using Electrical Induction Heating

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Abstract— Distillation for liquor out of fermented cashew juice is one of the traditional methods in Goa giving it a GI status. The traditional method uses old equipment and thus needs improvement for increase in production rate and quantity. Using induction heating we can improve the method as this mode of heating is comparatively more efficient than other methods of heating. A prototype of hybrid distillation unit was designed to improve the method and a comparative study was done with traditional method.

Index Terms — Alcohol, cashew juice, distillation, fermentation, hybrid still, induction heating.

1 INTRODUCTION

Production of traditional liquor called as Feni has been a cultural part of Goa. The state has also declared it to be the heritage drink of Goa and has given it a GI (Geographical Index) status in the recent years. The raw material for the production is either coconut sap or fermented cashew juice. The traditional method is still been followed in many parts of Goa. Cashew being a tropical seasonal fruit the distillation process is carried out in the summer season (March, April and May). Along the west coast cashew is grown in Goa, Maharashtra, Karnataka and Kerala and in the east it is grown in Tamil Nadu, Andhra Pradesh, Orissa and West Bengal. But only in Goa Feni and Urrack (first distillate before Feni) are produced. These drinks are not only recreational but also have medicinal properties and used to cure worm sickness, cold, body ache, cramps, low blood pressure, fever or flu, toothache, wounds or cuts etc [1].

The distillation process of making the product has changed over the years from using big clay pots to copper pots called as Bhaan. The condensation process was done by using Launni - an earthen pot where the vapors were collected for condensation. These have changed to metal pipes immersed in water for condensation. The

full process takes about more than 4hrs to complete consuming about 70 kg of firewood [1]. The process requires a lot of time and the workers have to work in the heat for hours. For large amount of raw material, the yield is comparatively less. Improper combustion, soot formation and the breaking of the clay pot still with the hot vapor pressure and improper condensation are some of the problems faced in the process. With the introduction of new single metal stills and hybrid stills, the process can be improved.

With the advancement in technology and knowledge there is an increase in the efficiency of various processes. Cooking and heating has been introduced with induction heating using electrical energy as a medium. With electricity provided all around the country and state, people have shifted from firewood stove and natural gas stoves to induction cook tops. Industries are employing induction heating to melt various metals. Distillation stills have been replaced from clay pots to copper stills to hybrid stills for better output. With these advancements Feni distillation can be improved. The objectives are:

- 1 To improve the process using induction heating as a medium and designing the hybrid still for distillation.
- 2 To study the process of distillation of first distillate (Urrack) using fermented cashew juice and designed prototype.

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- 3 To study the time and power consumed for the process and compare it with the traditional process.

2 METHODOLOGY

Distillation is a process used to separate a heterogeneous mixture of liquid to different components present in it. Ethanol distillation from different fermented fruit juices is found all around the world. It requires a heat source so as to increase the temperature of the liquid mix to different temperatures. The boiling point of Ethanol is about 78.5, [6] lower than that of water hence it requires less heat input.

A distillation unit was designed using 304 stainless steel and copper. The still is a hybrid still having TC clamps for coupling with capacity of around 8 liters of raw material. The helical coil condenser used has counter flow with cold liquid as water and copper tubes for the hot liquid. A temperature sensor has been placed in the steel to measure the temperature rise. The setup is showed in figure 1.



Figure 1 – The distillation unit setup

A fermented juice of cashew was used as the raw material for distillation. The juice was fermented for around 4-5 days. The pH of cashew was between 4.1 and 4.7 and total sugar concentration was 6.7 to 10.5% [2]. Use of good ripe cashew apples is very important, as unripe cashew

apples would affect the quality of final product. Ethyl alcohol is a product of fermentation by intact yeast cells of hexose sugar of cashew apple juice. One liter of 60-62 per cent ethyl alcohol could be obtained from 8 liters of cashew apple juice [3].

The induction heater used was the Prestige cook top of 2 kW rating. The efficiency of the induction cook top can be as high as 80-84% as compared to electrical resistance based cook top which has efficiency from 50-60% and LPG cook top with only 40% [4]. The energy that is consumed in LPG is more than the induction cooking and the unit cost of energy was found out to be higher in LPG compared to induction cooking [5].

The traditional method of distillation uses firewood of around 70kg for the whole process which takes about 4 hours for a raw material of about 130 liters. The output is of about 25-26 liters.

3 EXPERIMENTATION

After the whole setup was placed and fixed, the first test was done with water. In this there were two tests done for the constant power input of 2 kW. Table 1 shows the change in the temperature with time of the test.

The third test was done using the 8 liters of fermented cashew juice. The input of the induction cook top was kept as constant and the temperature versus time was noted down. The output of the distillation was also noted down in milliliters(ml). Fig 2 shows the plot of these experimental results.

Heat produced due to the induction cook top is used to heat up the fermented juice. The vapors formed travel through the connecting pipe then to the condenser which consists of helical copper coils through which the vapor travels and gets condensed. The condensed liquid then is collected in a collecting jar through the condenser outlet.

The product was then tested using an alcoholmeter to compare the results with the traditional method.

Then the fourth test was performed trying to

keep the temperature at a constant for better concentration of ethanol in the final product.

Time (in min)	Test	
	1	2
	Temperature 1 (°C)	Temperature 2 (°C)
0	34.69	34.25
5	45.31	41.75
10	52.31	48
15	59.32	54.06
20	65.5	59.9
25	71.69	65.37
30	77.44	71
35	82.94	76.12
40	88.31	80.94
45	93.31	85.62
50	97.94	90.06
55		93.06
60		97.25
65		99.37

Table 1 - Experimental values for test with water

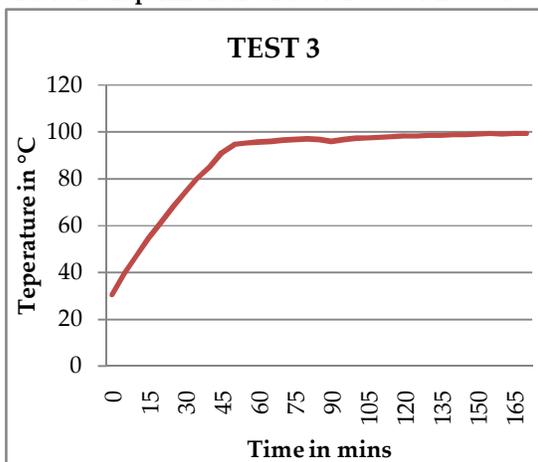


Figure 3 - Experimental test with fermented juice plot of temperature vs. time

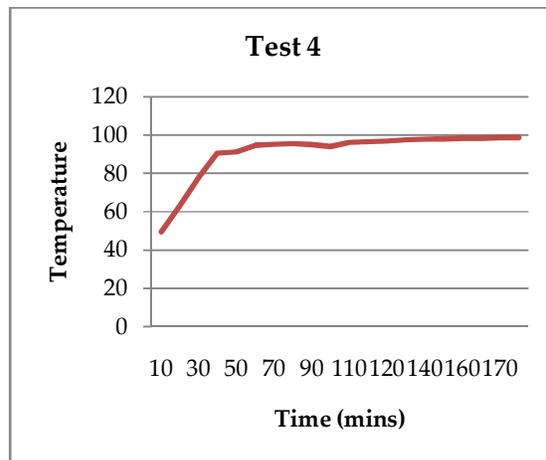


Figure 4 - Experimental plot for varying power input for fermented juice

4 RESULTS AND DISCUSSION

The results of the tests done were as shown in the graphical representation in figure 3. From the results it was seen that as the time increases there is rapid increase in the temperature and the rate of condensation increases after around 50 minutes of the process. From the fourth test we found out that we can keep the temperature constant by changing the input of the induction heater. The experimental results and the graphical representation are shown in figure 4.

The time taken for the third test was around 170 minutes for an output of 1440 ml of condensate. The fourth test gave an output of about 800 ml for the same time with the varying heat input.

The alcoholmeter test is shown in figure 5. It shows that the alcohol content decreased as the temperature and time increased and the final reading of the total content was around 15 which are 2 to 1 units less than the alcohol content of the traditional method product.

The traditional process takes more than 4 hours to get an output of 25 to 26 liters for an input of 130 liters of fermented juice.

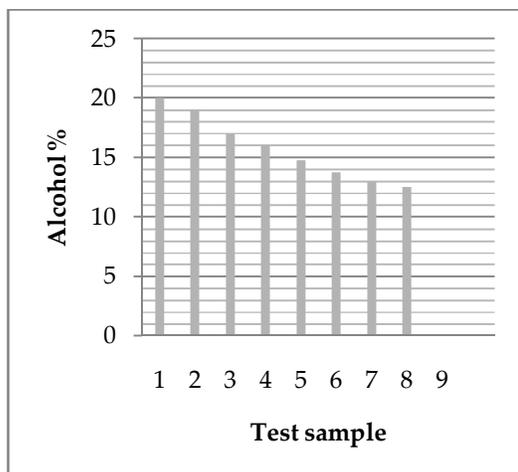


Figure 4 - Alcoholmeter reading of the test samples



Figure 5 - Test samples



Figure 6 - Alcoholmeter in the sample

4 CONCLUSION

The distillation process was successful by obtaining around 1.913 liters of distillate from 8 liters of fermented cashew juice. The time taken for the distillation was less compared to the traditional method with an output rate of the designed distillation unit. The temperature of the unit can be controlled. There are heat losses in the unit since there is no insulation. The rate of the output is faster as we increase the power rating of the induction cook top. The heat loss can be reduced further by making the process more efficient and by designing a helical coil induction heating system around the cylindrical base of the still. There was no smoke and soot problem as seen in the traditional method and the condensation process was improved.

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