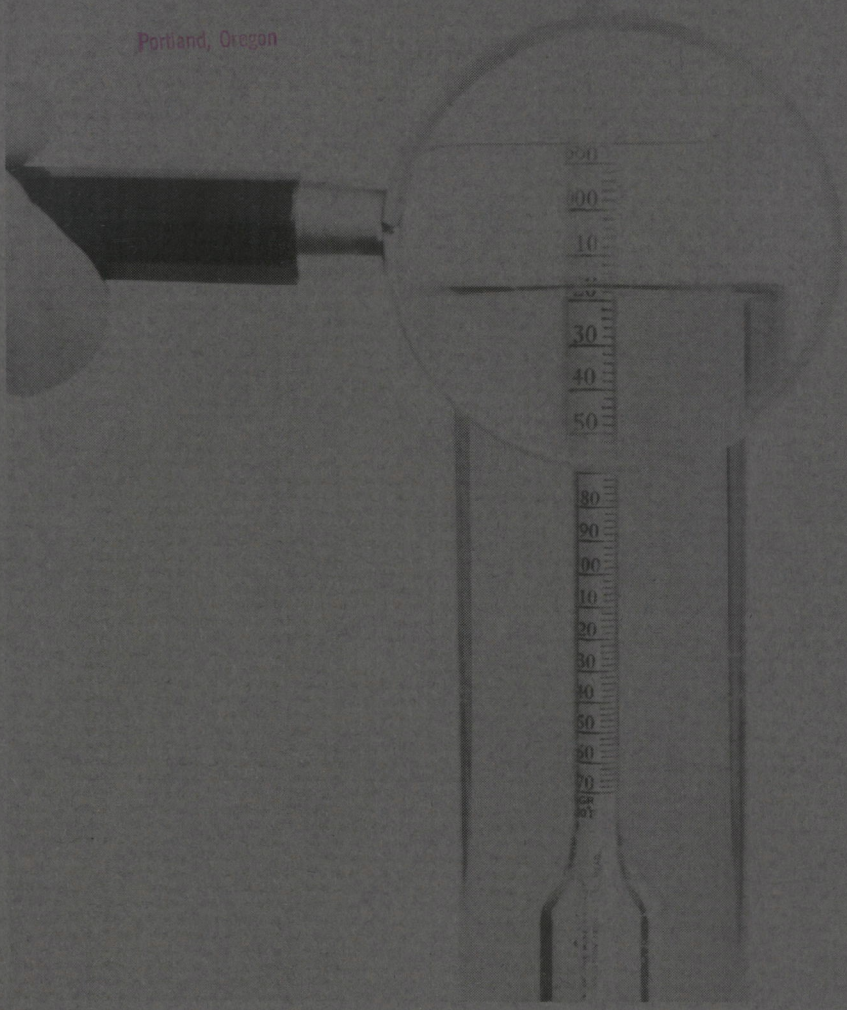
# Amateur Brewer Communications





AMATEUR BREWER ANNUAL NO. 9, 1982

Amateur Brewer Annual No. 9
1982
Editor Fred Eckhardt
Telephone (503) 289-7596

Published by Fred Eckhardt
J.I. Takita

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*Amateur Brewer Communications for the Serious Home Brewer* is published annually, in conjunction with *Talk to Your Beer*, Amateur Brewer Bulletins published six times a year by The Amateur Brewer Information Service, Box 546, Portland, OR 97207.

Cover: Hydrometer, by Fred Eckhardt.



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# BIBLIOGRAPHY

Numbers in the text refer to the numbers below for certain references. Some of these books have been reprinted or there may be a later edition, I can not be certain that the information in a later edition is still what I am refering to, and this is true especially for tables of reference. If your library does not have these volumes, refer to our newsletter 8-4, for a list of libraries which may have them.

1. Amerine, Laboratory Procedures for the Enologist, UCD 1956. Has been re-issued as a book, which is more complete.
2. Amerine, Berg and Cruess, *Technology of Wine Making*, Second Ed., 1967: Westport CT, AVI Pub Co.
3. American Society of Brewing Chemists (1949 ed), *Methods of Analysis*. This old volume is much easier to use, the current one is hideously thick and horribly technical. Published annually.

(Continued inside back cover)

# GILBERT STRAUB AND THE PENNSYLVANIA BREWING TRADITION

By George Fix



**Pennsylvania** has had a long and rich history of lager brewing. The first pure strain of *Saccharomyces uvarum* to reach North America arrived in Philadelphia, and this formed a basis for an industry that at one point had over 450 independent breweries in operation. Their numbers are, alas, greatly diminished today; however, the spirit and vigor of the small independent brewery is by no means dead. Of those still in operation, the most interesting, in my opinion, is the smallest; namely, the Straub Brewing Co., whose output is 930,000 gallons per year. It is located in St. Marys, Pa., a small community in scenic Elk County in the north central part of the state. This family-owned firm was founded in 1872, and has always been profitable. In recent years they have consistently been operating at full capacity and selling everything they make. In fact, the demand for their beer has become so intense that they have had to limit distributors.

The guiding light behind this operation is Gilbert ("Gibby") Straub, who only recently retired as brewmaster. Gilbert's long career has been totally devoted to excellence in brewing. He brews an all-grain beer that has no additives. In fact, even though the spring water used is remarkably soft (the total hardness is only 25ppm), he refuses to add water salts, counting instead on an ingenious mashing technique to convert the grains.

Gilbert is also a strong defender of the small local brewery. The firm's economic health and the strong demand for their beer would easily support a major expansion, and yet they have refused to do so. When questioned by visitors

on this subject, Gilbert often jokes that expansion would mean they couldn't take off at three each afternoon and go fishing. When questioned in private, Gilbert says they have remained small so they can brew exactly the sort of beer they want to brew without being forced into compromises he sees being made in larger operations.

It was my good fortune to have struck up a friendship with Gilbert nearly a decade ago. Since that time we have collaborated closely on a variety of home brewing projects. Gilbert is well aware that good beers can be produced from small batches using elementary equipment, and he himself did a lot of home brewing during Prohibition. "This is the way we kept Straub beer flowing during that sad era," he has remarked.

What I have learned from this remarkable man could fill volumes, and I am convinced that as far as brewing is concerned, he is a genius. Included here are only a few points that are particularly pertinent to home brewing.

Gilbert has insisted from the start that we work only with grain beers. He argued that, given the quality of barley malt available today, there should be no problems in mashing the grains with kitchen equipment. Moreover, he sees the mash as an important strategic tool in the hands of a brewer. When fine tuning a particular recipe, it is often more effective to make alterations in the mash than to alter the type and amount of ingredients used (e.g., lowering the conversion temperature to marginally increase the dryness and strength of the finished beer). Before I met Gilbert, I used grains only for flavoring, relying mainly on malt syrups for the extract. From the start, the grain beers came as a major revelation, and I am now convinced that any recipe, no matter how successful, would be improved if the syrups and sugar used were replaced with appropriate grains.

There is, however, one major drawback with grain beers that has not been widely discussed in the literature; namely, the limited shelf life of barley malt. Gilbert makes sure that the brewery gets new malt every few weeks, and while the shelf life of malt is a good deal longer than that, Gilbert says if he ever found malt over six months old, he would feed it to the local elk rather than brewing with it. As a malt ages, the flavor of the finished beer takes on uncharacteristic stale and tired overtones. I wonder how many all-malt home brews have turned out to be disappointments only because of the unsuspecting use of old malt? Gilbert's suppliers provide the exact dates when the barley was malted. Perhaps we should request the same of ours.

Gilbert also uses flaked maize in his beer. This is done not for reasons of economy — the flakes are actually more expensive than barley malt — but rather to achieve a desired flavor profile. Incidentally, his beer is the best existing example of the traditional Pennsylvania lager style. It is strong and full flavored (the locals call it "High Test"), yet it has a light body with a dry and clean finish. Gilbert feels that it would be impossible to brew a beer in this style without the flakes.

Before I met Gilbert, I had a very negative feeling about cereal grains. This is

primarily because of the outfront corn flavoring that can be found in some American beers. The latter, however, arises from the use of corn grits. They have to be boiled with some malt in a cooker mash before they can be converted. The cooking time can last as long as 45 minutes, and it is during this period that the corny flavoring is produced. Maize, on the other hand, is added directly to the mash tub and adds smooth and grainy beer-like flavors. I now feel it is an excellent grain to use in the place of dextrose, provided barley malts provide at least 67 percent of the fermentables.

Gilbert also has a high regard for flaked barley. This grain, however, does pose problems for the home brewer, since it is hard to convert, and the finished beer has a strong propensity for starch hazes. The flavors, nevertheless, are excellent. Rice, on the other hand, poses different problems. It, like corn grits, must be cooked before it can be converted in a mash. This is very hard to do without extracting husky off-flavors from the malt. Gilbert feels this is even a problem for small breweries, and that one should avoid cooking grains if at all possible. Flaked rice, similar to flaked maize, is also satisfactory as a grain adjunct. Flaked rice is good as it will produce a more neutral flavor.

Gilbert's ideas about dry hopping are also quite interesting, and differ in many important respects from those found in the home brewing literature. In Gilbert's procedure the aging period is broken into two parts, a short primary period which lasts five days, and a longer secondary aging period. The temperature in both is held at 32°F (0°C). When the fermentation is complete, the beer is racked into fresh containers at the start of the primary aging period, and it is here that the dry hops are added. They are removed at the end of this period as the beer is transferred into new containers for the secondary aging period. The reasons for this are twofold. First, at the low storage temperature the danger of bacterial activity (always a danger with dry hops) is minimized. Secondly, because the beer is stored in airtight containers the aromatics imparted by the dry hops is bound into the beer, giving it a big and generous nose (this property is de rigueur for traditional Pennsylvania lagers).

Another important aspect of this procedure is the way the dry hops are sterilized. This should not be done by boiling them in water as is often recommended, for this removes the aromatics. Instead, they should be steam sterilized. This can be done by attaching a nylon cloth to the top of a kettle of boiling water. The hops are then put on top of the cloth and allowed to steam. Fifteen minutes is adequate, provided the steaming water is at a good, hard boil.

The final topic concerns the filtration of beer. During the Prohibition, Gilbert designed and built a unit for filtering his five-gallon batches of home brew. Similar units are available today, but the marketing is primarily directed to labs of commercial breweries. Gilbert feels the best such unit is made by *Zahm and Nagel*[2], and he helped me get one of their units. It is to be emphasized that units such as this are designed to give a polished finish to a basically clear beer. The effects, however, are truly remarkable, especially on the finesse of the finished beer and its aftertaste. The unit is somewhat similar to home wine filters in the sense that the liquid is filtered through pulp. It differs in that

the beer is gently pushed by $CO_2$ pressure (rather than gravity) through the filter. In addition to removing dead yeast and sediment, this procedure also removes all dissolved air as the $CO_2$ flows up through the beer after it has passed through the filter. Gilbert and I have taken a number of dissolved air readings with his instruments (also made by *Zahm and Nagel*). Typically, before filtration, the dissolved air will be around 1 ml. per liter (which is acceptable but in time will have some effect), and after the filtration it is a dead zero. Incidentally, we ran some tests with ascorbic acid without the filtration, and in some cases the dissolved air was actually increased after a week, and in one case to the danger level of 1 ml. per one-third liter.[3]

The *Zahm and Nagel* unit can also serve as a first-rate Kraesen tank, making this procedure for carbonating beer virtually failsafe. In addition, they have accessories that will permit the carbonation of beer using the traditional Lampson carbonating stones. However, since home brewers are typically not able to collect $CO_2$ from the fermentation, they would have to use a separate $CO_2$ supply, and hence this latter method would not be a natural carbonation.

I would strongly recommend a visit to St. Marys to anyone near this area. The brewery has a tap room which has an ample supply of good conversation and "High Test." Visitors will find the Straub family to be friendly, outgoing, and totally devoted to the ancient art of brewing.

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## HOME BREW VERSION OF STRAUB BEER — 6-GALLON BATCH

INGREDIENTS — 6 US Gallons

1. Water — 8 gallons. If there is any possibility of residual chlorine, this water should be boiled. If the alkalinity is above 50 ppm, it should be held at a hard boil for 30 minutes to precipitate most of the carbonate salts.
2. Grist — 6½ lbs. 6-row barley malt and 3¾ lbs. flaked maize
3. Hops — 1½ oz. kettle hops and ¼ oz. dry hops
4. Yeast — 3 oz. brewer's lager yeast. It has been nearly 10 years since I have used freeze-dried yeast. Presumably they could be used here; however, I hope there are better products available now than 10 years ago. I remember them as quite erratic.

MASH

1. Combine cracked malt and 2 gallons of water for a protein rest at 110°F (43°C), holding this temperature for 30 minutes.
2. Add 1 gallon of boiling water and raise the temperature to 150°F (65°C). Stir in maize at the end, using it as a brake.
3. Hold at 150°F (65°C) for 15 minutes and then raise the temperature to 156°F (65°C). Hold until all starch is converted as indicated by an iodine test (15-30 minutes).

4. Mash off at 175°F (79°C) and sparge with 5 gallons of water at this temperature.

REMARKS

1. As always, one should stir regularly during the entire mash.
2. The above is a hard water mash (i.e., using water with a total hardness of at least 350 ppm and an alkalinity of not more than 50 ppm). If softer water is used, it would not hurt to take an acid rest at 95°F (35°C), or in any case, not leave the protein rest with the pH above 5.2.
3. The kettle boil is for 1½ hours with the hops added in three increments, after 45 minutes, 1 hour, and 1:15. The Irish Moss (if used) is added after 1 hour.
4. Ferment at a fixed temperature in the range 45°-55°F (7°-13°C).
5. Dry hop and age as noted in article.
6. One can use a dextrose bottle prime here without fear of cider overtones; however, a krausen produces better results.

ORIGINAL GRAVITY: 1.042-46 (10°-11°B)
TERMINAL AROUND: 1.010 (2.5°B)
EST. ALCOHOL: 3.6% /w

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About the author — George Fix has won many prizes for his beer in judgings around the country, including the Home Wine and Beer Trade Judgings in 1981 and 1982. He has been an *AB* subscriber since 1978, and we have corresponded for about three years now, mostly about Gilbert Straub, whom George greatly admires. Gilbert Straub's mashing techniques are not delved into in the above article, but George did give me a little more information in his correspondence:

"...Most methods for mashing with soft water are variations of the ... *Pilsen* [system with a] lengthy acid rest. Labor costs and union work rules make it impossible to use such procedures [in the U.S.]. Gilbert's system ... requires only half the time.... More remarkable [the] procedure does not even include an acid rest! What he does is to use unorthodox rest remperatures and mash thickness ... the finished beer has a distinctive smooth and mellow taste."

Mr. Straub set a condition for helping George:

"He made me swear allegiance to the concept of pure grain beers and to his [Gilbert Straub's] own personal *Rheihheitsgebot*, i.e., fresh grains and hops, water and yeast with absolutely nothing else added. In particular, I had to promise that I would never open a can of malt syrup nor a bag of dextrose during our collaboration!" George Fix describes some of the problems he had with all-grain mashing. The majority of [our earlier] batches were unstable with respect to chill hazes because "I was attempting to follow standard commercial procedures with only kitchen equipment. In a large mash I was unable to maintain the strict temperature control required in these procedures."

"Problems like that only stimulated Gilbert's fertile imagination. After a few trials he came up with a continuous upward infusion mashing system somewhat similar to the one used in his brew, but one that can readily be done in the average kitchen. These days I get consistent and satisfying results with my Artesian water (hardness 415 ppm, alkalinity 35 ppm). However, there is still no real explanation as to the secret of Straub's use of their very soft (25 ppm hardness) water to produce good beer. "I will probably go to my grave without fully understanding how [Gilbert] can use such soft water in his commercial beer!" George Fix makes his beer in a single container where the ferment is allowed to go to completion at 45°F (7°C), which normally takes eight to nine days with brewery yeast. The beer is then racked into glass carboys containing steam-sterilized dry hops, and left for seven days at 35° (1.7°C) on a bed of steam-sterilized dry hops. The beer is then filtered by a Zahm and Nagle unit, which George obtained for $30, used, and set to secondary or aging storage for four weeks at 32°F (0°C). The beer is then carbonated by the same unit and given a polish filtration, and bottled.

The system consists of a 5-gallon (19-liter) stainless steel soda pop container ($10 deposit) with a $CO_2$ supply (including pressure gauge), a Z&N pulp filter, and a hand-bottling unit. George explained, "In the primary filtration one attaches the supply of the $CO_2$ line of the tank and the filter to the liquid line. After the beer is transferred into the tank, the top is closed, and the $CO_2$ supply turned in. The beer is then pushed out of the tank through the filter into fresh carboys. This is a gentle filtration and does not overly "strip" the beer. In fact, in my opinion, its chief advantage lies in the fact that the $CO_2$ is also pushing air out of the beer as it pushes the beer through the filter. There is a small amount of dissolved $CO_2$ left in the beer at the end of the filtration, but this is released during the secondary storage, taking with it the last of any air dissolved in the beer."

He goes on, "My method for carbonating with this equipment is to add a 20 percent krausen to the beer in the tank, while Gilbert prefers to directly inject $CO_2$. In either case, the pressure is allowed to build up to 30 pounds and the temperature is lowered to 32°F. The trick now is to get the beer out of the tank and into the bottles without losing $CO_2$, as would be the case, for example, if we pushed it out of the tank with the $CO_2$ supply. Gilbert's idea is to attach a second $CO_2$ line to the tank, which is used to apply counter-pressure on the bottle; i.e., it tends to push the beer back out of the bottle and back into the tank. With the supply pressure being slightly higher than the counter-pressure, the beer flows smoothly into the bottle with the counter-pressure holding the $CO_2$ in the beer. With the krausen carbonation it is necessary to also use the pulp filter to prevent a renewed fermentation in the bottle.

"I am really happy with this equipment. It consistently gives the beer a commercial clarity, and I find it results in cleaner and fresher flavors. The pressure levels are also very reliable. Theoretically, it should result in a $CO_2$ level of 2.7 volumes $CO_2$. I measure each batch with an instrument of Gilbert's Brewery, and during the last year the lowest reading was 2.65, the highest 2.72."

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George told me he had visited Germany on business last year, and he managed to visit a few small breweries. "It is really great to see how well small

breweries are doing there. A really interesting one is found at Ottoburen near Munich. The owner of this small but first-class operation, Mr. Max Groff, spoke in glowing terms about both Fritz Maytag and Gilbert Straub. He credits them as playing a decisive role in his decision not to expand, but rather re-invest profits to improve his existing operation whenever possible. For once I was really proud of American brewing. Now if those influences could only find their way to Milwaukee!"

George was kind enough to send me samples both of his beer (an all-malt sample, not the above recipe) and that of *Straub* beer. Both beers measured up to all of my expectations. I felt a little sad that *Straub* beer had not been represented at Boulder, CO, for the Great American Beer Festival in June, but George assures me that both he and Gilbert will be there next year.

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FOOTNOTES:

[1]See J.D. Robertson's evaluation in *The Great American Beer Book.*

[2]*Zahm & Nagel,* 74A Jewett Ave., Buffalo, NY 14214, (716) 833-1532. Around $100.

[3]This is apparently a well-known phenomena in commercial practice. See, for example, Hough, Briggs, and Stevens, *Malting and Brewing Science,* pp. 641-2.

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## COFFEE URN TO MASH TUN

**By Vince Cottone**

**Amateur** brewers have a wealth of commercial equipment at their disposal which can be modified to suit various brewing requirements. One such item is the large stainless steel coffee urn used in some restaurants and cafeterias. These are often replaced these days with smaller drip systems in the interest of fresher coffee. These coffee urns are, with a few modifications, ideal for mashing grain beers. They are to be found in salvage yards, surplus and second-hand stores and swap meets at reasonable prices (I paid $25 for mine!). The units have two cylindrical wells of several gallons capacity each (usually 3-5 gallons — 12-20 litres), which are surrounded by a thermostatically controlled hot water jacket. There is a device which sprays the coffee grounds with hot water and which is easily adapted for sparging. If you have the space, a little mechanical know-how and utilities available (cold water supply — laundry works fine; electrical — 220-240v, 30-amp circuit — clothes dryer hookup is fine), you may want to procure one of these to do your mashing. See fig 1. These urns come in various sizes, but the most common seem to be twin 3-gallon and twin 5-gallon sizes (urn has two wells, *each* of that capacity);

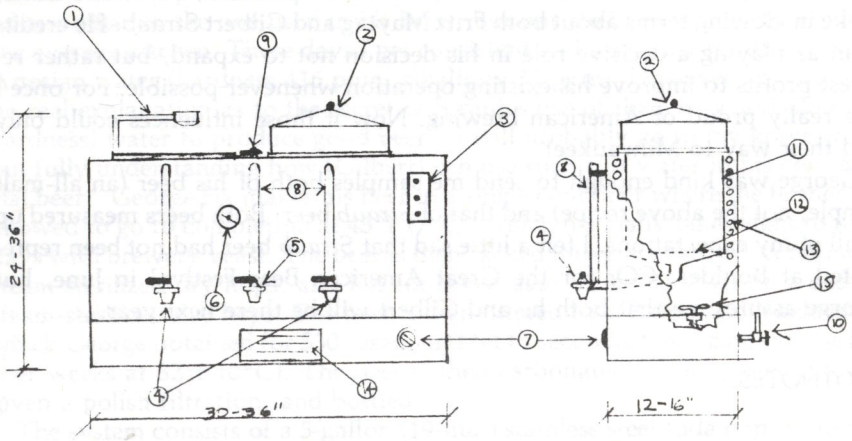


Fig. 1 Typical coffee urn
1. Sprayer arm 2. Well lid 3. Controls 4. Spigots (wells) 5. Spigot (jacket) 6. Jacket thermometer 7. Thermostat 8. Sight glass 9. Sprayer valve 10. Inlet valve (to cold water supply) 11. Well 12. False bottom (added) 13. Internal heating coil for sparge water 14. Access panel (to heating element & wiring) 15. Heating element

these are probably the best for our purposes. To determine the capacity, find the volume of the well as follows: Volume v = radius$^2$ × 3.142 × depth. For my unit, the diameter 11½", depth 8", radius = 11.5/2 = 5.75". Therefore, 5.75 × 5.75 × 3.142 × 8 = 831.059 cu. in., which is converted to US gallons by multiplying that by the factor 0.0043. 831 × 0.0043 = 3.6 gallons. (In metrics the process is even simpler, because the result is in cubic centimeters, which are the same as milliliters. In the above case 13,596ml, or 13.6 litre.) This size allows me to mash up to 10 pounds of grain which will produce 5 gallons wort at gravities between 1060 and 1070. This using only one of the two wells!

Some urns have tall, narrow wells, but the low squatty ones are better because the grain bed depth will be shallower to make sparging easier and quicker. My twin 3½-gallon unit is very good for this with its 11½" diameter. The 5-gallon units I have seen are narrower (about 10½"). Thus far I've used only one well on my unit, but I plan to use both as soon as I can equip them for lautering (straining) and sparging (and as soon as I devise equipment to boil 5-15 gallons of wort!).

When you go off hunting for your future mash tun, it's a good idea to take along a tape measure, both regular and Phillips-head screwdrivers, penlight, pocket calculator and, if available, a small Ohmmeter or electrical continuity checker (these last for checking the heating element). Your urn should have all the parts that go with it: lids for wells, spigots, sprinklers, etc. Check inside the water jacket (with flashlight through vent openings at the top of the unit) for excessive rust or scale. If it is bad you may have to disassemble and clean it. Check the heating element for corrosion, appearance, broken surface or pits

and holes. The element is usually a figure-8-shaped affair in the bottom of the unit. These can be expensive to replace unless you find a used one in good shape. While you're at it, check the wattage of the element; up to 6000w is okay for 30-amp circuit; the more wattage the better. The wattage information is noted on the manufacturer's nameplate. Older urns have hand-operated, mechanical fill and "brew" ("sparge" to us) valves, while newer ones have electrical solenoid valves operated by push buttons. Both types are fairly reliable, but the mechanical ones are easier to fix if something does go wrong. The heating element should also be checked for continuity and shorts to ground with the Ohmmeter. The terminals are located underneath the unit. Finally, the general appearance of the machine can be a clue to its condition. Ask yourself if it looks like it was in good operating condition when taken from service. Partially disassembled units are evidence of problems. I have seen many serviceable units for $25-$50 here in Seattle.

## SETTING IT UP

First clean out all coffee residue. The most effective cleaner is a mild solution of household lye (wear long rubber gloves and goggles, avoid the fumes) used with fine steel wool. Fill the wells partly with solution and let them soak for a few hours. Let some solution out through the spigots. You may need to disassemble these to clean them. If you prefer not to use lye, dishwasher detergent or oven cleaner (also contains lye; use precautions) will do the job but less effectively. Next, fabricate a false bottom or straining device for the lautering stage. I had a piece of stainless steel perforated (0.04" — 1mm) and cut to fit snugly in the bottom of the well. Before that I had used a piece of coiled copper tubing with hacksaw slots at 1" intervals, which worked nearly as well. You might experiment by using a grain bag type of strainer, although the bag will inhibit heat transfer from jacket to mash.

You'll need to plumb the machine to a cold water supply for filling and sparging. For that I used an assortment of brass fittings from a plumbing supply plus a washing machine hose to connect to my laundry tub. You must re-rig the electrical connection for use at a dryer outlet. I used a heavy (#8 copper) triangular grounded plug which I connected to the junction box on the back of the unit.

Most of these urns have a rotary-type dial thermometer to monitor the water jacket temperature, but they only have indication for the brew temperature of coffee (about 197°F; 90°C). Using a thermometer of known accuracy, it is easy to calibrate this device in degrees during your first "dry run." Accuracy is not critical (±2-3 degrees), but you *will* need an accurate hand thermometer to monitor the actual mash temperatures. I made a paper scale and fitted it around the dial. I marked it off in approximately 5° intervals. You may want to calibrate the thermostat dial as well, since that will probably be lacking, too. When you are heating the jacket water you will be able to hear the water

heating, and when it stops you'll be able to hear the thermostat click "off." Calibrations for an upward step mashing system should encompass the range 90°-185°F (32°-85°C) at 2½C or 5F intervals.

For the sparging system the existing sprayers may be used, although the holes in them (and thus the flow rate) are a bit on the large size. I fabricated a copper ring of tubing with tiny holes drilled (less than 1/32" — 0.8mm), and this works fairly well, but I hope to improve upon it. When sparging, I keep the water level just above the top of the grain bed. Now, if you're ready, we can finally brew some beer.

## SIMPLE INFUSION MASH

This is recommended only for fully modified English malts. Preheat the jacket water and brewing liquor (in the well) to 160°-165°F (70°-74°C). Stir in the crushed malt, and check to see that the temperature has fallen to about 150°F (65°C). Now run off a little jacket water, and at the same time run in (replace) it with some cold water to drop the jacket temperature to about 154°-155°F (67°-68°C). Back off the thermostat until you hear it click "off." Now your mash temperature should stabilize itself to within a degree or so. If the vessel is not covered, keep the jacket temperature a couple of degrees above the mash temperature to make up for heat loss. Stir occasionally. If the vessel is covered, the jacket temperature should be the same as the mash temperature. It's fairly easy to control. You can also run some hot liquor into the mash through the sparger to raise the temperature if it drops off. Keep in mind that thinning the mash will favor the production of fermentable sugars. When conversion is complete, raise the mash temperature to about 170°F (77°C) (the jacket temperature should be about 180°F (82°C), and this will provide sparge water at 170°-175°F (77°-79°C). Stir the mash while raising the temperature. Allow the mash to settle for 20-30 minutes, then open the pfaff (spigot) and draw off the turbid wort into a suitable container. When the draw runs clear, return the cloudy wort to the mash and start running the clean wort into your brew kettle. Open the sparging valve as the liquid falls to the grain bed level and maintain that level as close as possible. Collect the required amount of wort and boil as usual. For the definitive treatise on simple infusion mashing, see Dave Line's *Big Book of Brewing.*

## UPWARD STEP MASH

This is to be recommended for all malts, and is almost a requirement for American, Canadian and Continental European malts in order to achieve maximum extract and clarity. It is neither as difficult nor as time consuming as it sounds. It pays good dividends in better beer. The procedure is outlined in exacting detail in the *Amateur Brewer Mashing Notebook,* available from *ABIS* ($2.50).

It is necessary to estimate how much the water jacket temperature must ex-

ceed the mash temperature to effect rapid heating of the mash between temperature rests. It is necessary to stir the mash continuously during the heating cycle to accomplish this.*

Even so, the temperature will probably not rise as rapidly as you'd like, but with some modifications, it will serve. My unit takes about 15 minutes to raise the jacket temperature from 122°-148°F (50°-64°C), and about 20 minutes to bring the mash temperature from 122°-145°F (50°-63°C). Since this has the effect of prolonging the "sugar rest" phase, lately I have been going directly from the *protein* rest to the *dextrin* rest without actually stopping for a *sugar* rest. The mash actually spends more than enough time in that temperature range, so the effect is the same as if it were held at that temperature for 5-15 minutes.

I find that when using the upward step infusion mash, keeping the jacket temperature about 15 percent above the mash temperature, when heating, effects rapid heat transfer without letting it get out of control. Mash viscosity also effects heat transfer. Use about 1¼-1½ US quarts (2.6-3.1 litre/Kg; 1-1¼ UK quarts/lb.) of malts makes an ideal mash. The only limiting factor is total mash volume (I'm limited to about 3¼ gallons [12 litres; 2.7 UK gallons] per well).

Once you bring the temperature to the *dextrin* rest phase, the procedure is similar to that of the infusion mash outlined above.

With a little experimentation you can devise procedures that will work best for you and your equipment to produce the beer *YOU* like. The beauty of this system is, once you have the method worked out, you can achieve repeatable accuracy. GOOD BREWING!

*Being lazy, I have constructed various stirring devices. The best one is made from an ice cream maker motor. This and other equipment will be covered in my forthcoming article, "Rube Goldberg Comes to Amateur Brewing," to be published in late 1986.

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Vince Cottone is a Seattle home brewer and is quite active in promoting home brewing around the Seattle area. He is especially fond of calling me at 7 in the morning to discuss his latest venture, or "find," as he calls them. He earns his living as a home improvement contractor, but he'd rather be brewing. Indeed, he attended last April's Micro-Brewery seminar at Davis, and the five-day Intensive Brewing Science for Practical Brewing course at the beginning of September. He hopes to find employment in the Micro-Brewing industry, if not his own operation. As you can see, he is very clever at putting things together for better brewing. He also has, in his basement, a multi-tap arrangement for serving several of his beers at the same time. He adapted a multi-unit soda dispensing outfit for his purposes.

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# BAKER'S YEAST REVISITED

By Chris Quint


How do the different yeast types fit into home-brewing and what is the truth about baker's yeast and brewing? This was a question I asked Dr. Michael Lewis, of the Food Technology Department at the University of California, Davis. I was there attending his excellent class on advanced home-brewing. The response I got was surprising.

"Unless you have access to pure yeast cultures, the most reliable types will be the packaged dry yeasts," Lewis began. "Of those, regardless of what the package may state, most are ale yeasts. In our testing we have never found a packet marked 'ale' to be a lager yeast."

"Wine, baker's, and ale yeasts are all top fermentors or *Saccharomyces cerevisiae.* The only differences are that they vary slightly in performance," Dr. Lewis explained.

"It is claimed that baker's yeast will not perform as well as the ale variety. It isn't supposed to settle out as well or attenuate as efficiently. It is an interesting thought; will baker's yeast work well? We haven't experimented with it here, so I can't say it won't. Why don't you give it a try," he urged, and I did.

First I brewed an eight-gallon batch. I used 11.5 pounds of Mutton and Fison light, unhopped canned malt extract. This I boiled in nine gallons of city water with three ounces of fresh *Eroica* hops and two pounds crushed crystal malt. The boil took 90 minutes.

After the wort was cooled in a wort chiller, nearly equal amounts were siphoned into two glass carboys for one-step fermentation. Into each carboy went three seven-gram packets of dry yeast as recommended by Dr. Lewis.

In carboy A, I used *Fleischmann's* Active Dry baker's yeast. *Red Star (Great Dane)* Ale yeast was sprinkled into carboy B. Each beer was treated exactly the same, and I recorded the activities of each in my log, carefully.

Both beers fermented at 20 degrees C (68 degrees F) during the entire experiment. In just 12 hours there was vigorous fermentation going on in carboy A, the one with the baker's yeast. Its gentle burping came every five seconds compared to carboy B's feeble bubble at the end of a long 80 seconds.

Carboy A had a thicker head sooner and for a longer time than B did. After two days the bubble rate for A and B were equal, and in six days the visual signs of fermentation had ceased.

After 10 days, the yeast sediment was about equal for both, but B seemed to have compacted very slightly more than A. It could be that A produced more yeast to create the larger yeast cake.

I added finings to both and let them age for 12 more days. Then I added

equal amounts of priming sugar when I bottled. The total brewing time was 21 days. I left the bottles to settle out and carbonate for two more weeks. At the end of that time both beers appeared the same in the bottle. The yeast sediment was the same size and when shaken they unsettled at the same time.

Now it was time to test the beers for flavor. I enlisted the trained palates of two famous brewing clubs, the *Anza Brewers and Connoisseurs* of Riverside, CA, and the *San Gabriel Valley Wort Hogs.* Both clubs were given the same evaluation form, and both were served the beers side by side for better comparison. They were told only to evaluate, compare and contrast these two similar beers numerically and verbally. I told them nothing else.

The combined panels totaled 23 tasters. It was the first beer of the evening to be tasted, so there were clear palates all around. Eleven panelists preferred A, the baker's yeast, better; and seven preferred B. Five of them were unable to detect any taste difference, or thought the two beers equal in quality and taste.

The 20-point scale was used. The average scores were: A: 13.8; and B: 13.6. The scores and comments showed differences to be minimal. Some comments:

"I couldn't tell the difference."

"Seems like beer B didn't ferment out completely."

"Similar characteristics."

"Beer A seems to have more hops and carbonation."

"...B is better balanced."

"Aroma of each not too pleasing to me."

"B may have been slightly less clear but distinctly resembles A."

"Two of the finest home-brews I have tasted!"

"B is more mellow."

"...They could not be separated."

"Very little difference between the two."

I have thought about the results of this yeast comparison for three months now. When I talk to my brewing friends, they are as surprised as I was at the findings. Now I have come to some conclusions.

It could be there is no important difference between baker's yeast and brewer's ale yeast. We, the home-brewers, need to do more testing on the microbiological level.

Dr. Lewis points out that when in a bind for yeast, American breweries have used baker's yeast to save a brew.

He also says, "There is less flavor difference among all varieties of *Saccaromyces cerevisiae* (ale and baker's) than the flavor difference between *Saccharomyces cerevisiae* and *Saccharomyces uvarum* (lager yeast)."

We might conclude that all ale strains (including baker's yeast) will produce similar taste, especially when compared to that from lager strains.

We might also conclude that we home-brewers may be too dogmatic about the supposed evil qualities of baker's yeast. It is said that baker's yeast will ferment at higher temperatures, and aren't hot summer days one of our greatest problems in brewing quality beer?

***

*Chris Quint* lives in La Puente, CA, and has been a prime mover in the San Gabriel Valley Wort Hogs Beer Club of Pomona (near Los Angeles). Chris and his wife are planning to sell their home, buy a boat, and set sail around the world in what will surely be a floating brewery, because Chris plans to make his excellent beer "all around the world." He hopes to earn some of his support by writing about his adventures. We wish Chris lots of luck and good sail-brewing in his new venture. Dr. Lewis' class will again be offered at UCD next February.

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**All** this reminds ye olde editor of some experiments in brewing between two batches of lager and ale in 1972.

I brewed 11 gallons of beer wort using two three-pound tins of Blue Ribbon plain malt extract, 5½ pounds dextrose as corn sugar, 4 ounces compressed cluster hops, and 1 ounce of blended Oregon finishing hops (loose). Water treatment: 2 tsp. plain salt.

Original specific gravity: 1.040, acid 0.09 percent as tartaric. I withdrew 1 gallon for krausen, and separated the brew into two open fermentors of approximate equal volume. Into batch No. 1 I added English Grey Owl liquid lager yeast in wort starter, at a pitching temperature of 78 degrees F. Batch No. 2 was pitched at the same time and at the same temperature with the same company's liquid ale yeast in starter. I photographed the ferment in each vessel, and used the photos in my slide shows.

The ale was the first to show ferment. After only nine hours a light foam appeared, which developed to lower krausen by 12 hours, at which time the steam beer (lager) was showing only the beginnings of ferment. At 18 hours the ale SG was 1,030, after reaching full krausen and skimmed at 17 hours. The steam beer was 1.035 at that time. It reached full krausen sometime between 24 and 32 hours, while I slept.

Here are some details from my logs. Remember, this was 10 years ago and I do many things differently these days.

| Time (hours) | Ale | Steam Beer |
|---|---|---|
| 17 | full krausen — skim about 1½" thick heavy with resins | early krausen |
| 18 | new head has formed sg 1.030 73F | early krausen sg 1.035 71F |
| 24 | skim head again sg 1.026 72F | early krausen |
| 32 | | krausen fall |

| | | |
|---|---|---|
| 36 | yeast head forming<br>sg 1.020 70F | skim<br>sg 1.026 70F |
| 42 | no visible change | new head, light, fluffy |
| 60 | yeast head gone<br>1.006 72F | 2nd fall — head gone<br>1.016 72F |
| 63 | rack to secondary<br>add ¼ tsp. yeast energizer | rack to secondary (64 hrs.)<br>add ¼ tsp. yeast energizer |
| 96 | sg 1.002 72F | sg 1.010 72F |
| 135 | sg 1.002 | sg 1.005 |
| 17 days | sg 1.002 | sg 1.002 |
| 27 days | bottle date<br>sg 1.002 | bottle date<br>sg 1.001 |

I didn't do much comparison with other people trying the beers side by side, but the ale tasted very similar to the lager, with the only difference being that it was a little harsher in flavor — there seemed to be no great taste difference other than that.

There is a distinct possibility that when you make such a side-by-side test the yeast gets mixed or bastardized. There is also the possibility that the yeasts were actually the same, although that seems unlikely in view of the ferment record noted above. There were few visual differences, judging from my photos. I'd certainly like to see results of more studies like these.

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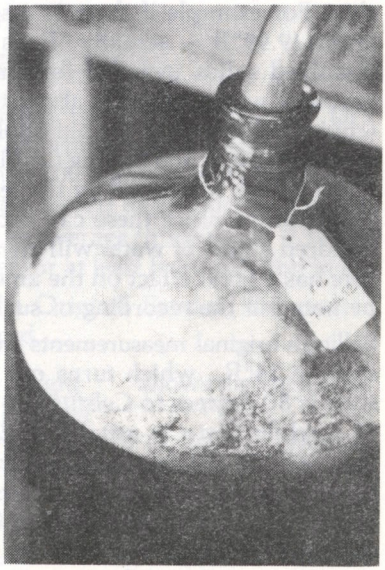

**CHRIS QUINT'S single step fermentor.**

# ATTENUATION, YIELD, EXTRACT AND OTHER SUCH NONSENSE

**By Fred Eckhardt, © 1982**

Your hydrometer or saccharometer is very valuable because it enables you to calculate such things as original gravity, alcohol content and fermentability of the beer in question. In a given beer wort, for example, the saccharometer indicates the number of grams/100 grams of wort. In breweries this is usually calculated as pounds of extract (soluble particles) per 100-lbs of wort, or kg/100-hectolitres. This is also the Balling of the wort. Remember that when we say Balling, we include the corrections which were made by Plato. In the brewing industry and on some tables these are called degrees Plato. I hope to appraise you of the differences, similarities, and common grounds of the various measuring systems. Balling, Plato, and Brix all relate to the increase in weight of various fermentable worts. Brix usually refers to the sugar in a given solution, a degree is a percent. Balling, as corrected by Plato refers to sugar, but also to the soluble solids in a given solution, by percent. A degree is a percent. Since these solids effect the specific gravity, there is also that relationship. For example if there is a sg 1.040 (SG 1040, °G = 40), there are 9.99 grams (9.99°B — actually °P, as we have noted) of *Extract*, which is the total dissolved solids included fermentable and unfermentable sugars, plus 90.01 grams of water, which is about the same volume of water, or 90.01-milliliters (cubic centimeters in the old books). Table I concerns the relationship between specific gravity and Balling (as Plato).

All of this is affected by the temperature of the fluid under test, and the air temperature, since these can each have its effect on the actual volume. One hundred grams of water will always weigh a hundred grams, but the temperature has a great effect on the amount of space or volume it occupies. This will be noted in the recording of such measurements in various analysis. We find Balling's original measurements were done for temperatures of the old *Reaumur* scale at 14°R., which turns out to be 17.5C or 63.5F, because the *Reaumur* scale is 80 degrees to *Celsius* 100 and 180 *Fahrenheit*. So the *Balling* scale is at 17.5 while *Plato* is usually at 20C (68F), and the British Brewing industry uses 60F (15.5F) for their gravity measurements. Brix is found at 15C (59F) sometimes, as well as the others. The net result is very confusing, and the corrections so minute (between 0.1 and 0.2 Sg between 15 and 20C) that we can easily afford to ignore them, more especially as our volumes are small and our instruments not that accurate, nor our methods especially precise. At any rate we see such notations as that from Hough et al (5 p654):

> The percentages by weight in column 6, corresponding with the specific gravities at 60F given in column 1, were computed by interpolation from Plato's table for true specific gravities at 15°/15°C and 16°/15C corrected to 60°/60°F and then brought to 60°/60° in air by adding (sp. gr. -1) × 0.00121.

The first temperature is that of the liquid, and the second that of air. Anyway, I just wanted you to know what you were ignoring. Don't say I never tol' you.

The solubles present in beer wort at the beginning of ferment are called *Original Extract* (OE), or sometimes Original Gravity (OG), Original Balling (OB), etc. This is the initial reading we take, and it is very important. In some countries the beer is taxed on Original Extract!

When the beer has completed its ferment it contains unfermentable sugars, other solids, carbon dioxide, and alcohol. The Extract at this time is difficult to determine. The gravity of the beer at that point is called *Apparent Extract* (AE). The difference from the Original Extract to finished Extract is called *Attenuation.* Attenuation is the progress of fermentation that has, or is, taking place. This difference, in extract between the original wort and the finished beer is called *Apparent Attenuation* (AA). The presence of alcohol prevents us from finding the actual extract or attenuation of the beer. If we wish to find either the alcohol content or the true Extract, we must remove the alcohol (by boiling the beer until the alcohol has disappeared) and add water to replace the water and alcohol that was lost in boiling. In this liquid the saccharometer or hydrometer will show the actual true extract present in the finished beer, this is called *Real Extract* (RE) The difference between Original Extract and Real Extract shows how much sugar was actually fermented, and thus the *Real Attenuation* (RA).

## DR. BALLING'S CALCULATIONS

The alcohol content can be determined from these measurements. Dr. Balling explored these relationships (1833) and determined certain facts:

1. 100 gm of beer are obtained from more than 100 grams of wort. He found that it takes 2.0665 grams of fermentable extract (wort) to produce 1-gram of alcohol plus by-products 0.9565 gm $CO_2$ and an average (it varies) of 0.11-gm yeast, both of which are removed from the beer (or at least from solution in it).

2. Other things being equal, the higher the Original Extract, the greater amounts of alcohol, $CO_2$ and yeast are produced.

3. The relationship $\frac{\text{alcohol percent by weight}}{\text{original extract less real extract}}$ shows the variences. He produced a table of these Attenuation Quotients (q) (4, p428)*, varying from 0.221 (1% Original Extract) to 0.240 (20% Original Extract).

*Numbers indicate Bibliographical references in our Bibliography.

4. A more interesting relationship concerns that between the alcohol concentration and the difference between apparent extract (AE) and the real extract (RE), one due entirely to the alcohol content of the beer. He found that this difference (as specific gravity) will be the same as that of pure water and an alcohol concentration of the same strength as the beer. Such alcohol/water tables are published in various sources (4, p433), (2, p689), (10, vI p578), and (1, table 6). Such tables are also published by the U.S. Bureau of Standards (circular C440, National Bureau of Standards, Washington, D.C.).

5. From that Balling calculated certain alcohol factors = alcohol percent by weight ÷ real extract plus apparent extract; a relationship that also varies with the original extract.

6. He also found that the difference real extract less apparent extract, when divided by the proper alcohol quotient gives the extract which has disappeared (to alcohol, $CO_2$ and yeast). That is, it would equal original extract less real extract.

7. The above relationships may be used as a basis for calculating the original gravity or extract. He constructed the following formula for this: Original Extract pct = (real extract pct less apparent extract pct ÷ attenuation quotient) plus real extract pct. This is usually written:

$$OB = \left(\frac{RE - AE}{q}\right) + RE$$

When original extract is known, alcohol content w/w (by weight) may be calculated from original extract percent less apparent extract percent multiplied by the attenuation quotient (0.231) reciprocal (0.4167, [1 ÷ q] from Balling's table [4, p428] for an average OB of 11°). The alternate factor with use for gravities may be found by applying the relationship between G and °B (Table I). We find an average of about 4G = 1°B, but at worts of 11°B (to conform to our information above), 1044.19 -1000 ÷ 11 = 4.017, so 0.4167 ÷ 4.017 = 0.1037.

## CALCULATIONS FROM THE BEER

Using a beer sample it is possible to find the original extract, alcohol content, and attenuation.

1. Measure the apparent extract (beer gravity). Place a proper size sample in a cup or glass and pour this back and forth between two vessels to rid the sample of $CO_2$ gas. You might even filter it to further exclude the bubbles. Measure the proper amount of fluid in your hydrometer jar. You must know the exact volume. Take a hydrometer reading, correct for temperature (table II), convert to Balling (Table I), and record this as Apparent Extract.

2. Carefully decant *all* of the liquid into a small saucepan (or a glass beaker, if you have access to a laboratory with Bunson Burners etc.)

3. Heat the beer until it boils and continue to boil until the volume is reduced by more than one-third.

4. Cool this and decant *all* of the remaining liquid back into your hydrometer jar or measuring vessel. Rinse the boiling vessel and add that with distilled water to *exactly* the volume of the original sample.

5. Take a careful hydrometer reading and correct the temperature. Enter this as Real Extract gravity. Convert to Balling for Real Extract percent. (Table I).

6. Using Balling's formula (#7 above) find the original balling or gravity. Suppose a beer with a sg to 1.010 (SG 1010), 2.6°B, AE = 2.6. Next boil the sample, rid it of alcohol, and take another reading: 1017, 4.3°B, RE = 4.3. Balling's average q value (pgh #8 above) = 0.232. Substituting these values in the formula OB = (RE - AE ÷ q) + RE = (4.3 - 2.6 ÷ 0.231) + 4.3 = 11.7 which is OG 1047. Now AA = OB - AE = 11.7 - 2.6 = 9.1. To find alcohol content, multiply AA (9.1) by the factor 1 ÷ 0.231 (1 ÷ q) = 0.4167 (pgh 7)

= alcohol pct by weight = 9.1 × 0.4167 = 3.8% w/w. For SG figures: AA = (1047 -1000) - 10 = 37 × 0.1037 (sg factor) = 3.8%. Consulting Table III, we find 4% w/w. Close — you expected perfection?

## DEGREE OF ATTENUATION

The degree of attenuation is the attenuation (fermentation percentage of the original gravity or Balling. This is the usual way of expressing the percentage of ferment. For example, using the beer above, we have OB(G) 11.7 (1047) beer Ball or apparent 2.6° (1010). Let me remind you that if you bottle condition your beer, the OE figure must include the sugar or extract added at bottling to carbonate the beer, which is usually about 0.5°B (2G). The above beer may have had a wort G of 1045, which became 1047 when the carbonation extract (2G) was added to the total, as necessary to the equation. As we have seen the apparent attenuation (or gravity drop) in the above beer is 11.7 - 2.6 = 9.1 (1047 -1010 = 37): Have you noticed how we have switched to using SG 1047 and 1010 instead of sg 1.047 and 1.010? This follows British practice and simplifies recording that information. Divide these results by the respective Original Extracts and multiply by 100 to find the apparent degree (percent) of attenuation: 9.1 ÷ 11.7 = 77.7% and 37 ÷ 47 = 78.7%. So much for accuracy. The conversions never seem to quite match, but close enough. As you will note in the G calculations we used SG -1000.

Real attenuation may be calculated by the formula RA °B = Alcohol pct w/w × 2.0665 (from Balling), 3.8 × 2.0665 = 7.9. RA (SG-1000) = Alcohol pct × (2.0665 × 4.017) = 3.8 × 8.3 = 31.5. RDA real degree (percent) of attenuation: 7.9 × 100 ÷ 11.7 = 67.5% and 31.5 × 100 ÷ 47 = 67%. Table III explores these relationships and allows you to skip the above math to find the alcohol percent from the beer only. Of course if you know the OB (OG) you can also calculate the alcohol percent, using the apparent attenuation (Balling drop), and Balling's OE - AE factor averages (pgh 7), i.e. 0.4167, rounded to 0.42. Thus in the above example AE 9.1 × 0.42 = 3.8%, or use 0.1037 rounded to 0.104 for G values. 37 × 0.104 = 3.85% w/w. And that brings us to the following nonsense.

## WEIGHT AND VOLUME

In my articles on hydrometers (next) I show that if the weight of a particular volume of liquid is known, the specific gravity of that liquid may be calculated. sg = weight of liquid ÷ volume of liquid at a particular air/liquid temperature. That of water, for example = weight (1000-grams) ÷ volume (100-milliliters) = 1.000 at 60°F (15.5C). Water is the standard to measure the others. For our purposes beer wort is a sugar-water solution, and beer an alcohol-sugar-water solution. Now sugar solutions are heavier (greater sg) than water, and alcohol solutions are lighter (lower sg) than water. If we have a sugar-water solution of 1000-gms (1-kg), including 100-grams of sugar, that is a 10% solution, 10% weight (sugar) in weight (water). This is written 10% w/w (weight/weight), or more commonly 10% by weight. This is also 10-

degrees Brix or Balling (Plato). A glance at Table I will show the relationships of specific gravity, degrees Balling (Plato)/Brix. They are more or less interchangeable, but Brix usually refers to percentages of sugar solutions, while Balling is used to refer to sugar solutions which are being fermented, and which are sugar-alcohol solutions. In all of my writing Balling and Plato are called Balling, although technically I SHOULD use the term Plato.* I won't. We can calculate that 10° Brix/Balling in a sugar solution has a specific gravity sg 1.04003 (sometimes written 1.040.03 or sg 1040.03) and we can show that this particular 1000-gram solution will occupy only 961.2-milliliters of space or volume, and therefore is less than an equivalent weight of water only, since we have only 900-grams of water here.

So much for sugar, but alcohol is lighter than water with a sg of 0.7939 at 100% pure ethanol ($C_2H_5OH$), (200 proof, U.S., and 175 imperial proof spirits). That tells us we need more space to hold 1000-grams of alcohol. Actually 1,259.6-milliliters of space is required. Conversely 1,000-milliliters of space/volume will hold only 793.9-grams of ethanol. If you understand the relationships of space : volumes you can then realize the relationship between volume and weight measurements as they concern alcohol solutions. In dealing with volumes (instead of weights), if we add 100-ml alcohol (weight 79.39-gm) to water, and a total volume of 1000-ml(cc), there will be 1000-ml of solution with 79.39 grams of alcohol volume/volume. As you can see THAT is 7.939% v/v, or by volume. Obviously comparing volumes and weights is a little like comparing apples and oranges. Alcohol by weight = (Alcohol by volume × sg alcohol ÷ sg water) = 0.794 ÷ 1.000 = 0.794, let's say 0.8. Alcohol by volume = (alcohol by weight × sg water ÷ sg alcohol = 1.000 ÷ 0.794 = 1.26, but it's much easier to remember 1.25 for that factor. Multiply w/w by 1.25 for v/v and multiply v/v × 0.8 for w/w. Simple!

The volume system is used by the American winemaking industry, and in the British Commonwealth, while the weight system is used by the American Brewing industry, and in much of the rest of the world, where it is compatable with the Metric system. However a British Brewing manual from Pauls & Whites (8) p124 has this to say:

> As wort is always measured by volume, and not by weight, it seems rather illogical and somewhat clumsy to express the concentration of wort in percent solids by weight. It would seem to be more logical, and to render calculations simpler, to use a percentage by volume, especially where the volume measurement is metricated.

You pays you money and you takes you chances!

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*You should know that in most brewing texts BOTH Plato and Balling scales are printed with appropriate specific gravities. Dr. Balling's calculations were made in mid-nineteenth century. Dr. Plato revised them later with more accurate information from sugar solutions of greater purity than were available to Dr. Balling. In winemaking circles Brix and Balling are used interchangeably, but the figures are those of Dr. Plato. The Brewing industry uses degrees Plato.

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# YOUR HYDROMETER AND YOU

The most important *tool* in the amateur brewer's bag is the hydrometer. You can make good beer without the use of this remarkable scientific instrument, but if you do, it may be quite by accident. Only an expert brewer could have any assurance of quality results without his trusty hydrometer. On the other hand, few experts would be foolhardy enough to even try to make beer without their hydrometer. The use of a good hydrometer eliminates guesswork in setting and formulating your beer, in checking its fermentation progress, and in determining its final alcohol content.

The word hydrometer is from the Greek; it means "water measurer." Hydrometers are used in science and industry to measure the density (or "thickness") of liquids, such as salt and anti-freeze solutions, acid solutions (battery testing), milk, and a host of other important liquids. One large U.S. supply house catalogue* lists 19 different types of hydrometers. That doesn't include the three types of hydrometers we usually find in beermaking supply stores.

Archimedes is said to have discovered the relationship of densities while sitting in his bathtub. He moved various portions of his anatomy in and out of the water and deduced that he could compare the relationship of weights of objects to that of water. John Richardson invented the first workable hydrometer for the English brewing industry in 1787.

The hydrometer is used in beermaking to measure the density of beer wort in relation to the density of pure water. This ratio is called specific gravity (sg), or sometimes just "gravity." The formula for specific gravity is: sg = density of liquid under test/density of pure water. This is usually read to three decimal places, but often it is verbally expressed as the last two or three figures only, and also as "Ten —." The gravity of pure water is 1.000, or 1000, sometimes "zero." Alcohol, which is lighter than water has a sg 0.794. The average original (or starting) gravity of many homemade beers is 1.040-1040, or simply OG forty. I have chosen to use the specific gravity system in *Amateur Brewer* recipe formulations for several reasons, but in the U.S. brewing and winemaking industries, the gravities are measured with the Brix-Balling-Plato scale, which is based on the percent of sugar, by weight, in a given solution. When the hydrometer is calibrated in that manner, the instrument is called a *saccharometer* or "sugar measurer." There are several scales in addition to the above, including *Baume* and *Dujardin-Salleron.*

The hydrometer, while accurate enough for our purposes, is actually, as we must use it, relatively inaccurate. There are many variables to effect any readings, and error may be compounded on error. Nevertheless, the overall effect is one of reasonable accuracy in keeping with other measurements we use.

Ideally, a homebrewer would own two hydrometers. One with a full range winemaking scale from about 0.990 to 1.170 (-2.5°B to 38°B), and a second hydrometer with a range near 0.886 to 1.020 (-3.5°-5°B). I have one, a *saccharometer*, with a range of -5° to 5°B (0.880-1.020), which I obtained from *RUTTCO*, a hydrometer manufacturer.** Most supply firms do not stock this

**VWR Scientific* 82-83 Catalogue; see listing at end.

***See end of this article for a list of manufacturers and suppliers.

item. There is also on the market a beer *Balling* Saccharometer available with a range 0-8.5°B (1000-1034), but it has a built-in thermometer and is more expensive. The longer a hydrometer is, the more accurate it will be, since the divisions will be further apart, and easier to read. The standard home winemaker's hydrometer is deficient in this respect also, but because of its versatility it is still the hydrometer I recommend, especially if you plan to acquire one only. The standard home winemaker's hydrometer will also have, in addition to the specific gravity, the Balling scale plus a potential alcohol (Dujardin-Salleron) scale. This latter is relatively useless, although it is used in the French Winemaking industry. There is one hydrometer that I most emphatically do NOT recommend, and that is the so-called "beer tester," which is a *Balling* saccharometer with a range of 0-10°B (1.000-1040). The so-called beer tester is not adequate for many beers made these days, but if you already have one, it may be used as a *Balling Saccharometer* if you ignore the so-called "red line" (used in Prohibition days as a mark to bottle the beer by). This is not feasible with most modern home brews and starting gravities well over 10°B. In any case, all of our recipes also quote the degrees *Balling* equivalent, and there is also a conversion table in this issue, as I've already noted, Table I.

## USING YOUR HYDROMETER

The hydrometer or saccharometer is a sealed glass tube with a weighted bulb. It is read by carefully noting where the surface of the liquid under test cuts across the scale. The surface tension of the liquid causes the surface to curve upwards on contact with the hydrometer or the walls of the hydrometer jar. This distortion is called the menescus effect, and it must be ignored. Fig. 1 shows hydrometer in jar. Fig. 2 the hydrometer at the start of ferment illustrating the effect of the menescus line in obtaining accurate readings. As you

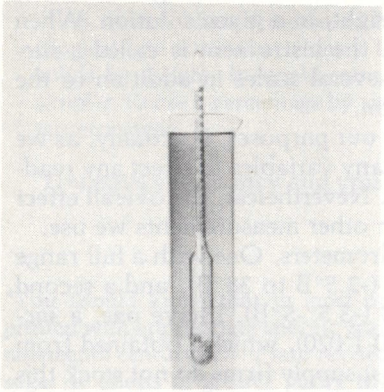

fig. 1.

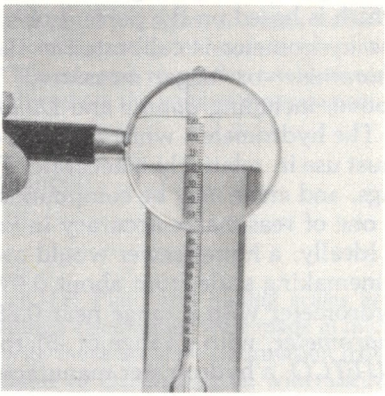

fig. 2.

may note, the low numbers are at the top of the hydrometer, and the high numbers are at the bottom. When the beer wort is first set, the hydrometer rides high in the sugar saturated liquid. As the yeast converts the sugar to carbon dioxide ($CO_2$) gas, which escapes, and alcohol which is lighter than water, the hydrometer settles lower and lower in the solution, until fermentation ceases. In wine the end point may be below 1,000, because of the effect of alcohol on the final hydrometer reading, but an apparent extract (terminal gravity) of below zero is very rare in beer, partly because of the relatively low alcohol levels involved, and partly due to the higher percentage of unfermentable sugars than are normally found in wine. With old style low-malt homebrew the end point will also be near zero. Todays high-malt beers will have a much higher end point.

I strongly urge you to purchase a good hydrometer jar at the same time you buy your hydrometer, and use it at all times rather than try to read the hydrometer while that instrument is floating amidst the bubbles of your fermentor. You can draw off the liquid to be sampled with a wine thief or a sterile gravy baster saved *only* for that purpose. Fill your hydrometer jar nearly full (but allow room for the hydrometer to float). Next place the hydrometer carefully into the liquid, without pushing it down as the liquid clinging to the tube will pull it down deeper to cause a false reading. Now spin it to rid it of clinging bubbles which will lift the hydrometer and also distort the reading. Read by viewing the surface at eye level as shown in fig. 3. A reading should be taken before adding yeast, which will tell you whether you need to add more extract such as dextrose or malt syrup. Naturally if the reading is too high, you may wish to add a little water to the wort. Anything added to cooled beer wort should be pasteurized for purposes of sterility.

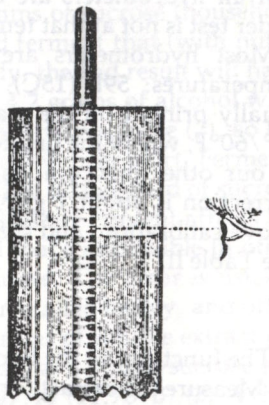

FIG. 3 —Method of reading meniscus on a hydrometer.

Once a beer has been set to ferment it is best not to make any adjustments or indeed to rack the beer. The best fermentation method seems to be by the use of stainless steel carbonated beverage tank or a glass carboy as a single-stage fermentor. (We do *NOT* recommend the plastic so-called single-stage bucket for fermenting your beer). It is wise, however, to keep track of the ferment with regular hydrometer readings, and this may be facilitated by setting a small bottle (half-gallon wine bottle) aside under fermentation lock. This sample is kept under the same conditions as the carboy holding your beer, and hydrometer readings may be taken regularly from such a sample to keep careful track of progress. The sample will be discarded at bottling and should not be added to the regular batch, so as not to contaminate that. This method will protect your beer, and yet allow careful monitoring during ferment and aging.

During the fermenting phase of the beer, the readings will be confused by the presence of CO2 bubbles. The beer may be decarbonized by rapidly pouring the liquid back and forth between two vessels (after first measuring the amount needed in the hydrometer jar). Next allow the foam to settle for a few minutes before attempting to fix a reading. Needless to say the hydrometer should always be sterilized before and after each use. If you are measuring several batches of beer, you should disinfect between each batch so as not to contaminate any of the beers with stray bacteria.

## HYDROMETER CORRECTIONS

As we have already mentioned there are a number of variables that can effect your hydrometer readings, which are, after all, only an indication of the total dissolved solids in your beer or wort. Some of these dissolved solids will be in the form of unfermentable sugars, proteins, ash, vitamins, various free and volatile acids, and many other solubles. These constitute as much as 3-4% of the total, and they will effect the reading by a factor of about 6-12 points, but since they remain from wort to finished product at the same level, they may be ignored for many of our calculations. The major exception is non-fermentable sugars (mostly dextrins), which make a very important contribution to the beer in body, taste and palate.

The other major area of hydrometer error derives from the fact that water itself has a variable specific gravity according to it's temperature. Thus we find that all hydrometers are corrected to a given temperature, and if the liquid under test is not at that temperature then a correction must be made.

Most hydrometers are calibrated for reading at one of the following temperatures: 59F (15C), 60F (15.56C), or 68F (20C). This information is usually printed on the scale near the base of the hydrometer. Often written 60°/60°F, where the first temperature is air, and the second the liquid. With all of our other inaccuracies we can certainly ignore the air temperature. The correction is about 1 gravity point for each 9°F (5°C), *add* for temperature above calibration, and *subtract* for those below calibration (worts over 1040). See Table II.

## SUMMARY

The functions of the hydrometer are as follows:

1. Measure the extract (or sugar) content of the wort.
2. Indicate the progress of attenuation (rate of ferment).
3. Calculate the alcohol content.
4. Determine when the ferment may be finished.
5. Alternately, to detect if the fermentation is, or is not, proceding as expected or desired.
6. Assist in determining bottle pressure during the condition of the finished product.

The procedure for taking a hydrometer reading is as follows: A sample of beer or wort is decanted or siphoned into the hydrometer jar or cylinder. Avoid excessive aeration and stirring up froth or bubbles, alternately if the beer is saturated with CO2, a decarbonization procedure must be followed. The hydrometer is then placed in the liquid where it will sink until the weight

of the displaced liquid equals that of the hydrometer. Spin the hydrometer to rid it of clinging bubbles. When the instrument is at rest the gravity is read by holding the eye at the level of the surface of the liquor. Read the indication at the bottom of the menescis line (fig 3). The temperature should be measured before or after the hydrometer reading, and the figures corrected accordingly. (Table II).

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## HYDROMETER MANUFACTURERS AND SUPPLIERS

*Ruttco* Mfg Co., Inc., 105-20 Metropolitan Ave., Forrest Hills, NY 11375.
*Vintech* Instruments, 12 Tucker St., Lenox MA 01240.
*VWR* Scientific, P.O. Box 3200, Rincon Annex, San Francisco, CA 94110.

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## ABOUT THE YIELD TABLE

Brewing textbooks spend a great deal of time telling brewers how to calculate yield. What do they mean by yield? Put 100 grams of sucrose (household sugar) in water to 1 litre volume (10% or 10°B) and ferment that (with nutrients, because there are none in sucrose). Theoretically, the end result will have no sugar remaining, no Real Extract, and there'll be 4.2 grams of alcohol w/w in solution. Traditionally sucrose has been considered fully soluble (7), so the yield is 100% soluble extract to be incorporated into any beer wort. Fermentability is also 100%. Sucrose, then, is the standard. The actual yield of sucrose is less, because of a small 1-3% moisture content. Moisture content affects the yield because, unless all moisture is eliminated (and that's impossible in other than laboratory conditions), the weight is not accurate. The error is usually 1-2% in sucrose, 7½% in dextrose, and up to 13% in malted barley, and other malts and cereals. Yield extract percent is, simply, grams of soluble extract per 100 grams of material. The U.S. Government tells us that 1 pound sucrose in 1 gallon water (119.83 gm/litre) will have an SG 1047.46 (11.78°B),(2). When this is translated into pounds per UKgallon, which is equal to 100 grams/litre (multiply by 0.83216), the SG is 1039.49. A UKgallon weighs 10 pounds at 62F (16.7C), which is a 10% solution w/w (remember all of the variables), and that translates into 100 grams per kilogram, or roughly 100 gram/litre. A U.S. gallon weighs 8.3216 pounds at 20C (68F), so to translate SG readings we must multiply the UKSG — 1000× 1.2, which also works with Balling's degrees (don't forget all of those variables). Column 1 gives the yield extract percent of the ingredients. No two sources agree on any of these, so the figures are ballpark, and since the entire table is predicated on the yield percent, the entire table must be suspect. As we have said earlier, yield extract percent is the percentage of solubles in each ingredient, as sucrose, which is the defining ele-

(Continued on page 28)

## TABLE I Conversion Specific Gravity to Balling

**SPECIFIC GRAVITY, 20 °/20 °C, IN AIR, TO % w/w SUCROSE, IN VACUO (°PLATO OR °BRIX)**

| *SP. GR.* | *Sucrose* % *w/w* | *SP. GR.* | *Sucrose* % *w/w* |
|---|---|---|---|
| 1.000 | 0.000 | 1.042 | 10.475 |
| 1.001 | 0.257 | 1.043 | 10.716 |
| 1.002 | 0.514 | 1.044 | 10.956 |
| 1.003 | 0.770 | 1.045 | 11.195 |
| 1.004 | 1.026 | 1.046 | 11.435 |
| 1.005 | 1.283 | 1.047 | 11.673 |
| 1.006 | 1.539 | 1.048 | 11.912 |
| 1.007 | 1.795 | 1.049 | 12.150 |
| 1.008 | 2.053 | 1.050 | 12.387 |
| 1.009 | 2.305 | 1.051 | 12.624 |
| 1.010 | 2.560 | 1.052 | 12.861 |
| 1.011 | 2.814 | 1.053 | 13.098 |
| 1.012 | 3.067 | 1.054 | 13.333 |
| 1.013 | 3.321 | 1.055 | 13.569 |
| 1.014 | 3.573 | 1.056 | 13.804 |
| 1.015 | 3.826 | 1.057 | 14.039 |
| 1.016 | 4.077 | 1.058 | 14.273 |
| 1.017 | 4.329 | 1.059 | 14.507 |
| 1.018 | 4.580 | 1.060 | 14.741 |
| 1.019 | 4.830 | 1.061 | 14.974 |
| 1.020 | 5.080 | 1.062 | 15.207 |
| 1.021 | 5.330 | 1.063 | 15.439 |
| 1.022 | 5.580 | 1.064 | 15.671 |
| 1.023 | 5.828 | 1.065 | 15.903 |
| 1.024 | 6.077 | 1.066 | 16.134 |
| 1.025 | 6.325 | 1.067 | 16.365 |
| 1.026 | 6.572 | 1.068 | 16.595 |
| 1.027 | 6.819 | 1.069 | 16.825 |
| 1.028 | 7.066 | 1.070 | 17.055 |
| 1.029 | 7.312 | 1.071 | 17.284 |
| 1.030 | 7.558 | 1.072 | 17.513 |
| 1.031 | 7.803 | 1.073 | 17.741 |
| 1.032 | 8.048 | 1.074 | 17.970 |
| 1.033 | 8.293 | 1.075 | 18.197 |
| 1.034 | 8.537 | 1.076 | 18.425 |
| 1.035 | 8.781 | 1.077 | 18.652 |
| 1.036 | 9.024 | 1.078 | 18.878 |
| 1.037 | 9.267 | 1.079 | 19.105 |
| 1.038 | 9.509 | 1.080 | 19.331 |
| 1.039 | 9.751 | 1.081 | 19.556 |
| 1.040 | 9.993 | 1.082 | 19.782 |
| 1.041 | 10.234 | 1.083 | 20.007 |

Abstracted from "Tables Related to Determinations on Wort, Beer, and Brewing Sugars and Syrups" (American Society of Brewing Chemists)

**TABLE II**

Hydrometer correction by temperature (10% sugar solution) source (2, 8)

| °F | °C | 60/60F Hydrometer | 20/20C (68F) |
|---|---|---|---|
| 33 | 0.5 | -2.6 | -3.7 |
| 41 | 5 | -1.8 | -2.4 |
| 50 | 10 | -0.65 | -1.8 |
| 60 | 15.56 | correct | -1.0 |
| 68 | 20 | +0.9 | correct |
| 77 | 25 | +2.0 | +1.4 |
| 86 | 30 | +3.4 | +2.7 |

TABLE III

TABLE OF ALCOHOL CONTENT BY WEIGHT IN BEER

| Real Extract (RE) Specific Gravity of dealcoholized extract (Balling) | apparent extract (AE)--Specific Gravity of the beer | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SG Balling | 1000 0.0 | 1002 0.5 | 1004 1.0 | 1006 1.5 | 1008 2.0 | 1010 2.6 | 1012 3.1 | 1014 3.6 | 1016 4.1 | 1018 4.6 | 1020 5.1 | 1022 5.6 |
| 1006(1.5) | 3.3 | - | - | - | - | - | - | - | - | - | - | - |
| 1007(1.8) | 4.0 | 2.9 | - | - | - | - | - | - | - | - | - | - |
| 1008(2.0) | 4.4 | 3.3 | - | - | - | - | - | - | - | - | - | - |
| 1009(2.3) | 5.1 | 4.0 | 2.9 | - | - | - | - | - | - | - | - | - |
| 1010(2.6) | 5.8 | 4.7 | 3.5 | - | - | - | - | - | - | - | - | - |
| 1011(2.8) | 6.2 | 5.1 | 4.0 | 2.9 | - | - | - | - | - | - | - | - |
| 1012(3.1) | 6.9 | 5.8 | 4.7 | 3.5 | - | - | - | - | - | - | - | - |
| 1013(3.3) | - | 6.2 | 5.1 | 4.0 | 2.9 | - | - | - | - | - | - | - |
| 1014(3.6) | - | 6.9 | 5.8 | 4.7 | 3.5 | - | - | - | - | - | - | - |
| 1015(3.8) | - | 7.4 | 6.2 | 5.1 | 4.0 | 2.9 | - | - | - | - | - | - |
| 1016(4.1) | - | - | 6.9 | 5.8 | 4.7 | 3.5 | - | - | - | - | - | - |
| 1017(4.3) | - | - | - | 6.2 | 5.1 | 4.0 | - | - | - | - | - | - |
| 1018(4.6) | - | - | - | 6.9 | 5.8 | 4.7 | 3.5 | - | - | - | - | - |
| 1019(4.8) | - | - | - | 7.4 | 6.2 | 5.1 | 4.0 | - | - | - | - | - |
| 1020(5.1) | - | - | - | - | 6.9 | 5.8 | 4.7 | 3.5 | - | - | - | - |
| 1021(5.3) | - | - | - | - | 7.4 | 6.2 | 5.1 | 4.0 | - | - | - | - |
| 1022(5.6) | - | - | - | - | - | 6.9 | 5.8 | 4.7 | 3.5 | - | - | - |
| 1023(5.8) | - | - | - | - | - | 7.4 | 6.2 | 5.1 | 4.0 | - | - | - |
| 1024(6.1) | - | - | - | - | - | - | 6.9 | 5.8 | 4.7 | 3.5 | - | - |
| 1025(6.3) | - | - | - | - | - | - | 7.4 | 6.2 | 5.1 | 4.0 | - | - |
| 1026(6.6) | - | - | - | - | - | - | 8.1 | 6.9 | 5.8 | 4.7 | 3.5 | - |
| 1027(6.8) | - | - | - | - | - | - | - | 7.4 | 6.2 | 5.1 | 4.0 | - |
| 1028(7.1) | - | - | - | - | - | - | - | 8.1 | 6.9 | 5.8 | 4.7 | 3.5 |
| 1029(7.3) | - | - | - | - | - | - | - | - | 7.4 | 6.2 | 5.1 | 4.0 |
| 1030(7.6) | - | - | - | - | - | - | - | - | 8.1 | 6.9 | 5.8 | 4.7 |
| 1031(7.8) | - | - | - | - | - | - | - | - | - | 7.4 | 6.2 | 5.1 |
| 1032(8.0) | - | - | - | - | - | - | - | - | - | 7.8 | 6.7 | 5.6 |
| 1033(8.3) | - | - | - | - | - | - | - | - | - | - | 7.4 | 6.2 |

Source: DeClerck (4). To determine Real Extract, measure an amount of beer and bring it to a boil. Boil until the volume is reduced by a third, cool to original temperature, add distilled water to original level. Hydrometer reading is the real extract. OG = AE +(Alcohol w/w x 9.64). Alcohol v/v = Aw/w x 1.26. Caution--table is inaccurate.

ment: 100% corrected for moisture. The extract yield percent (compiled from various sources — 3, 3b, 4, 5, 6, 7, 8, and 9) divided by 10 gives the Balling of 100 grams/kg(litre), which is (roughly) the same as the Balling of 1/lb/UK gallon, Column 5. Column 4, the SG of the Balling figure from Column 5 (interpolated from table I). Column 2 (US SG)=Column 4 -1000× 1.2, and Column 3, the Balling of Column 2. You can see the compounding of errors possible! The whole table is ridiculous, but moderately useful (I hope). Column 6 is the Apparent Degree of Attenuation, and Column 7 the Real D.A. Again sucrose is the standard, at 100% fermentable (R.D.A.). The other R.D.A.'s are a percentage of sucrose R.D.A. Sucrose A.D.A. 86.1% is calculated from Balling's alcohol water table (1, 4, 2, 10). Column 6 is calculated entirely from Column 7, and again the experts fail to agree.

The yield of a given ingredient is certainly a variable depending on circumstances of growth, malting, storage, moisture content, and a host of other possibilities, a ball park figure at best, while the attenuation degree is also subject to a wide variety of variables, including yeast strain, fermentation conditions, and fermentation temperature, method of ferment, etc., etc. More nonsense. I've done all I could to get the information as accurate as possible, and it should be quite useful to you in many ways; just remember the limitations.

Table IV p32

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# PRACTICAL CALCULATIONS FOR THE HOMEBREWER

Brewing texts (at least the old ones) are full of information on calculating how many pounds per barrel of this or that was needed if you had 43 pounds of malt with extract yield of 68%, and wanted to make a beer with 30% maize flakes. With ourselves the major question is usually much simpler: Do I need one or two cans of malt extract in my beer, and how much sugar or dry malt extract to adjust to the gravity I want? How much sugar do I need, and would an all-malt beer be more practical?

For example, I have a 3.5-pound can of malt extract for a beer of 1040 (9.99B). How much sugar (dextrose) do I need to make 5 gallons? Total extract required is 5 (gals)×40 (OG)=200. Table IV tells me to expect 1035-40 per lb/USgal. Using 1040 as malt extract yield, multiply by pounds (3.5) M.E.S.=3.5×40=140. 200-140=60. We need 60 sugar units. Dextrose yield is 1044, so 60/44=1.36. We need 1.36 lbs. dextrose, or 1 lb. 6 oz. The sugar will provide 60/100 of the total extract, 30%, an acceptable figure for some, not so for others (I try to keep adjuncts under 20%). How much dry malted, then, if we do use 20% sugar? 20% of 200=400. 40/44=0.9, that's 0.9 lb., or 14½ oz. sugar. Total extract thus far=140+40=180. We still need 20 points. Dry malt extract or crystal malt are the logical choices in this small quantity. D.M.E. yield 43. 20/43=0.46 lb. (7½ oz.). How about crystal malt? Yield 26. 20/23=0.9 lb.=14 oz.

Anyway, that's the system. Multiply the desired OG×Nr. of gallons, or litres (but you must use all metrics if you do) for the total extract required. Multiply pounds (kg) of the ingredient by yield (SG/lb. or °B/lb.) and then subtract this from the total extract to find what's still needed.

Grain brewers can approach the matter in more the style of the big boys. Yield, as we explained earlier (ad nauseam), is expressed in percent, and is the number of grams, soluble, from 100 grams of material. The brewing industry, of course, uses pounds per 100 lbs., and English brewers have (more or less) switched from measuring pounds per quarter (of 336 lbs.), a cumbersome system dating from 1784, and which we won't discuss, to the use of litre/kg, or hecto-litres/100 kg. Actually, they call them litre-degrees/kg., at 20C (68F), (8). Many English brewing texts have tables where the extract is expressed in lbs./qtr. on some tables (usually referring to English ingredients), while in others the extract is in percent (usually concerning European or U.S. malts (5,8), An inaccurate conversion may be had by multiplying the English lb./qtr. figure by 0.753 to get yield percent.

American brewers calculate yield (in use) as pounds per barrel (31 gallons wort), and there are tables for that purpose (9,10). For example, an 11° (1044) wort has 29.7 lbs. of soluble extract per barrel. Nevertheless, the most practical method for Amateur grain brewers to use remains SG/lb./gal., or metrically SG/100 gm/litre, the same method we have been using for the extract brewer. Suppose I wish to make 5½ gallons weizen (wheat) beer with an OG 1055, 40% wheat malt and 60% barley malt. Total extract needed: 55 (OG)×5.5 (gals)=302.5. How much wheat malt do I need? 40% of 302.5=121; the yield of what malt is 36G, so 121/36=3.36 lbs., 3 lb., 6 oz. How much barley malt? 302.5-121=181.5, 181.5/30=6.05 lbs. malt with a yield of 30.

In years past, I used to accumulate various malt extract syrups, and at the end of the year I would have a party, after making a keg of beer from those mixed malts. Usually I'd make 20 gallons, and keg 15.5 gallons. My fermentor would only allow a primary ferment of 14 gallons, but I did have secondary space for 20 gallons. What to do? One year I had 2 cans *Blue Ribbon* (3 lbs. each), and 2 tins of English malt extract syrup (2.5 lb. each), and 6.5 lbs. of dark English dry malt extract. The extract was as follows: 6 lbs. Blue Ribbon×35=210, 5 lbs. English M.E.S.×40=200, and 6.5 lbs. D.M.E.×42=273. Total extract available 683. Extract needed: 20 gallons×44G (my desired OG)=880 total. 880-683=197. I was 197 units short, and dextrose (corn sugar) was my choice for the balance, which would represent 22% of the total. The problem was I could only set 14 gallons. I had to use a system, coimmon among the big boys, called "heavy brewing." Total extract 880 divided by 14 (gals.) meant I had to have an OG of 1063 if I wanted to concentrate the wort into 14 gallons for primary ferment, and then I'd have to add 6 gallons of water at racking to complete the 20-gallon volume I wanted. I racked the beer at 1029 to three 6.5-gallon carboys, each of which already had 2 gallons of water at the bottom. The new SG should have been 1020 (actual 1018.4). The beer had a terminal SG 1004.5. The method produced very good beer, and I've used it many times.

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## BEER ANALYSIS SIMPLIFIED (a series)

## MALT GRAIN EXTRACT YIELD

REFERENCES: (3, 10 vIp548)

*EQUIPMENT:*

1. Food Scale to measure small quantities in grams, or a balance.
2. Malt grinding apparatus.
3. Standard flour sifter with #16 mesh (1/16; 1.5 mm) screen.
4. Beaker, 600 ml cap. or a small quart saucepan.
5. 1-litre or quart of distilled or very soft (under 50ppm hardness) water.
6. Variable flame stove to control heat, such as gas stove, camp stove, Ronson variflame cookette, Bunson Burner, etc.
7. Quick reacting thermometer (F or C).
8. Glass or plastic stirring rod.
9. Iodine reagent or tincture of Iodine dilluted 1:1 with water (see ABNL 8-3).
10. Eye dropper.
11. Small white plate or disc.
12. Medium size funnel, 500ml cap.
13. 500ml Ehrlenmeyer flask or 1-pt bottle.
14. Hydrometer and jar.

*PROCEDURE:*

1. Start with one cup of whole grain malted barley. Adjust your malt grinder so that when the grains are ground and 50-gm are sifted thru the standard 1/16" mesh flour sifter there remains about 3-5 grams of grist (6-10%) unsifted fragments — mostly husks. After the proper setting for that is achieved, grind about half a cup of malt grains.
2. Place about 200ml of distilled or very soft water in a 600-ml beaker or small saucepan. Heat to about 115F (46C) and add 50-gm of the ground malt grains to be tested. Mix well with glass or plastic rod.
3. Note odor — should be pleasantly aromatic, not musty.
4. Hold at 113-115F (45-46C) for 30-min, stirring frequently and regularly. Time this from adding the malt to water.
5. Raise the mash temperature slowly and gradually to 158F (70C) over a 25-min period. This is 1°C per minutes, or 9°F (5C) per 5-minute period. Stir frequently and regularly.
6. Add 100ml water (heated to 158-160F — 70-71C), stir thoroughly.
7. Hold the mash at 158F. After 30-min, test for starch. Repeat at 5-min intervals, until a negative starch reaction is obtained. Note total time at 158F until inversion.

STARCH TEST

a. Place a drop of liquid to be tested on a clean white plate or disc.
b. Use N 0.1 to N 0.02 Iodine reagent or tincture of Iodine diluted 1:1 with water.
c. Add a drop of Iodine reagent to the drop of test liquid.
d. If the mixture turns blue (positive) starch remains and mash cycle must continue.
e. If the mixture turns yellow-brown (negative) there is no starch (inversion completed).

8. Hold the mash at 158F (70C) for 60-minutes total if that much time has not already elapsed.
9. Add water to 430ml (or 450gm total weight, including grains), stir thoroughly.
10. Cool to 60F (15.5C) (hydrometer temperature) within 10-15 minutes, by the use of a water bath. Stir again.
11. Place a large (500ml cap) funnel in a 500-1000ml flask (or 1-qt bottle). The large *Cluthe* funnel #3005, available in many winemaking supply stores, is just right when used with the smallest mesh screen, (comes with the funnel). Cover with a watch glass or cardboard. A lab funnel with fluted filter paper is proper. Filter paper such as Eaton-Dikeman 32cm #509, or Schleicher & Schull 32cm #314 3/4).
12. Return the first 100ml of the filtrate to the funnel.
13. The filtering process should be complete in 1-hour and not over 2-hours maximum.
14. Stand for 15-minutes longer, record *clarity*: clear, slightly hazy, hazy.
15. Pour a sample in hydrometer jar and record specific gravity (or degrees Balling) and return to flask. SG is GY (Gravity Yield) SG/lb/US gallon: One lb of this malt mashed in water to 1-gallon volume total including malt.

Calculate any of the following as you may require.
Balling yield. Table I.
Metric Yield. GY -1000 × 0.832, also UK Yield.
Percent extract yield (Industry standard) = GY -1000 × 2.107.
The sample can also be used to measure the color, acidity, pH and attenuation degree (with your standard yeast).

The limitations on this are obvious. The laboratory conditions will not be the same as your brewing conditions. There is no pH adjustment. In any case the results will almost always show more yield than you can achieve in practice.

Recently a friend asked me to measure the yield of a 100-lb bag of 6-row malt he had obtained so that he would be able to calculate how much of the malt he needed for the various brews he wanted to try. The process took 58-minutes to reach 158° (3-min longer than it should have), but close enough for my purposes. I used a water pan, alcohol burner with the beaker standing in a water bath. Inversion was reached in 12-minutes. Total time including filtering and cooling, was 2-hrs, 40-minutes. Specific Gravity 1030, pH 4.7, acid 0.175 as Tartaric, (× 1.2 = 2.1 as Lactic, which is the Brewing industry standard, and their reports will be "as lactic"). From this Metric Yield = 30 × 0.832 = 1025, 6.3°B from table I, ×10 = 63% yield, which figure is essential if one is to compare one's figures with those of your nearest brewery's results.

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## TABLE IV--TABLE OF YIELDS AND GRAVITIES

| Ingredient | U.S. Measure Yield Extract % as sucrose | U.S. Measure SG: lb/USgal (120-gm/litre) | U.S. Measure Balling U.S. | English/Metric SG: lb/UKgal (100-gm/litre) | English/Metric Balling metric | Attenuation A.D.A. | Attenuation R.D.A. |
|---|---|---|---|---|---|---|---|
| Sucrose (cane sugar) | 98.7 | 1047.46* | 11.78 | 1039.49 | 9.87 | 86.1 | 100 |
| Dextrose(corn sugar) | 92 | 1044 | 10.96 | 1036.7 | 9.2 | 69.8 | 81 |
| Glucose Chips | 86 | 1041.2 | 10.28 | 1034.3 | 8.6 | 69.8 | 81 |
| Malto-Dextrin | 92 | 1044 | 10.96 | 1036.7 | 9.2 | 14 | 16 |
| Malt Extract syrup | 73-82 | 1035-40 | 8.8-10 | 1029-33 | 7.3-8.2 | 66 | 76 |
| Dried Malt Ext. | 84-90 | 1041-43 | 10.2-.7 | 1034-36 | 8.4-9.0 | 66 | 76 |
| Malted barley 6-row | 65-69 | 1031-32 | 7.8-8 | 1026-7 | 6.5-.9 | 52 | 60 |
| Malted barley 2-row | 75-78 | 1036-7 | 9-9.3 | 1030-1 | 7.5-7.8 | 52 | 60 |
| English Pale malt 2R | 74-77 | 1035-7 | 8.7-9.3 | 1029-31 | 7.4-7.7 | 52 | 60 |
| Continental lager m. | 74-77 | 1035-7 | 8.7-9.3 | 1029-31 | 7.4-7.7 | 52 | 60 |
| Munich malt | 77 | 1037 | 9.3 | 1031 | 7.7 | 52 | 60 |
| Caramel/crystal malt | 57 | 1026 | 6.6 | 1022 | 5.7 | 58 | 68 |
| Black Patent Malt | 50 | 1024 | 6 | 1020 | 5 | 0 | 0 |
| Amber malt | 65-70 | 1031-4 | 7.8-8.4 | 1026-8 | 6.5-7 | 52 | 60 |
| Brown malt | 68 | 1032 | 8.1 | 1027 | 6.8 | 52 | 60 |
| Wheat malt | 75 | 1036 | 9 | 1030 | 7.5 | 65 | 75 |
| Flaked Barley | 70 | 1034 | 8.5 | 1028 | 7 | 65 | 75 |
| Roasted Barley | 63 | 1030 | 7.6 | 1025 | 6.3 | 0 | 0 |
| Maize Flakes | 83 | 1040 | 9.9 | 1033 | 8.3 | 65 | 75 |
| Polenta (corn) | 80 | 1038 | 9.4 | 1032 | 8.0 | 65 | 75 |
| Flaked rice | 83 | 1040 | 9.9 | 1033 | 8.3 | 65 | 75 |
| Rice | 80 | 1038 | 9.4 | 1032 | 8.0 | 65 | 75 |
| Wheat Flakes | 73 | 1035 | 8.8 | 1029 | 7.3 | 65 | 75 |

Yield = Grams of extract/100-grams of material, expressed as percent of sucrose. Col. 1 compiled from various sources: (3, 3b, 4, 5, 6, 7, 8, 9)(see Bibliography). Col. 2 = Col 4 x 1.2 Col. 3, from Table I. Col. 4, Interpolation from Table I. Col. 5 = $\frac{\text{Col. 1}}{10}$. Col. 6. Calculated from Col. 7. Col. 7 compiled from various sources. To calculate British lbs/qtr (yield extract) multiply column 1 by 1.328. * U.S.Bureau of Standards figure

Remember, this table may LOOK accurate, don't be fooled, see text.

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AMATEUR BREWER NO. 9, 1982
Published by the Amateur Brewer Information Service
P.O. Box 546
Portland, OR 97207
U.S.A.