Foam Evaluation. I. Primary Cling; Secondary Cling; Foam Strength

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MUCH OF THE visual attractiveness of a freshly poured glass of beer is due to the creamy-white head of foam which rides atop the surface of the beer (2). This appeal is not lost as the foam collapses or as the glass is emptied, because a good head of foam will deposit a generous, lacy "cling" on the glass, and a good "cling" has unique visual charm for the person who knows and appreciates good beer. The laboratory evaluation of beer foam quality is therefore a matter of no small importance ; it is, unfortunately, also a matter of no small difficulty. It is all too easy for a person working in a laboratory to be led astray by his methods of analysis and to measure foam attributes which have little, if anything, to do with foam appearance and behavior under practical conditions.

Published procedures for the evaluation of beer foam have generally been based on measurements of the liquid beer contained in or drained from the foam under standardized conditions of foam generation and decay (1). Such procedures are generally attractive to laboratory personnel because they yield *numerical values* which permit statistical treatment of the data, promote neat record-keeping, and are (somehow) intellectually satisfying to those trained in scientific or business pursuits. It is not at all certain, however, that such test values correlate closely with the behavior or the general attractiveness of beer foam in the drinking glass. We plan to report our findings in this matter in a subsequent paper, and we mention this only in passing at this time.

More pertinent to the present paper is the fact that beer foam quality, is the resultant of a combination of a number of different foam attributes, in which foam drainage plays only a subsidiary role. This is evident. from the continuing sense of dissatisfaction with foam assay procedures based solely on measurements of foam drainage rate or beer-contained-in-foam, as shown by the publication of methods for foam evaluation which are based on other foam measurements (3,4,5,6).

Cling is probably the most conspicuous property of beer foam not measured by drainage procedures: it is simply in plain sight for one's appraisal. As a consequence, the consumer is probably more aware of cling than he is of collapse rate or creaminess. A second very conspicuous aspect of foam which is also not measured by drainage procedures is the ability of foam to resist the deleterious actions of foam inhibitors.

A number of workers have published methods for the evaluation of cling (5,6,8). A method for estimating the ability of beer foam to resist the deleterious effects of soap has been published (4). The resistance of beer foam to foam inhibitors native to beer has been studied (7). It does not appear likely that one test can measure or that one numerical value can epitomize all the varied attributes of "good beer foam." New measurements, supplementary to those we already have, are needed.

In this paper we wish to present two novel procedures for the evaluation of beer foam. The first is designed for the evaluation of cling; it is a very simple procedure, and provides what we believe to be a fresh insight into this aspect of beer foam_ Heretofore, studies of cling have been limited to that cling

which is deposited by the original head of foam in the freshly filled glass. Under practical conditions, however, the consumer at intervals removes some of the beer from the glass and, as a result, a different kind of cling deposit is formed.

It is therefore necessary that this kind of cling also be considered in the overall evaluation of foam. Accordingly, we have introduced the concepts of "primary cling" and "secondary cling," and we have provided methods for their evaluation.

The second procedure measures what we have designated as "Foam Strength," by which term we mean the ability of beer foam to persist and to form a good cling deposit under adverse conditions, more particularly in the presence of trace-amounts of surface-active foam inhibitors. This procedure is a very practical one, as it approximates consumer conditions very closely. If a beer foam is poor as observed by the consumer, he blames the beer, not the glass. It matters little to him that a detergent or other surfaceactive material is to blame. Hence, a beer must have satisfactory "foam strength" in order to look good to the consumer under practical conditions.

A Method for the Evaluation of "Cling" or Foam Adhesion

Apparatus. The apparatus used is shown in Fig. 1. In addition, a number of clear, 10-oz., shell-type drinking glasses are needed. A stopwatch is also required.

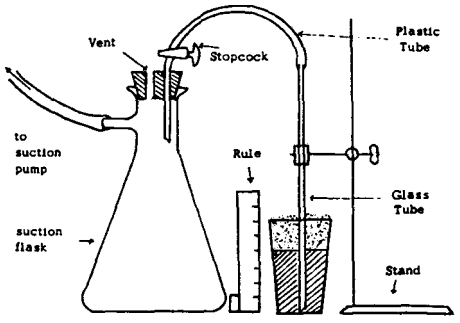


Fig. 1. Sketch of apparatus.

Procedure. The apparatus and the drinking glasses are washed and rinsed thoroughly and are allowed to air-dry.

Beer at 5°C. is poured into a glass in such a manner that about a 2-in. head of foam is produced. The beer is allowed to overflow slightly so as to sweep overboard the large, coarse bubbles which collect at the top of the foam: this provides for a greater reproducibility of the test results. The resulting foam head is allowed to collapse for a 5-min. period. The cling which is deposited during this time is termed the *Primary Cling;* see Fig. 2. The glass

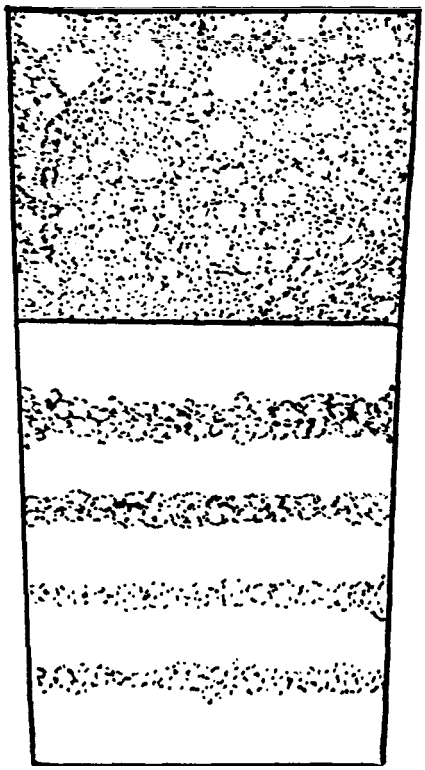


Fig. 2. Drawing representing a glass with clinging foam. *Upper:* Primary Cling. The foam material deposited on the glass by the original "head" of foam during a 5-min. standing period. *Lower:* Secondary Cling. The foam material deposited on the glass as the level of the beer is lowered in steps of 0.5 in. at 1-min. intervals.

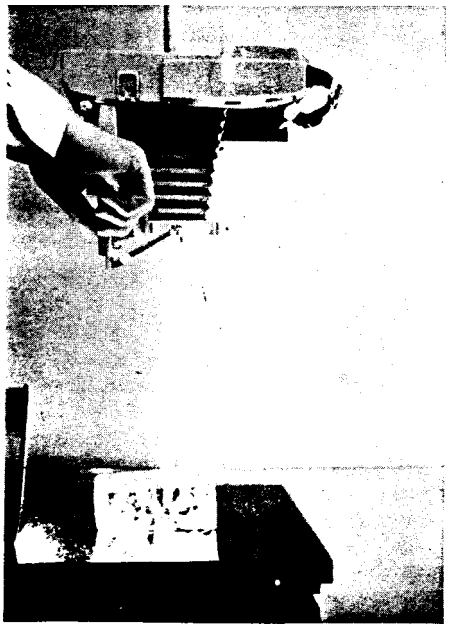
tube of the apparatus is then put into the beer as indicated in Fig. 1, and, by means of suction, the level of the beer in the glass is lowered %2 in. at a time at 1-min. intervals so that four or five possible rings of *Secondary Cling may* form; see Fig. 2.

The results of tests of three different commercial beers are shown in Fig. 3.

Fig. 3. Results of tests of three commercial beers.

In the photo at the left, the deposit! of primary and secondary cling are both very good. In the center photo, pri. mary cling is good but secondary cling is poor. In the test results shown at the right, primary cling is fairly good but secondary cling is almost nil. If we had limited our observations to primary cling, we would have concluded that these three beers all had satisfactory cling properties. It is obvious from this that primary cling and secondary cling are entirely separate entities and that each should be considered in foam evaluation.

In our experience with this test procedure we have found that different beers differ considerably in their cling properties, and that their differences as to secondary cling are frequently more striking than their differences as to primary cling.



The results of a cling test may be recorded most conveniently by photographic means. Figure 4 shows a compact set-up using a Polaroid camera mounted on a stand. The camera is fitted with an auxiliary close-up lens, and the lens-to-object distance is permanently fixed. Using illumination as shown, and a fast film, one can produce a finished picture of the cling deposit while it is still fresh. As shown here, the glass is photographed in the horizontal position. Cling deposits adhere firmly to the glass and do not shift position when the glass is photographed in this manner. Such Polaroid pictures form a permanent record and allow one to compare beers tested at different times.

Figure 5 shows three such Polaroid pictures. In the center picture are cling test results of a beer having excellent foam properties. At the left, another bottle of the same lot of beer had been treated to contain 1 ppm. of the detergent compound cetyl trimethyl ammonium bromide (CTABr) before the test was run: the results indicate some damage to both primary and secondary cling. At the right, another bottle of the same lot of beer had been "doctored" to contain 2 ppm. CTABr before the test was run; cling deposits were virtually nil. This beer was very sensitive to the CTABr. Other beers are more resistant to CTABr and show only a small amount of cling damage when

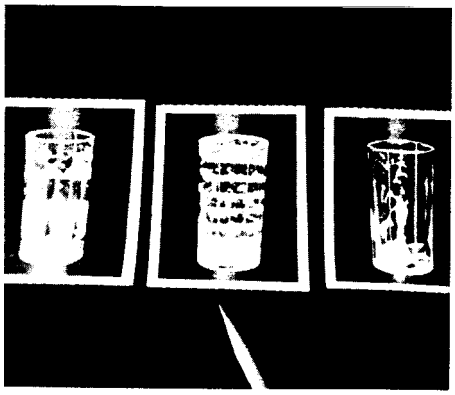


Fig. 5. Three Polaroid pictures of cling test results.

they contain as much as 4 ppm. of CTABr. Findings such as these led us to study and develop a test for Foam Strength.

A Method for the Evaluation of "Foam Strength"

We have applied the term "Foam Strength" to the ability of a beer foam to persist and to deposit a good cling under adverse conditions. "Adverse conditions" are defined as the presence of trace accounts of surface-active foam killers such as lard, soap, milk, deter gents, margarine, butter, cooking oils, greases, and lubricants in the drinking glass. Of all these, detergents left in the drinking glass are probably the most common source of complaints of poor beer foam. Trace amounts of detergent may remain in the drinking glass as a consequence of incomplete rinsing, or they may he a component of a final sanitizing rinse and be left in the glass intentionally. In either case, the detergent is a genuine threat to foam, and the ability of a beer foam to resist detergents is a natter of serious concern to the brewer.

Figure 6 outlines a simple procedure we have devised to evaluate Foam Strength. The circles represent a row of 10-oz. drinking glasses. The first glass (left) does not receive any detergent, the next glass gets one drop, the one after that gets two drops, and so on. The detergent used is cetyl trimethyl ammonium bromide (Eastman Kodak No. T5650) in 0.36% aqueous solution. This material was chosen because it is a definite compound of reasonable purity and known composition, because it is a powerful foam destroyer, and because it is one of the class of compounds known as quaternary ammonium salts, which are much used in formulations of proprietary cleaning compounds. We tested a number of other surface-active detergent materials, including cationic, anionic, and nonionic types, and found that they all behaved very much like the CTABr. Hence, CTABr can be considered to be a good representative of this kind of material and suitable for use as a standard material in a foam test. Lard, butter, margarine, milk, soap, and other fatty materials are less suitable for use in this test, because they are less uniform in their composition, because solutions of them are awkward to prepare or require special solvents, or because they are not commonly encountered in glasses used for beer. The 0.36% concentration was chosen because one drop (0.05 ml.) of such a solution added to a 10-oz. drinking glass which is to be filled with about 180 ml. of beer plus the usual head of foam will supply approximately 1 ppm. of the detergent to the beer.

The beer is poured into the prepared glasses in the usual manner as for a pouring test of the foam. The foam is examined as it collapses, and the Foam Strength Value is estimated as the highest ppm. dose of detergent which the foam can tolerate with no appreciable worsening of the cling or collapse rate. A Foam Strength Value (FSV) of 1 would mean that a foam can tolerate only a 1-ppm. dose of detergent; FSV 2, as much as a 2-ppm. dose, and so on.

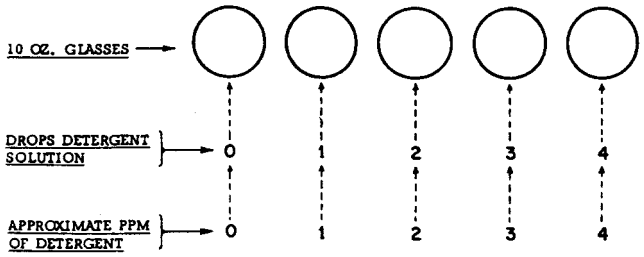


Fig. 6. Foam strength test, simple form.

A second and possibly more interesting form of this test is outlined in Fig. 7. As indicated, one beer sample is poured into one row of prepared drinking glasses and a second beer sample is poured into the other. This allows direct

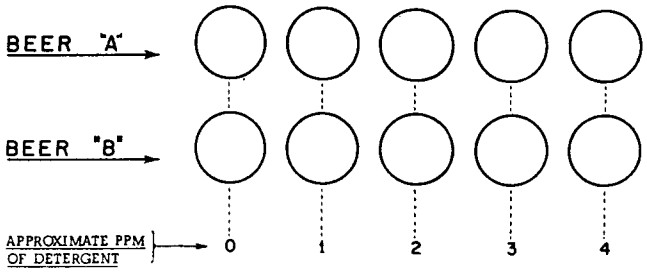


Fig. 7. Foam strength test, comparison form.

comparison of two different beers and is a useful technique for studying the effects of different brewing procedures, different ingredients, and different additives on beer foam.

The end result of such a comparative test of Foam Strength is shown in Fig.

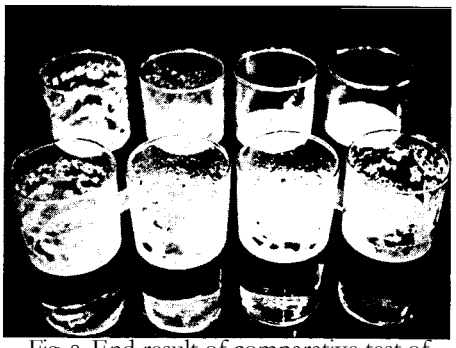


Fig. 8. End result of comparative test of Foam Strength (see Fig. 6, lower).

8. The superiority of the" beer in the front row of glasses is evident; it had FSV of about 3. The beer in the back row of glasses had FSV of about 1. Our experience with this Foam Strength test procedure has indicated that the vast majority of U. S. beers have FSV of 0 or 1, with a very few beers rating as high as 3 or 4 or more. These FSV's may seem to occur in a very narrow range, but there is a highly significant practical difference between beers having FSV's of 0 or 1 and those having FSV's of 3 or more. In our experience, under conditions the consumer is likely to encounter, beers with inherently good foam but with FSV's no greater than 1 will sometimes suffer as to foam when poured into serving glasses which are not absolutely clean, whereas beers having FSV's 3 or more will be able to withstand less-than-optimal serving conditions and to form and hold a good head of foam and produce a generous cling deposit.

Summary

A simple method for evaluation of the cling properties of beer foam has been developed. Tests using it have indicated that the cling material deposited by beer foam consists of two separate and distinct entities which we have termed "Primary Cling" and "Secondary Cling." Differences between commercial beers as to their secondary cling are frequently more striking than their differences as to primary cling.

"Foam Strength," defined as the ability of beer foam to persist and to deposit a good cling under adverse conditions, particularly the presence of trace amounts of surface-active foam killers, may be assayed semiquantitatively in a simple test based on the use of a representative detergent, cetyl trimethyl ammonium bromide. Data obtained using this test indicate that commercial beers can differ significantly as to their Foam Strength.

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