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Influence of Temperature and the Presence of Adjuncts in the Removing of Protein-Polyphenol Complexes and Carbohydrates in Cold Wort

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Abstract: The influence of the temperature and adjuncts in the formation of cold trub in beer. During cooling of the wort, the so-called cold trub precipitates out which consists mainly of undesirable hops bittering compounds Protein-polyphenol complexes and carbohydrates which have combined with tannins from the raw materials. Two methods has been used flotation and diatomaceous earth filtration. Flotation is the method uses in the classical brewing or small breweries and diatomaceous earth filtration is the most use in the modern brewing. The principal reason for removing the cold trub is that suspended solids can lead to adverse effects on foam and flavour stability and avoid clouded bottles in the supermarket when the beer is cooling until ^{0}C. The best condition was obtained when the temperature corresponds to zero Celsius degree and 25-30% of adjuncts.

Key words: Filtration, brewing , adjuncts, diatomaceous, earth and wort

Introduction

When the wort is cooling the protein-polyphenol complexes and carbohydrates, begin to blind, especially when cooled to lower than 7^{o}C. In the brewing language, when protein-polypheno complexes and carbohydrates precipitate at higher of lower temperature are called trub. When the trub is removed by cooling the name is cold trub (The Practical Brewer, 1977). Opinions changes about the effect of the cold trub over the quality of the beer. Several breweries, especially in Europe, believes that removing at least some could trub to improve yeast viability and the quality of the beer, however, other breweries consider that the removing all cold trub has not benefit.

In this study, we outline the influence of the temperature and adjuncts in the cold wort using two method of removal: flotation and diatomaceous earthfiltration (DEFM). In Europe, the breweries report a total dry weight average of cold trub of 17.7g hL^{-1}, although the value depends on the type of the beer (Ale or Lager), mashing program, removing hot trub and yeast generation. We are not offer a solution for improve the quality of the beer, it is difficult to generalize, however, the cold trub is seriously affect for the temperature and adjuncts. The optimal temperature for removing the cold trub is zero Celsius degree with 25% or more of adjuncts.

Methods of Protein-polyphenol Complexes and Carbohydrates Removal: Two methods are considered: The first is diatomaceous earth filtration and second one is flotation.

Diatomaceous Earth Filtration: The diatomaceous earth is fine white powder, but under the mircroscope it is seen to possess certain unique properties which make it highly desirable as a filter medium (The Practical Brewer,1977) As an individual particle, it exists many shapes, all of which resemble petrified tumbleweed of near microscopic size. It resembles the tumbleweed because it is lacy, weblike particle which is approximately 90 percent void and 10 percent solid fiber. It is petrified in a literal sense because it is the rigid, skeleton like fossil of a very small form of plant life from prehistoric times.

The characteristics which make diatomite a filter medium can thus be seen when one imagines a cake or crust of small, rigid, porous particles piled one upon the other to form a fine screen, being placed in the path of flowing stream of water. The openings in the screen are large enough to permit the flow of beer, but small enough to obstruct the passage of virtually the smallest particle of foreign material. The diatomaceous earth filter cake is therefore a highly efficient filter medium, so efficient in fact, that it requires special care to keep it porous and unfunctioning for extended periods of time (Simpson, 1994).

Diatomaceous earth filtration is commonly used for water and beer (Wackenbauer and Evers, 1992). It makes use of a dirt-collecting medium; which is discarded along with the dirt itself when the filter cycle is completed. Although three or four disposable media can be used in such system, the one most commonly used is diatomaceous earth. A cost comparison of different types of filters should be conducted before installing diatomaceous earth filters. These filters have a history of high maintenance and repair cost.

All diatomaceous earth filter are equipped with septums (often referred to as the filter elements) or devices upon which the diatomaceous earth powder is

collected in its cake from, Fig.1. The septum may be a cylindrical tube or a plastic or metal fabric of sufficiently fine weave to collect the filter cake. The septum is often a bundle of tubes, disks or wafers assembled to a pipe or pipe manifold which receives the filtered water and directs it through the recirculation system piping to the pool. Understanding the functions of the filter medium and septum makes the diatomaceous earth filter plant rather easy to visualize (Fig.1). It may be either a closed tank which operates under pressure, or an open tank from which the water is drawn under vacuum to pump suction. In either case the system is comprised of a tank to receive unfiltered water, a septum to support the filter cake and a pipe or manifold to collect filtered water from the septum and deliver it to the distribution system piping. In the case of the pressure type system, a crock or tank for precoating the filter is attached either to the filter itself or to the adjuncts piping.

Flotation: In the flotation method, the cooled wort is saturated with sterile air. Hours later, a brown, compact head forms at the top of the wort due to the air bubbles carry cold trub with them. Later, the wort is removed from the bottom of the tank. A quickly cooling wort and aerating with turbulence will promote good flocculation of trub.

Results

As first phase of this study, the amount of cold trub precipitation has been calculated to different wort temperature using a settling tank. The type of beer was lager beer. A resume is depicted in the Table 1. At lower temperature the amount of precipitated trub increases sharply.

Table 1: Precipitated trub in lager beer

Wort Temperature (^{o}C)	Precipitated Trub (g/hL)
40	5.2
35	6.8
30	8.4
25	12.6
20	16.7
15	19.1
10	25.3
5	34.3
0	44.5

A flotation tank was designed with a capacity of 25 L. The sterile air is bubbling to the tank for to get the trub at the top of the tank as was above described. The diatomaceous earth filtration data was collected in real time using a small filter with inlet flow equal to the wort was cooled to 5C in both systems (flotation and diatomaceous earth filtration). The first set of results included the influence of standing time in the removing of trub. The results are in the Table 2. The results were obvious, more standing time, more trub, however after of 5 hours the amount of cold trub collected does not improve significantly. In short standing times (1-2 hours), the cake uses to break because it is not impact enough. The relationship standing time vs cold trub is not linear, in consequence the optimal must be calculated using various beer and different methods. The results in this paper are based on lager beer without adjuncts. Standing times over 6 hours have not been considered because, long standing times can affectthe production program seriously.

Table 2: Standing time vs precipitated cold trub in flotation method

Standing time (h)	Precipitated cold trub (g/hL)
1	7.5
2	11.7
3	18.8
4	24.1
5	26.6
6	27.8

A second set of results is depicted in the Table 3. In the Table 3, the flotation and diatomaceous earth filtration methods are compared in the same type of beer at different temperatures. In the flotation method the standing time was 4 hours.

The DEFM is better than flotation clearly, the amount of cold trub collected from DEFM was greater than flotation; however, the operation costs of DEFM were higher than flotation methods due to that DEFM needs the automatic system for collected process and at least two operators. The flotation methods is more simple and inefficient although the operation costs are relative negligible. The higher temperature ($>7^{o}$C) both methods have the same efficacy due to the cold trub precipitates better better between 4 and 0 ^{o}C especially the polyphenols.

The adjuncts are very popular in American breweries; corn flakes and rice flakes are the most used. The adjuncts increase the presence of fermentable sugars in the wort and proteins, in consequence, their presence in the wort affect the amount of cold trub. The influence of amount of adjuncts in the precipitation of cold trub was studied using rice flakes due to it is cheap and easy to get in the market. The wort was prepared using different % of rice and cooling until 4^{o}C. The results are depicted in the Table 4. The maximum % of adjuncts in the wort was the 40% because the brewer masters do not recommend using adjuncts over 40%.

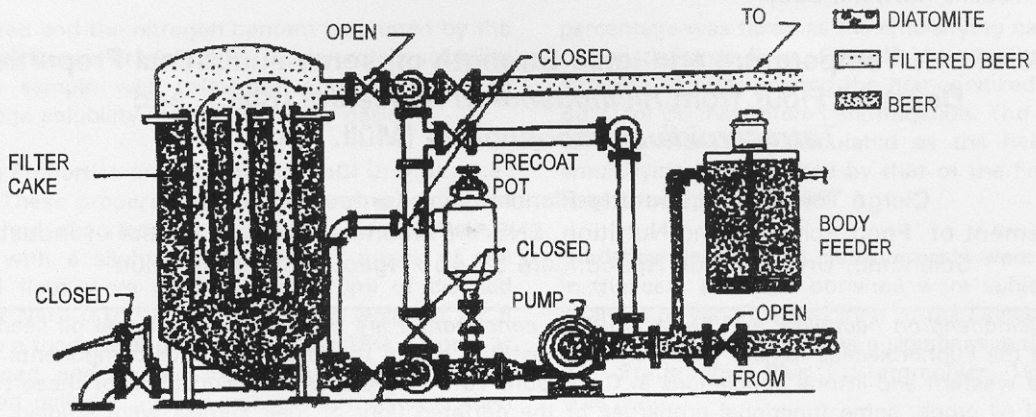

Fig. 1: Diatomaceous earth filter

Table 3: Evaluation of flotation vs diatomaceous earth methods at different temperatures

Temperature (°C)	Cold trub (g/hL) Flotation	Diatomaceous earth filtration
8	9.5	10.5
7	15.4	18.6
6	20.9	27.8
5	26.8	33.4
4	28.7	36.9
3	33.2	40.1
2	35.9	42.6
1	37.8	44.8
0	40.2	46.9

Table 4: Evaluation of flotation methods using different amount of adjuncts

Adjuncts (%)	Cold trub (g/hL)
0	28.7
5	27.3
10	25.6
15	22.2
20	21.1
25	20.7
30	18.8
35	15.2
40	14.6

Observing the results, wort brewed with adjuncts produce less cold trub. The reason is that the effect of the adjuncts over the amount of proteins in the wort can be neglected; however the adjuncts contribute with a considerable quantity of fermentable sugar. The most important is the quality of the beer; the brewers use to accept the adjuncts between 20-30%. Considering our results, the optimal is 30% or greater if possible.

Conclusions

Although some controversy surrounds this subject, we recommend removing the cold trub from the wort because it can extend the shelf life of beer, clean fermentation and the bottled and canned beers can be chilld around zero Celsius degree without yield clouded bottles and cans due to cold trub. We advice trying different methods over various beers and different yeast generations because it is very difficult to generalize.

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