A Review of Fully Automated Home Brewing Systems for Craft Beer

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Abstract

Craft beer has gained widespread popularity in the past decade. While the fundamentals of the brewing process can be mastered with very little technical knowledge, a consistent quality of craft beer requires the optimal use of all the required ingredients in the correct manner. Breakthroughs in technology have thus enabled craft beer production to be scaled down from industrial breweries to a much smaller scale, targeted towards individuals at home. This review paper briefly reviews the most widely used, fully automated methods of home brewing craft beer.

Keywords: Automation, Home Brewing, Craft Beer

I. INTRODUCTION

Beer is the world’s oldest and most consumed alcoholic beverage. Beer is produced by a method known as ‘brewing’ which involves the fermentation of starches and sugars to carbon dioxide and alcohol. Arising from the microbrewery movement in the UK in the 1970s came the concept of Craft Beer.

Craft Beer distinguishes itself from commercially available options offered by corporate brands by the use of premium and authentic ingredients. Commercial brands often use preservatives, synthetic ingredients, and potentially harmful chemicals in their beers to artificially correct alcohol & pH levels, increase shelf life of the product, and consequently maximize profits. Craft beer is also defined as beer that is brewed by small scale and independent ‘micro breweries’ (annual production < 2 million liters).

Apart from the natural integrity, there are also several health benefits associated with the moderate consumption of craft beer such as: increased bone density leading to prevention of Osteoporosis, increased absorption of dietary fiber, decreased risk of Diabetes, decreased risk of hypertension, and anticancer activity.

II. CRAFT BEER BREWING PROCESS

The key ingredients in the process are Malted Grains (also known as Malts), Hops, Yeast, and Water. The entire simplified brewing process can be broken down into 3 stages, namely: Brewing, Cooling, and Fermentation (Fig. 1).

A. Brewing

The main objective of brewing is to prepare ‘wort’ with malt (extracts or grains), hops and water. Malts are steeped and boiled in water along with the addition of hops for a period of roughly sixty minutes to obtain a viscous liquid known as wort. The type of malts, quantity of malts, and time intervals at which hops are added in the boiling wort are the variables that depend on the particular recipe of craft beer being brewed. Alteration of any variables results in a different type of brew.

B. Cooling

After the boiling is done and the wort is ready, it needs to be cooled as soon as possible. Yeast, which is imperative for fermentation, cannot survive in high temperatures and bacteria are inhibited at hot temperatures. So while it cools, wort is prone to damage and infection and must be cooled to room temperature as quickly as possible.

C. Fermentation

Post cooling, yeast is added to the wort and the process of fermentation begins. Here, simple sugars obtained from starches are consumed by yeast to form carbon dioxide and alcohol. There may be one or two stages of fermentation before the beer is ready, depending on the particular recipe. Fermentation may require the use of external cooling to maintain the temperature low. Many
recipes such as lager require a fermentation temperature of under 17 °C. Fermentation time depends on the amount and quality of yeast pitched as well as the recipe.

Fig. 1: Beer brewing process

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III. CURRENTLY USED METHODS FOR HOME BREWING

With home brewing of craft beer gaining popularity and interest, there are various ways in which the above mentioned brewing steps are carried out. All these methods can be categorized into the following three types:

- Fully manual systems - all the steps are carried out by hand and using conventional equipment such as stoves for heating and ice baths for cooling. It is a very tedious process. However, it requires the least amount of capital to get started.
- Semi-automated systems - some of the steps in the process are controlled using specific electronic controllers. Human interaction in the process is still necessary at various stages to control variables by hand.
- Fully automated systems - these systems only require the user to feed the ingredients. The rest of the process is completely automated using microcontrollers and specialized parts.

However, the discussion in this review paper is limited to Fully Automated home brewing systems.

IV. FULLY AUTOMATED HOME BREWING SYSTEMS

Fully automated home brewing systems try to achieve complete process control with the help of electronic microcontrollers that monitor and adjust all the variables in the brewing process according to the recipe being brewed. This eliminates the need for continuous monitoring by humans for the duration of the brewing process (which often takes over 3 hours). Fully automated systems often use intricate temperature sensors and flow control valves to alter the movement of material to suit the recipe’s needs. The most popular fully automated systems available to consumers today are discussed in detail:

A. PicoBrew

- PicoBrew is a small form factor, all grain automatic brewing machine that can brew 2.5 gallons (9.46 liters) of finished brew per batch (Fig. 1).
- It works in tandem with a 3 gallon keg to initially supply the water to the unit, meaning that you can literally brew anywhere you have electricity.
- PicoBrew uses a proprietary plastic container for brewing which may break or leak if damaged.
- The standard PicoBrew can only brew all grain recipes, meaning it takes longer to brew due to the added mashing cycle.
- You can only use the separately sold ‘PicoPacks’ to brew in the Picobrew Zymatic, and not your own ingredients which may be cheaper.
- The PicoBrew is priced at USD 1999 (approximately 1,34,000 INR exclusive of taxes and duties).

![PicoBrew](image1.png)

**B. Brewie**

- Brewie (Fig. 2) is another fully automated homebrew system which covers all the steps of brewing from mashing to boiling.
- It can brew between 10-20L of beer in a batch.
- Due to having two compartments to run a cycle, the effective capacity with respect to the size of the machine is half of other systems with one vessel.
- Brewie requires the use of proprietary ‘pads’ as the ingredients and does not allow the use of custom ingredients.
- Users can control the system with an android application from their smartphones.
- It is priced at USD 1899 (approximately 1,30,000 INR)

![Brewie](image2.png)

**C. BrewArt**

- BrewArt (Fig. 3) is an Australian automated homebrewing system that is modelled around the form factor of a coffee machine
- The brew capacity of BrewArt is 10 Liters
- BrewArt can be controlled via an iOS app
- Runs on proprietary ingredient sachets known as BrewPrints. These range in price from 28 AUD to 44 AUD (1447 INR to 2274 INR)
- The BrewArt retails for approximately 45000INR

![BrewArt](image3.png)
D. **MiniBrew**

- MiniBrew (Fig. 4) is a Dutch home brewing system that is automated with process control. However, users need to feed in yeast and hops at the intervals mentioned making it somewhat semi-automated.
- The MiniBrew has a brew capacity of 5 Liters
- It has active cooling feature on the keg itself, eliminating the need for an external refrigeration system to maintain fermentation temperatures.
- It uses a real copper vessel for the process.
- The MiniBrew retails for USD 1200 (approximately 80,000 INR) excluding taxes and shipping.

V. **Conclusion**

In this paper, the current solutions for fully automated home brewing systems for craft beer are reviewed. A tabular comparison of key parameters of these systems is shown in Table 1. The study of this paper is intended to guide readers to a better understanding of the strengths and limitations of the currently available fully automated systems. From the paper, it is evident that a limitation that exists for all these systems is the pricing and/or rigidity in ingredient use. Proprietary ingredients mean that user cannot use ingredients sourced on their own and that the users are limited when it comes to recipe choice.

<table>
<thead>
<tr>
<th>System</th>
<th>Brew Capacity</th>
<th>Ingredient Usage</th>
<th>User Control</th>
<th>Dimensions</th>
<th>Power</th>
<th>Price (INR)</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>PicoBrew</td>
<td>2.5 Gal (9.46L)</td>
<td>PicoPaks, Proprietary</td>
<td>802.11 b/g Wi-Fi LCD Screen</td>
<td>16x12x14 in</td>
<td>110-120V 15A</td>
<td>134000 INR</td>
<td>Cost, rigidity in ingredient choice</td>
</tr>
<tr>
<td>Brewie</td>
<td>10 L</td>
<td>Pads, Proprietary</td>
<td>Android, Windows Phone App Wi-Fi LCD Touchscreen</td>
<td>29x13.3x18.4 in</td>
<td>230V/120V 1800 W</td>
<td>130000 INR</td>
<td>Cost, rigidity in ingredient choice, Large physical dimensions</td>
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</tr>
<tr>
<td>BrewArt</td>
<td>10 L</td>
<td>BrewPrints, Proprietary</td>
<td>iOS Application</td>
<td>-</td>
<td>-</td>
<td>45000 INR</td>
<td>Cost, rigidity in ingredient choice</td>
</tr>
<tr>
<td>MiniBrew</td>
<td>5 L</td>
<td>Any</td>
<td>iOS Application</td>
<td>11x22x17 in</td>
<td>220V/230V V/110V</td>
<td>80000 INR</td>
<td>Cost</td>
</tr>
</tbody>
</table>

REFERENCES