

Focus on Ingredients -- Malt I

Converting All-Grain Recipes to
Extract / Partial Mash

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Welcome!!

This seminar is designed to show you how easy it is to brew great beer based on all-grain recipes without “having” to make the commitment in equipment and space that all-grain brewing usually requires. Using only simple, home-made equipment and a few easy-to-follow techniques, you will be able to convert almost any all-grain recipe into one based on extract, that you can brew with your present set-up. Using today’s high-quality extracts, you can compete with the best all-grain brewers!



Obligatory Disclaimer & Fine-Print Department:

Many commercial concerns and other organizations are referenced in this presentation. In no way am I connected with any of these businesses and organizations unless explicitly indicated. The information is provided as reference material only.

Introduction

I'm Ken Schwartz. I live in El Paso, Texas, in the heart of the Chihuahuan Desert on the US/Mexican border. I could tell you all sorts of things about myself, but that's not why you're here. But I think the story of my homebrewing career may ring true with you and encourage you to take the next step in your brewing technique, and hopefully you can avoid having to live some of the hard lessons I eventually learned.

I began brewing in late 1992 with a rag-tag pile of equipment I pieced together from a number of sources. Though I had read a couple of long-since-discarded books on brewing, I really wasn't aware of the homebrewing community at large, and so I brewed "in a vacuum" for quite a while, with little information or help to guide me. I made a couple of batches of some pretty marginal beer, and my interest in brewing waned a few months later. After not having brewed for several months, my wife wondered out loud whether I would ever brew again. I decided to give it another shot. I researched homebrewing a bit deeper and made a few simple changes to my equipment and technique. My beers began to taste more like...well, *beer*...and I was on my way. I discovered and joined my local homebrew club, the Borderline Brewers, in 1994, and through the knowledge I picked up from other brewers, my beers began to improve noticeably with each batch, with a new technique or piece of equipment applied each time.

Eventually my taste grew more refined and I began to wonder why my beer still didn't taste like classic imports (or even like some of the more senior homebrewers' product). I decided that the only way to get the flavors tuned in the way I wanted was to gain more control over my recipes. That meant either partial-mashing or brewing all-grain.

A friend of mine in the club was brewing primarily with partial-mashing and extract, so I went to his house one day to watch the process. I was positively horrified at the Rube Goldberg rig he had contrapted, based on some sketch in one of the homebrew books. Between the scorched mash that wouldn't hold the right temperature, the stuck sparge, the water and wort splattering everywhere, and all that extra time, I decided I would skip this mess and go straight to all-grain brewing.

After going through the process of building and using my all-grain brewery, it dawned on me just how easy partial-mashing *should* be. My friend's methods and equipment were followed almost to the letter from some book whose author was more concerned with function than elegance. I think that elegance -- and simplicity -- can and *should* be achievable by any brewer. The equipment I will present here is so simple and effective that anyone can rig up a great partial-mash system in an hour. I'll also show you how to convert those award-winning all-grain recipes into easy-to-brew specialty-grain or partial-mash plus extract recipes. That coupled with the excellent extracts commonly available today leaves almost no excuse for any serious homebrewer not to derive a larger portion of their beers from grain. In doing so, you will take a huge step toward adding an authenticity and depth to your beer that you may have thought could only be achieved with complicated all-grain brewing.

Today, our **Goal** is to learn how to emulate all-grain recipes as closely as possible while still primarily using familiar extract brewing techniques and equipment.

Why do People Brew with Extract?

Most people start homebrewing with “kit” beers, or with recipes based mostly or entirely on malt extract. There are several good reasons for this. First, brewing this way can be as simple as adding a can or two of kit extract to boiling water, chilling, pitching yeast, and fermenting. Also, because the extract is just very-concentrated wort, the extract brewer can use smaller vessels and the kitchen stove instead of larger (and much more expensive) kettles, whose contents would otherwise take forever to boil on the kitchen stove (if it reached a boil at all). The all-grain brewer has more equipment to deal with and requires more space for it all. But often the serious extract homebrewer eventually finds extract brewing to be limited in the depth and “authenticity” of the final product (for reasons explained in the next section). This is what usually drives one to begin all-grain brewing, which can be a big, expensive, and time- and space-consuming step.

In the evolution of your extract brewing technique, you may have already used a couple of “tricks” to bring your brewing a few steps closer to all-grain authenticity. You probably have used “specialty malts”, steeping a quantity of crystal or roasted malt in your brewing water to add “grain character” to your extract brews. Steeping other types of grain like munich malt is tricky, since even though h munich contains adequate *enzymes* to convert its own starch to sugar, the chemical environment of a typical extract brewer’s steep is far from optimum for effective conversion of starch to sugar, and can lead to problems such as astringency (a drying, husky, grainy flavor character) and unconverted starch (possibly leading to haze and infection by starch-loving bacteria and wild yeasts). Finally, simply steeping ingredients like flaked barley or biscuit malt which contain *no* enzymes will probably not accomplish the intended goal at all, and again can lead to haze, astringency, and infection. It’s inherent limitations such as these that often prevent extract beers from competing with all-grain versions.

Why Do People Brew All-Grain?

The all-grain brewer enjoys complete control over his/her recipe because each component of the grain bill is carefully selected and proportioned to accomplish a particular effect. Extracts, on the other hand, come in a wide variety of compositions, but you are stuck with the available selection and often you can’t even tell what the extract is made of. Is that amber extract made from pale ale malt and crystal malt, or is it pilsner and munich malts? Or is it largely corn syrup and caramel coloring? Does this dark extract have any roasted malt at all? If so, is it black patent or chocolate? Is it appropriate in my recipe? As you can see, the use of extract is more complicated than you might have thought and the lack of control of its composition often makes brewing a true-to-style recipe difficult.

What can an extract brewer do to more-closely emulate All-Grain recipes without all the hassles?

It’s simple. With today’s high-quality malt extract, you can make a very good version of an all-grain

recipe without discarding your existing extract brewing setup and technique. You will add a new weapon to your arsenal, though, and this weapon, *partial-mashing*, can give you all-grain authenticity without most of the hassles and cost involved with switching to all-grain brewing.

How can I Get All-Grain Character from an Extract-Based Recipe?

The all-grain recipe conversion method presented here involves breaking down the *grain bill* (the list of grains in the recipe) into groups or “types” based on characteristics of each grain in the recipe. Once you have separated the grains this way, you can establish a clear and easy-to-follow strategy for working with each grain type in a way that makes the best sense for that group. You will substitute extract for a portion of the grain bill, and deal with the remaining grains in a way that is simple yet appropriate. In this way, your recipe is still largely extract-based, but the extract and grains will be selected and proportioned to closely emulate the original all-grain recipe. Often this will require partial-mashing, which simply means that only *part* of the original grain bill is *mashed* (the rest being made up with extract). *Mashing* refers to the process of converting starchy grain to fermentable sugar utilizing the naturally-occurring *enzymes* in malt.

How Big of a Hassle will this be?

Because you will be using extract for most of the recipe, the equipment and process requirements for partial-mashing the grain are reduced such that the only changes to your present extract setup will be an inexpensive, compact mash tun and a little extra time to allow the grain to work its magic.

Brief Introduction to Enzymes

Before we begin the conversion & technique details, it might be worth taking a moment to discuss *enzymes*. It's not important that you become a chemist to brew beer, but when you start to work with grain, you do have to understand at least the essentials of how a grain's starch is turned into fermentable sugar, in order to better control the outcome of the beer.

Simply put, enzymes are a class of chemicals that promote chemical reactions without being altered themselves. The enzymes we are concerned about in this presentation break large molecules into smaller molecules. There is a long list of enzymes in malt, but we will be concerned primarily with just two. The *amylase* enzymes break starch molecules into pieces. *Starches* are just big chains of sugar molecules chemically linked together. Therefore the smallest pieces of starch are simple sugars. *Alpha amylase* breaks starch molecules at *random points* in the chain and therefore tends to leave relatively large pieces behind. Eventually these pieces become small enough to be classified as a “sugar”, but they may still be large enough to be unfermentable (in this case they are called *dextrins*). *Beta amylase* breaks off small, highly-fermentable *maltose* (malt sugar) only from the very *ends* of starch chains. The relative activity of each of these two enzymes determines whether the resulting wort will be fermented into a sweet, dextrinous, lower-alcohol beer (if alpha-amylase activity is dominant); a dryer, thinner, more-alcoholic beer (if beta-amylase activity is dominant); or somewhere in between. The temperature at which alpha amylase is most active is different (higher) than beta's

optimum temperature, so controlling the mash temperature is an effective way to balance the action of these two enzymes.

The malt's enzymes are activated by adding hot water to the crushed grains. The water gives the enzymes a way to "float around" in search of starch molecules, and it also regulates the temperature. The process of adding hot water to grain for the purpose of enzymatic conversion of starch to sugar is called *mashing*. Enzymes can be destroyed (*denatured*) if exposed to excessive temperatures, but on the other hand a certain minimum temperature is required for proper activity. Therefore it's important to maintain reasonably controlled temperature while mashing. We'll talk more about this later.

The point of understanding enzymes is this. If a starchy ingredient such as flaked barley contains no enzymes, then all the steeping in the world will not break the starches into sugars, and the starch will pass directly into the wort and even into the finished beer, posing a number of problems including haze and potential infection. At the very least it will not serve the purpose you thought it would.

Recipe Conversion Procedure

OK, it's time to get down to business. You just found out that the NHC best-of-show beer is your favorite style, and you want to try to brew a copy of it. You tear into the recipe, only to find...drats! it's a complicated all-grain recipe. Well, pick yourself up and dust yourself off, because you're going to brew that beer!

Here is the process in a nutshell:

1. Break up the grain bill into one to four groups or "types" (given below) based on the characteristics of each grain in the recipe.
2. Decide whether a steep or a partial-mash is needed/desired and separate those grain(s).
3. Substitute extract for the remaining grain(s).
4. Write down the "new" extract-plus-grain recipe.
5. Brew the beer!

What we are doing is separating the part of the recipe that can be easily converted to extract, from the part that cannot, and planning a strategy to deal with both parts. Remember that by using extract, you can create a concentrated wort, and so your boil volumes can remain small enough to continue brewing on the stovetop as you may already be doing. Instead of bringing plain water to a boil and adding extracts, you'll create some all-grain wort instead, adding a whole new dimension to your beers.

Let's look at the basic elements of the recipe conversion process in detail first, then we'll formalize the procedure and work an example or two to demonstrate the process.

1. Classify the Grains

The first step in the conversion process is to break down the grain bill into “types” of grain based on its characteristics. This will help you to identify which ingredients can be converted to extract, which can be simply steeped, and which may need to be mashed..

There are four groups or “types” I propose:

- **Type 1 - Base Malt.** This is the malt that makes up the majority of the grain bill. Usually it’s a pale malt like two-row, pilsner, wheat, or pale-ale malt. Most or all of these grains can be substituted with readily-available extracts. These malts tend to be quite *enzymatic* (rich in enzymes).
- **Type 2 - Specialty (non-base) malts with extract equivalents.** *Specialty malt* usually refers to anything other than base malts. Some specialty malts are now available in extract form, including munich, crystal, and roasted malts. But if you want to use grain instead of extract for these malts, place them in either of the next two categories (crystal and roasted malts would fall under Type 3, others would fall under Type 4; see below).
- **Type 3 - Specialty (non-base) malts, without extract equivalents, that *don't* need mashing.** You may have steeped crystal or roasted malt in your brewing water in the past. These malts would fall into this category, assuming that you could not find or did not wish to use extract versions. In fact, crystal and roasted malts are really the *only* ones you should ever just steep without actually mashing, since they contain little residual starch and much of the character can be extracted by steeping. Type 3 grains have no enzymes.
- **Type 4 - Specialty (non-base) malts, without extract equivalents, that *do* need mashing.** These are malts and other non-malt starches that do not have extract substitutes. Examples would be flaked oats (non-enzymatic) or Belgian Aromatic malt (enzymatic). A partial-mash is *required* when these grains are present. Some have sufficient enzymes to convert their own starch, others have none.

Tip: some ingredients like sugars or syrups which are added directly to the boil do not need any conversion considerations and can be used exactly as described in the original recipe.

Here is an incomplete list of commonly-used grains and the categories into which they might be placed. Remember that there are always exceptions, and also remember that you can consider *any* grain to be a Type 4 if you want to include it in a mash rather than use extract.

Type 1 Malts -- Base Malt with Extract Equivalents: Two-row, six-row, pilsner (“pils”) malt, wheat malt. Note that wheat extract is usually not 100% wheat but rather is around 60% wheat + 40% pale malt. Ireks Weizenbier extract is 100% wheat.

Type 2 Malts -- Specialty Malts with Extract Equivalents: Munich, crystal, chocolate, roasted black malt. Note that these are usually a blend of the labeled malt and another “base” malt, which may or may not be appropriate for your recipe. For example, one supplier, Morgan’s, sells the followin g

under their “Master Blend” label:

“Caramalt” = 60% light to medium crystal + 40% pale malt

“Dark Crystal” = 60% dark crystal + 40% vienna malt

“Roasted Black Malt” = 12% Roasted black malt + 88% munich malt

“Chocolate Malt” = 15% chocolate malt + 85% munich malt

And from St. Patrick’s Homebrew Supply:

“Marie’s Munich” = 50% munich 20L + 50% “lager malt”

These are extracts made by mashing grains in the proportions given. Keep in mind that since each Type 2 malt only makes up a portion of the Type 2 extract, we must use more of the extract for a given amount of malt. For example, if you need ½ lb of Chocolate Malt extract, you’d need 3.3 lb of Morgan’s “Chocolate”, since it’s only 15% chocolate malt (divide the ½ lb of chocolate by 15% or 0.15). The other 85% (2.8 lb) is munich malt which might or might not be welcome in your recipe. This concept will be further illustrated in examples later in the presentation.

Or, you can choose not to convert these Type 2 grains to extract, in which case you would classify them as a Type 3 or Type 4 malt as follows:

Type 3 Malts: -- Specialty malts without extract equivalents that *don't* need mashing: Crystal/caramel malts (including all the Belgian “cara-” malts), Carapils, Special “B”, all dark roasted malts (carafa, chocolate, black patent, roast barley).

Type 4 Malts: Specialty malts without extract equivalents that *do* need mashing: *Non-Enzymatic (does not contain enzymes):* Raw (unmalted) wheat, rye, rice, corn, etc., flaked unmalted grains (oats, barley, maize, rice, wheat, rye, etc.), “honey” malt, Biscuit, Victory, and Special Roast malts, brown and amber malts. *Enzymatic (contains enough enzymes to convert itself):* Vienna, munich, mild ale, malted rye, peated malt, Belgian Aromatic. Wheat malt, and on rare occasions the other Type 1 malts, are sometimes used in small amounts and can be considered Type 4 in those cases.

2. Decide if a Partial-Mash is Required

Tip: if you have *any grains at all* from the Type 4 category, you will *have* to perform a partial-mash. In this case, you should strongly consider putting any Type 3 grains along with them and mashing both groups, as long as you have to mash one group anyway. You’ll get a much better effect this way, than you would by simply steeping them. Consider all mashed Type 3 grains to be *non-enzymatic* when evaluating the mash’s enzyme content (see next section).

Enzymes & Starch Load

Different grains contain different amounts of enzymes, so we must be careful to consider whether the

grains we plan to mash will have an adequate “enzyme pool” to completely convert. Another consideration is whether the enzymes can even get at the starch at all. Raw and unmalted grains hold their starch in tightly-locked cellulose cages, and some preparation may be required to free this starch for access.

Ensuring adequate enzymes for the mash

Take a look at your Type 4 grains. Some of these, like vienna and mild ale malts, have enough enzymes to convert themselves (plus perhaps a bit more starch). I’ve labeled them “enzymatic” in the list above. Others, like Biscuit malt and the flaked grains, contain little or no enzymes and need some help. These I’ve called “non-enzymatic”. If you have any Type 3 grains (always non-enzymatic), or any non-enzymatic Type 4 grains, you will need to boost the enzyme pool in the mash.

This is most simply done by “borrowing” some of the Type 1 base malt (which is usually *very* enzymatic). The base malts listed under Type 1 above have enough enzymes to convert themselves *plus* at least an equal weight of non-enzymatic starch¹. Add to the partial-mash an amount of Type 1 malt equal to or greater than the amount of *non-enzymatic* grain in the mash.

One thing to be careful of is that huskless grains such as wheat and flaked oats can “gum up” and cause a “stuck mash”, wherein the normally porous filter bed of grain becomes an impervious plug of glop. To avoid this, always be sure that at least half of your partial-mash is grain with husks. “Borrow” more husked Type 1 grain (i.e., not wheat malt) if necessary.

PreGelatinization

Most raw grains need to be processed to make their starch accessible to the enzymes. These grains must be heated to a certain temperature to break down the impervious cell walls and thus expose the starch inside. Flaked or rolled grains are already pre-gelatinized due to the heat experienced in the rolling process, and can be added directly into the mash without preparation. In order to avoid additional work, always try to use flaked or rolled grains wherever possible.

If you insist on using whole raw grain, like corn meal or rice, you’ll have to boil them ahead of time. Boil for at least 30 minutes to completely gelatinize the starch. After you’ve boiled the grain, allow the mash to cool to about 150F or so (or add cold water to speed up the cooling) before adding to the main mash.

3. Select Your Extracts

When selecting extract equivalents for the Types 1 and 2 grains in your recipe, there are two things to keep in mind. First, for the Type 1 conversion, look for plain, pale, unhopped extract. Hops are an important part of a recipe’s character, and we will be adding those separately rather than using pre-hopped “kit” extracts. Also, keep in mind that not all “pale extracts” are made from the same type of pale malt. There will be a difference between “pale ale malt” extract from England (most suitable

for English ales), “pale” or “pilsner malt” extract from continental Europe (intended for Pilsners and German lagers, for example), and American “pale malt” extract from domestic two-row barley (great for American ales and lagers). Ask your homebrew supplier for assistance if you’re not sure of the differences. Here are some suggestions³:

American Two-Row	American Six-Row	German/Continetal Lager (“Pils”)	British Pale Ale
<ul style="list-style-type: none"> •Alexander’s •Northwestern 	<ul style="list-style-type: none"> •Briess DME 	<ul style="list-style-type: none"> •Bierkeller 	<ul style="list-style-type: none"> •Edme •John Bull •Munton & Fison

Another consideration is dry versus liquid (syrup) form. Sometimes identifying the origin of bulk-packaged dry extract is difficult so ask your supplier. On the plus side, dry extract will last longer and any desired amount can be measured out without wasting the leftover as you would do with a can or bag of liquid extract. One suggestion would be to use as much liquid extract as possible from “whole” canfuls, and make up any odd additional amount required using dry extract. For example, if you decide you needed 4.2 lb of liquid extract, you could use one 3.3 lb can plus some dry extract for the remainder (more on this later).

In Appendix I there is a list of commonly-available extracts, published by the First State Brewer’s homebrew club³ (<http://triton.cms.udel.edu/~oliver/firststate/tips/maltexttract.html>), which identifies the important characteristics of many commonly-available extracts. Use it as a guide to select the characteristics you desire in your final product.

Grain to Extract Conversion

For the question of converting grain to extract, there is a short and a long answer. The short answer, based on typical all-grain processes and extract characteristics, is to use 3/4 (0.75) lb of liquid extract for each pound of grain being substituted, or 2/3 (0.67) lb dry extract. Now technically that means that it takes more liquid extract to equal dry extract, but in practice, you can use one conversion factor or the other, even if you plan to mix dry and liquid extracts. My suggestion is to convert the entire amount of grain to liquid extract, subtract off “whole canfuls” (3.3 lb / 1.5 kg increments), and convert the remainder to dry extract. You can convert liquid extract to dry by multiplying by 0.89, or dry to liquid by multiplying by 1.1.

For example, if you are converting 6 lb of pale ale malt to extract, you would need $6 \times 0.75 = 4.5$ lb of liquid extract. Since you’re buying a 3.3 lb can of extract, this leaves 1.2 lb to make up. Rather than using part of another 3.3 lb can (and wasting the rest), you can use 1.2 lb of dry extract. To be precise, you’d actually only need 1 lb dry extract (multiply the remaining 1.2 lb of liquid extract required by 0.89 to convert liquid to dry). Try it both ways and see.

Tip: If you want to use liquid extract for as much of the extract as possible, making up any difference with dry extract (DME), first convert the grain to liquid by multiplying by 0.75. Then

subtract off the amount that will be liquid extract (for example, whole cans of 3.3 lb / 1.5 kg), and multiply the remainder by 0.89 to get the amount of DME to use.

You should also take into account any amount of Type 1 grain you might have “borrowed” for adding enzymes to your partial mash. This is why I call it “borrowing”, because now you’ll deduct the amount of grain you “borrowed” from the amount to be converted to extract. In fact, if your partial-mash tun is not yet full, you might as well add *more* of your Type 1 malts as grain to maximize the grain recipe emulation. *I would suggest always mashing at least three pounds of grain.* This makes temperature control easier and the larger mass of grain will hold the heat better. Once you see how easy it is, you will probably want to mash even more than this. The partial-mash equipment described later will hold five to six pounds of grain, so go for it!

For example, suppose the recipe calls for 8 lb of two-row malt plus a pound of biscuit malt. You decide to “borrow” two pounds of two-row to convert the biscuit malt in a partial-mash (and fill out the three-pound minimum). Thus, you will only need to convert 6 lb of two-row to extract. 6 lb of grain equals 4.5 lb of extract (6 x 0.75), or one 3.3 lb can plus 1 to 1.2 lb dry extract as above. Or, go for it and mash *four* pounds of two-row plus one pound of biscuit (filling up the mash tun), and convert the remaining two pounds of two-row to 1.5 lb liquid (2 x 0.75) or 1.3 lb dry (2 x 0.67) extract.

The long answer to the conversion question involves determining the *potential* and *actual* sugar extraction of the original recipe’s grain bill, and figuring the equivalent amount of extract needed to equal it. This usually isn’t necessary and it is much more complicated, but if you’re interested, the relevant information is presented in Appendix II.

One other reason for borrowing grains would be if more than half of the partial-mash is huskless grains. This would include wheat, corn, rice, and any flaked grain. The husks of the grains help to “fluff up” the mash, allowing wort to drain off. If there is not enough husk material, the grain could compact and plug up, resulting in what is called a *stuck sparge* or *stuck mash*. Borrow more *husked* Type 1 grain if necessary to ensure that the partial-mash is at least 50% husked grain.

Now you should have two groups of ingredients -- One or more extracts and a grain bill ready to be steeped or (preferably) mashed.

4. Write down the New Extract-Based Recipe

Now that you have identified how much of which grains need to be steeped or partial-mashed, and how much of which were converted to extract, write down the new recipe and...

5. Brew the Beer!!

...which is the whole point!!

Summary

How about a quick review and a “recipe for recipe conversion”? First, we split the grain bill into as many as four groups or “Types” based on the characteristics of the individual grains in the recipe. If there are any Type 4 grains, we need a partial-mash. If we have any Type 3 grains, we have the option to steep them alone or to mash with other grain, but mashing is much preferred to get the best effect. Whenever we need a partial mash, we have to consider the enzyme pool available to the grains, as well as whether there is enough grain husks to form a good filter bed, so we might have to “borrow” some Type 1 base malt to boost the enzymes or add husks. We convert the Type 1 and Type 2 grains to extract, write down the converted recipe, and brew the beer.

10 Steps to Recipe Conversion

Here is a detailed “recipe” for the entire process, followed by two illustrative examples:

1. Classify the grains in the recipe as Type 1, 2, 3, and 4.
2. If there are any Type 4 grains, go to Step 6, otherwise continue to Step 3.
3. If there are no Type 3 grains, go to Step 5, otherwise continue to Step 4.
4. If you want to just steep the Type 3 grains, write "Steep (Type 3 grains) in brew water" in your recipe conversion log and go to Step 5. If you want to mash them (preferred), go to Step 6 instead.
5. Convert Type 1 and Type 2 grains to extract, keeping in mind that some extracts are a mixture of two or more malts. Consider “whole units” of packaged extract (e.g., 3.3 lb cans). Write "Bring brew water to boil, add (extract(s))" in your recipe conversion log. Go to Step 10.
6. If any of your Type 3 and Type 4 grains are non-enzymatic, borrow enough Type 1 grain to equal or exceed the total amount of non-enzymatic grain. Add more husked Type 1 grain if partial-mash is <50% husked grain or is less than three pounds total.
7. Write "Perform Partial-Mash on (Type 3 and Type 4 grains plus borrowed Type 1 grains), and sparge into brew water" in your recipe conversion log.
8. Adjust the original Type 1 grain quantity to account for any you might have borrowed in Step 6.
9. Go to Step 5.
10. Recipe Conversion is finished!

Notice that you almost always end up with at least two choices in your approach to the recipe conversion. One shows up in Step 1, where you can choose to treat certain grain as either Type 2 (choosing to use extract) or Type 3 / Type 4 (choosing to use grain instead). Another is in Step

4, where you can decide to either mash or steep your Type 3 grains. My advice is that you might as well mash as much of the recipe as practical and convert only the Type 1 grains to extract. Even when mashing 6 lb of grain, you will get no more than 3 gallons of runoff, so you won't need to abandon your stovetop technique & equipment.

Here's the first example, worked several ways to illustrate the options:

Amber Ale

7 lb two-row
1 lb munich
1 lb wheat malt
1 lb carapils
2 oz roast barley

Follow the 10 Steps as shown above:

1. *Classify the grains in the recipe as Type 1, 2, 3, and 4:*

7 lb two-row is Type 1

1 lb munich is either Type 2 (if we want to use Marie's Munich extract) or Type 4 (if we want to use grain)

1 lb wheat malt is either Type 2 (if we want to use wheat malt extract) or Type 4 (if we want to use grain)

1 lb carapils is Type 3

2 oz roast barley is Type 3

2. *If there are any Type 4 grains, go to Step 6, otherwise continue to Step 3:*

We have a choice to use either grain or extract for the munich and the wheat malts. Let's work it both ways. First, let's assume we'll use extract. In this case, these two grains will be considered Type 2 instead of Type 4 (we'll revisit them as Type 4 towards the end of this example). We continue:

3. *If there are no Type 3 grains, go to Step 5, otherwise continue to Step 4:*

The carapils and roast barley are Type 3 so we continue with Step 4.

4. *If you want to just steep the Type 3 grains, write "Steep (Type 3 grains) in brew water" and go to Step 5. If you want to mash them (preferred), go to Step 6:*

Again we have a choice. Let's start with the simpler choice which is to steep the carapils and roast barley rather than mashing it (we'll consider that later). In our recipe conversion log we write "Steep 1 lb carapils and 2 oz roast barley in brew water." and

continue to Step 5.

5. Convert Type 1 and Type 2 grains to extract, keeping in mind that some extracts are a mixture of two or more malts. Consider "whole units" of packaged extract (e.g., 3.3 lb cans). Write "Bring brew water to boil, add (extract(s))". Go to Step 10:

We have 7 lb of two-row (Type 1), and 1 lb munich and 1 lb of wheat malts (Type 2). We know that both the munich and wheat extracts are only part munich and wheat extract, and they contain some pale malt extract as well. So let's convert these first since the pale malt they contain will count against the remaining two-row.

First, convert the Type 2 grains to extract by multiplying by 0.75:

1 lb munich = 0.75 lb munich extract

1 lb wheat = 0.75 lb wheat extract

Now we have to take into account the fact that Marie's Munich and Alexander's Wheat are not 100% munich and wheat. To get the total amount needed which contains the right amount of munich or wheat, we have to *divide by the percentage of target ingredient* as follows:

0.75 lb of munich \div 50% (0.50) munich in Marie's = 1.5 lb Marie's Munich

0.75 lb of wheat \div 60% (0.60) wheat in Alexander's = 1.25 lb Alexander's Wheat

Now that we have the total Type 2 extract amounts, we can figure the amount of pale malt contained in these two extracts:

1.5 lb Marie's \times 50% (0.50) lager malt = 0.75 lb

1.25 lb Alexander's \times 40% (0.40) pale malt = 0.5 lb

for a total of 1.25 lb pale malt in these two extracts.

Next, convert the Type 1 two-row using Alexander's Pale.

7 lb \times 0.75 = 5.25 lb Alexander's Pale, then subtract the 1.25 already in the other two extracts = 4 lb.

This completes the recipe conversion using the simplest conversion method:

- Steep 1 lb carapils and 2 oz roast barley in brew water.
- Bring brew water to boil, add 1.5 lb Marie's Munich, 1.25 lb Alexander's Wheat, and 4 lb Alexander's Pale extract.

The 4 lb Alexander's would be wasteful of a second 3.3 lb can, so we can break it up into a 3.3 lb can plus 0.7 lb DME (or $0.7 \times 0.89 = 0.6$ lb DME to be more "precise") to make up the difference.

Let's go back to the decision we made in Step 4 to steep the grains. If we had chosen instead to mash the Type 3 grains, we would go to Step 6 instead of Step 5:

6. If any of your Type 3 and Type 4 grains are non-enzymatic, borrow enough Type 1 grain to equal or exceed the amount of non-enzymatic Type 4 grain. Add more husked Type 1 grain if partial-mash is <50% husked grain or is less than three pounds total:

The carapils and roast barley are non-enzymatic, so let's borrow 2 lb of two-row to both (a) equal or exceed the non-enzymatic grains and (b) meet the three pound mashing minimum. None of the mash is non-husked grain, so we continue on to Step 7:

7. Write "Perform Partial-Mash on (Type 3 and Type 4 grains plus borrowed Type 1 grains), and sparge into brew water" :

We write in our conversion log, "Perform Partial-Mash on 1 lb carapils, 2 ounces roast barley, and 2 lb two-row, and sparge into brew water." We continue to Step 8:

8. Adjust the original Type 1 grain quantity to account for any you might have borrowed in Step 6:

Since we borrowed two pounds of two-row for the mash, we only have to convert 5 lb to extract. Step 9 says to continue with Step 5:

5. Convert Type 1 and Type 2 grains to extract, making note of any extracts that combine two or more grains and adjusting the amounts of these so that each grain is properly converted. Consider "whole units" of packaged extract (e.g., 3.3 lb cans). Write "Bring brew water to boil, add (extract(s))". Go to Step 10:

We already converted the munich and the wheat malt to extract (1.5 lb Marie's and 1.25 lb Alexander's Wheat), but we only need to convert 5 lb of the two-row since we're mashing the other two pounds. So $5 \times 0.75 = 3.75$ lb Alexander's Pale, or $5 \times 0.67 = 3.35$ lb dry malt extract. Remember that the extracts contained 1.25 lb of pale extract, so we subtract that off of the conversion result to get 2.5 lb liquid or 2.1 lb dry:

- Perform Partial-Mash on 1 lb carapils, 2 oz roast barley, and 2 lb two-row, and sparge into brew water.
- Bring brew water to boil, add 1.5 lb Marie's Munich, 1.25 lb Alexander's Wheat, and either 2.5 lb Alexander's Pale or 2.1 lb pale DME.

In this case, we didn't have enough pale extract to equal a 3.3 lb can, although we might consider rounding off to a 2 lb bag of DME if that was how the homebrew shop had it packaged.

Finally, Step 10 says we're done.

But if we're going to partial-mash anyway, we might as well get as much grain going as possible. Let's mash everything and convert just the two-row to extract, this time treating the munich and the wheat as Type 4 grain rather than Type 2 extract. Starting where we first left off at Step 2, we see that we now have Type 4 grains (considering the wheat malt as Type 4 due to its relatively small amount), so we jump to Step 6:

6. If any of your Type 3 and Type 4 grains are non-enzymatic, borrow enough Type 1 grain to equal or exceed the amount of non-enzymatic Type 4 grain. Add more husked Type 1 grain if partial-mash is <50% husked grain or is less than three pounds total:

Our total partial-mash grain bill looks like this:

1 lb munich
1 lb wheat malt
1 lb carapils
2 oz roast barley
(3 lb 2 oz total)

Although the carapils and the roast barley are non-enzymatic, we have more than enough enzymatic wheat malt for them, and the munich will take care of itself. Also, the huskless wheat malt comprises less than 50% of the grain, so we don't have a problem there. Thus the only thing left to do is to convert the full remaining 7 lb of two-row to extract, $7 \times 0.75 = 5.25$ lb liquid or $7 \times 0.67 = 4.69$ lb dry. Our conversion looks like:

- Perform Partial-Mash on 1 lb carapils, 2 oz roast barley, 1 lb munich, and 1 lb wheat malt, and sparge into brew water.
- Bring brew water to boil, 5.25 lb Alexander's Pale extract or 4.69 lb DME.

Again, we can consider using a 3.3 lb can plus about $1\frac{3}{4}$ to 2 lb DME in place of the 5.25 lb.

All three of these conversions will make an approximation of the original all-grain recipe, but this last one is bound to be closest since it is produced by mashing more of the recipe.

One last attempt to further improve the emulation: fill out the mash to a full 5 lb by bringing two pounds of the two-row into the partial-mash. This leaves 5 lb of two row which converts to 3.75 lb liquid or 3.35 lb DME, or 3.3 lb liquid plus about $\frac{1}{2}$ lb DME:

- Perform Partial-Mash on 1 lb carapils, 2 oz roasted barley, 1 lb munich, 1 lb wheat malt, and 2 lb two-row, and sparge into brew water.
- Bring brew water to boil, 3.75 lb Alexander's Pale extract, 3.35 lb DME, or 3.3 lb can Alexander's Pale plus ½ lb DME.

For a second example, let's convert the following Robust Porter recipe:

Robust Porter

7 lb pale ale malt
 3/4 lb chocolate malt
 3/4 lb crystal 60L

1. *Classify the grains in the recipe as Type 1, 2, 3, and 4:*

7 lb pale ale malt is Type 1
 3/4 lb chocolate malt is Type 2 or Type 3
 3/4 lb crystal 60L is Type 2 or Type 3

2. *If there are any Type 4 grains, go to Step 6, otherwise continue to Step 3:*

No Type 4 grains; continue to Step 3.

3. *If there are no Type 3 grains, go to Step 5, otherwise continue to Step 4:*

Let's first consider the crystal and chocolate as Type 2, and convert them to Morgan's Master Blend extracts. Therefore we have no Type 3 grains so we continue with Step 5.

5. *Convert Type 1 and Type 2 grains to extract, keeping in mind that some extracts are a mixture of two or more malts. Consider "whole units" of packaged extract (e.g., 3.3 lb cans). Write "Bring brew water to boil, add (extract(s))" in your recipe conversion log. Go to Step 10:*

We convert to Morgan's as follows:

$3/4 (0.75) \text{ lb chocolate} \div 15\% (0.15) = 5 \text{ lb Morgan's Chocolate (15\% chocolate malt extract)}$

$3/4 (0.75) \text{ lb crystal 60L} \div 60\% (0.60) = 1.25 \text{ lb Morgan's Dark Crystal (60\% crystal malt extract)}$

The "pale malt" contained in these two extracts are:

$5 \text{ lb Morgan's Chocolate} \times 85\% \text{ Munich} = 4.25 \text{ lb munich}$

1.25 lb Morgan's Dark Crystal x 40% Vienna = 0.75 lb vienna

for a total of 5 lb "pale malt" extract. However, munich and vienna are hardly "pale malts" and may not be appropriate for this recipe. This obviously is entirely your choice, and in a full-bodied beer like a porter it just might be interesting. Assuming we'll go ahead and use the Morgan's and treat the munich and vienna as "base malt", we continue:

7 lb pale ale malt x 0.75 = 5.25 lb pale extract

Since we already have 5 lb "pale malt" in the Morgan's, we can stop here (and be a few ounces short of "perfection"), or we can make up the remaining ¼ lb with DME:

- Bring brew water to boil, add 5 lb Morgan's Chocolate , 1.25 lb Morgan's Dark Crystal, and ¼ lb pale DME.

Step 10 says we're done with this all-extract conversion. Now let's go back and work it as a steep or partial-mash.

4. If you want to just steep the Type 3 grains, write "Steep (Type 3 grains) in brew water" in your recipe conversion log and go to Step 5. If you want to mash them (preferred), go to Step 6 instead:

Let's quickly work the steeping option. We would steep the chocolate and crystal as-is and convert the 7 lb pale ale malt to 5.25 lb extract (3.3 lb can plus 1.95 lb x 0.89 = about 1.75 lb DME). But let's do the "right thing" and plan a partial-mash, proceeding to Step 6:

6. If any of your Type 3 and Type 4 grains are non-enzymatic, borrow enough Type 1 grain to equal or exceed the total amount of non-enzymatic grain. Add more husked Type 1 grain if partial-mash is <50% husked grain or is less than three pounds total:

The Type 3 crystal and chocolate malts are non-enzymatic, so we would need to borrow at least 1.5 lb pale ale malt to equal their weights to ensure adequate enzymes, which also gives us the three-pound partial-mash minimum. Let's do something different here, and plan to use one whole can of extract and partial-mash the rest of the pale malt. So we have to figure how much pale malt is equivalent to a single 3.3 lb can of extract. To do this we would work backward, *dividing the extract* by 0.75 instead of *multiplying the grain* as we have been doing. 3.3 lb extract ÷ 0.75 = 4.4 lb of grain. Subtract 4.4 from the original 7 to get 2.6 lb of grain. What this means then is that we can use exactly one can of high-quality pale ale extract (like Edme Maris Otter) in place of 4.4 lb of grain, and mash the remaining 2.6 lb with the crystal and chocolate. This makes a very simple and high-quality conversion:

7. Write "Perform Partial-Mash on (Type 3 and Type 4 grains plus borrowed Type 1 grains), and sparge into brew water" in your recipe

conversion log:

Duly noted...

8. *Adjust the original Type 1 grain quantity to account for any you might have borrowed in Step 6:*

We're borrowing 2.6 lb, so that we can convert the remaining 4.4 lb to exactly one 3.3 lb can as we just saw.

Step 9 says to go to Step 5:

5. *Convert Type 1 and Type 2 grains to extract, keeping in mind that some extracts are a mixture of two or more malts. Consider "whole units" of packaged extract (e.g., 3.3 lb cans). Write "Bring brew water to boil, add (extract(s))" in your recipe conversion log. Go to Step 10.*

Converting the remaining 4.4 lb to extract gives us 3.3 lb (we already knew that). The recipe finally looks like this:

- Perform Partial-Mash on 3/4 lb crystal 60L, 3/4 lb chocolate, and 2.6 lb pale ale malt, and sparge into brew water.
- Bring brew water to boil, add 3.3 lb can of Edme Marris Otter extract.

Step 10 says we're done, and so we are.

Tip: A 3.3 lb can of liquid pale extract substitutes for about 4.4 lb of pale malt.

Here's one last example. I'll work it quickly but of course you can (and should) always write out the steps in detail to keep you on track:

Irish Dry Stout

6 lb pale ale malt
3/4 lb roast barley
1 lb flaked barley

The last two grains can be treated as Type 4, non-enzymatic, total of 1.75 lb. So we need at least 1.75 lb of the pale ale malt, making a total mash of 3.5 lb. This exceeds the 3-lb minimum, and keeps the huskless flaked barley below 50% of the grain bill. This also leaves 4.2 lb of grain to convert, which is "pretty close" to the 4.4 lb that converts to a can of extract:

- Perform Partial-Mash on 3/4 lb roast barley, 1 lb flaked barley, and 1.75 lb pale ale malt, and sparge into brew water.
- Bring brew water to boil, add 3.3 lb can of Edme Marris Otter extract.

Because the partial-mash is fully 50% non-enzymatic, we'll want to mash for a longer period to help ensure complete conversion (see next section). It wouldn't hurt to borrow more pale ale malt (to add more enzymes) to improve and speed up conversion. Bring the total mash to 5 pounds (1 lb flaked barley, 3/4 lb roast barley, 3.25 lb pale ale malt), which leaves 2.75 lb pale malt, which converts to 1.8 lb DME:

- Perform Partial-Mash on 3/4 lb roast barley, 1 lb flaked barley, and 3.25 lb pale ale malt, and sparge into brew water.
- Bring brew water to boil, add 1.8 lb DME.

To finish this popular recipe, hop with 2 - 3 ounces of East Kent Goldings or Fuggles (4% - 5% AA) boiled 60 minutes, and ferment at 68F with Irish Ale yeast.

The Partial-Mash -- How-To

Hopefully by now you're comfortable with the idea of mashing part of your recipe, so let's take a look at the mechanics of conducting the mash itself.

Building the Mash Tun

First you'll need to construct a mash tun. I have presented two designs in Appendix III. One is a simple bucket-in-a-bucket rig based on Charlie Papazian's venerable "Zapap" system described in his book The New Complete Joy of Homebrewing². This set-up has the edge in simplicity but does require the mash temperature to be regulated in a stockpot on the stovetop or in the oven for the 60-90 minute conversion (or "rest") period. The other design is based on a small insulated beverage dispenser, and while it's just a wee bit more complicated to build, it has an advantage in that it will hold the temperature adequately for the mash conversion period all by itself. This will save you from needing one extra stockpot and having to use the oven (though read on for ways to get around this). Either setup will work well.

Mashing the Grains

The procedure is as follows. First, be sure the grain is milled (crushed) properly. If you don't own a mill, have your homebrew supplier crush it for you. Avoid the old rolling-pin-and-Ziploc grain-crushing trick, as you will probably not get a very good crush, and your extraction will suffer significantly as a result.

Another tool you'll need is a decent thermometer. The little 5" dial probe thermometers are amazingly accurate, and other thermometers for homebrewers are available from a number of sources. Be sure it will read at least from room temperature to boiling.

Next, prepare some hot water. A *single-infusion mash* is all that will be required in practically every case, given today's well-modified malts. This involves adding the grain to hot water, settling the mixture at a specified temperature, and allowing it to "rest" at this temperature for the conversion period (60 to 90 minutes).

Stovetop Method (bucket system)

Heat water to 168F in a ten-quart stockpot, then turn off the heat and add the grain slowly enough to break up the starchy balls of grain that form, but quickly enough that the grain cools the mixture to avoid premature denaturing of the enzymes. Somewhere around one minute to add all the grain is about right. The mash should end up somewhere in the mid-150's Fahrenheit (high-60's Celsius). This will be a good compromise temperature to balance alpha- and beta-amylase activity. The exact temperature isn't terribly critical, and anywhere from 150F to 158F is fine.

Place the stockpot on a rack in the oven (the mash is still in the stockpot at this point, not yet in the bucket!). The oven should be preheated to 150F or as low as it will hold. If the oven will not hold much below 200F, preheat it to 200F but turn it off after 20 to 30 minutes. Instead of using the oven, you can cover the stockpot and leave it on the stovetop. Briefly reheat it every so often to maintain the temperature within a couple of degrees (be careful not to scorch or overheat it).

Another idea is to cover the stockpot and wrap it in a bath towel (or two), blanket, or sleeping bag to insulate it. This should keep you from having to reheat the mash more than maybe once. Don't forget to place part of the wrap under the bottom of the stockpot to insulate it from the countertop. Check the temperature every 15 minutes and return it to the stove for a brief boost if the temperature has dropped more than, say, three degrees.

Finally, you can try mashing directly in the nested buckets as described below for the cooler. Add a couple of inches of hot mash water to the undrilled bucket before inserting the drilled bucket, and add the remaining hot water after the drilled bucket is inserted (*be sure pinch clamp is closed!*). This will prevent air from being trapped in the space below the drilled bucket. You will definitely need an insulating wrap such as a sleeping bag or at least two bath-sized towels to hold the temperature (and you can't put the buckets on the stove to boost the temperature!).

Cooler System

Heat the water to 173F, close the pinch clamp, and *slowly and carefully* pour it into the cooler. The water temperature will drop as the cooler itself absorbs heat from the water. When the temperature has dropped to about 165F (after about five minutes), add the grain to the cooler as

described above. Install the lid. Fold a towel and lay it on the lid of the cooler; these small coolers usually don't have insulated lids. The towel will help hold in some of the escaping heat, reducing the temperature drop over time. The temperature will stabilize around 155F, and may drop another four or five degrees during the mash rest. If you wish to mash in at a different temperature, adjust the initial water temperature accordingly.

Mash Conversion & Sparge Water Preparation

Allow the mash to sit ("rest") for 60 minutes, longer (up to 90 minutes) if you have a high load (40% - 50% of the total) of non-enzymatic grains. While the mash is resting, prepare more hot water. Heat the same amount of water as you used for mashing, to 170F. This will be your *sparge* or rinse water, which you will use later to rinse the sugars from the mash once you start running off the wort into the boiling kettle. *This water should never be hotter than 175F!*

Also, I like to stir the mash gently once part-way during the rest, say, at 30 minutes, which helps redistribute the temperature as well as the enzymes throughout the grist. It also lets you get a whiff of that yummy malt aroma! Cover the mash quickly so as not to lose too much heat.

Water Requirements and Wort Produced

Use 1 gallon of water per 3 lb of grain. If your mash is smaller than three pounds, "borrow" more Type 1 grain to bring the total mash to at three pounds. Or get the most for your mashing bucket and borrow enough Type 1 grain to mash five or six pounds! For various amounts of grain use this table to determine the amount of water to use and the amount of wort you can expect to run off (if you sparge with the same amount of water as you mashed with):

<u>Pounds of Grain</u>	<u>Mash/Sparge Water</u>	<u>Wort Collected</u>
3	1 gallon	1.4 gal
3-1/2	4-1/2 qt	1.6 gal
4	5-1/2 qt	2.0 gal
4-1/2	6 qt	2.1 gal
5*	6-1/2 qt	2.3 gal
5-1/2	7-1/2 qt	2.7 gal
6**	2 gallons	2.8 gal

* - maximum for 2-gallon (8 quart) mash container

** - requires 10-quart mash capacity

After the Conversion Rest

If you are using the bucket system with the mash in a stockpot, you need to prepare the mash to run

and transfer the mash (*use oven mitts when retrieving the stockpot from the oven!*). Pour a couple of inches of hot sparge water into the undrilled bucket (*be sure pinch clamp is closed!*). Insert the drilled bucket. Then, using a ladle, transfer the mash to the assembled buckets. Do this step slowly and “quietly”, that is, don’t just dump and glop the mash into the bucket. Rather, scoop out some grist and liquid from the stockpot, lay the ladle on top of the contents in the bucket, then gently tip and “slide” the ladle out from under it. This will minimize introduction of air into the mash, which could lead to oxidation or staling down the road. You can carefully pour the very last bits of grain and liquid to complete the transfer.

If using the cooler, or you mashed directly in the buckets, simply remove the lid in preparation for the next step.

Recirculating

The next step in mashing is to recirculate some of the wort until it is clear. The wort initially has a lot of particles (husks, bits of grain, etc.) suspended in it, which we want to avoid boiling. By running off a little wort and transferring it back to the top of the grain bed a few times, eventually the particles become trapped in the upper part of the mash, allowing clear wort to run off into the kettle.

Always run off the wort *slowly*. The small diameter tubing used in these designs will help keep the runoff rate under control, as well as preventing air from becoming trapped in the tubing (which could oxidize the wort). Too fast a runoff will decrease extraction and increase the possibility of a *stuck mash*, which occurs when the grain bed collapses on itself and plugs itself up. This is especially important if you have a high percentage of huskless grain in the mash.

Hold a one- or two-cup measuring cup below the countertop surface, and place the end of the tubing in the cup so it reaches the bottom of the cup (fill from the bottom to avoid splashing the wort). Now open the clamp one click and allow the wort to collect slowly into the cup. It should take about one minute to drain two cups, so adjust your runoff rate if necessary by adjusting the clamping pressure. When the cup is full, close the pinch clamp, and *slowly and quietly* pour the wort back over the top of the mash. To avoid gouging holes in the grain bed, which can stir up debris and reduce your sugar extraction, place a plastic butter-tub lid or similar object on top of the mash to break up the return flow. I use a 6" diameter plastic needlepoint “canvas” from the arts and crafts store; it breaks the flow of water yet still allows it to pass through to the grain without as much splashing. Do this recirculation several times until the wort is relatively free of debris and has improved in clarity. It may not be crystal-clear and there may still be a few floaties in there, but that’s OK; recirculate until you see no more improvement.

Sparging Into the Kettle

Finally, it’s time to start filling up your brew kettle with all-grain wort! Simply run off the wort,

as slowly as you did while recirculating, into the kettle you will brew in. Be sure the tubing reaches the bottom of the kettle to avoid splashing the wort.

Tip: you can preheat your remaining brewing water during the mash rest, and place the end of the runoff tubing underwater when sparging so that the draining wort's exposure to air is minimized. This can also save time overall since you can overlap your water heat-up time with the mash rest. The amount of water to preheat should be the difference between your normal boil volume and the expected runoff volume from the Water Requirements chart presented earlier in this section. For example, if you normally boil 4 gallons of wort, and you mash 3-1/2 lb of grain, you can expect to collect about 1.6 gallons of wort, so your preheat water would be $4 - 1.6 = 1.4$ gallons.

As the level of liquid over the top of the grain bed drops close to the grain itself (1/4" to 1/2" above), ladle in some of the 170F (never more than 175F) sparge water. Try to maintain a fairly constant liquid level over the grain. If using the bucket system, be careful not to add water above the top of the *outer* bucket, to prevent overflow on the outside. Continue until all the sparge water is used up, then allow the grain bed to *slowly* run dry as the last of the wort drains into the kettle. A runoff rate of about four or five minutes per quart will help maximize the sugar extraction.

Tip: stop the runoff when you just see bubbles start to run out of the mash tun. This indicates the "practical" end of the wort runoff. If using the bucket system, prop up the edge of the bucket opposite from the stopper before sparging to get more of the last runnings. Don't worry about getting the absolute last drop out of the mash tun; the risk of hot-side aeration and the small amount of extra sugar may not be worth the extra effort.

That's IT!

Congratulations, you've just completed the "hard" part of your brew day! From this point on, it's familiar territory. Add the extract once the water is boiling (turn off the heat as you add the extract to avoid scorching), bring back to a boil, then add the hops and any other fermentable ingredients such as honey or sugar per the recipe.

Water Chemistry Management

If you used your usual brewing water for the partial mash, you will end up with a decent product. However, mashing and sparging can be somewhat sensitive to certain characteristics of your water, and Appendix V covers some things you might want to consider. But to create an optimum brew water without needing a chemistry set, there is a simple approach that only requires that you use distilled or reverse-osmosis (RO) water. By adding a small amount of extract to this "pure" water, the right conditions for mashing and especially sparging will be established.

Tip: Add 1 tablespoon of extract per gallon of distilled or reverse-osmosis (RO) water, to create water that is ideal for mashing and sparging. This way you can optimize the water chemistry without fussing with acids, salts, or pH measurements.

If you like to add brewer's salts to affect your water's characteristics, you can add them to the boiling wort rather than to the mash.

Other Keys to Success

Remember that there is more to successful brewing than just recipe formulation. The following is a review of some other factors you can work on to really make your beers shine:

Sanitation -- Review and improve your sanitation routines. Unsanitized equipment can cause off-flavors ranging from noticeable to totally ruining. Also, be sure to thoroughly rinse chlorine-based sanitizers, and allow iodine-based sanitizers to drip dry.

HSA (Hot-Side Aeration) -- This refers to the introduction of air (*aeration*) during the *hot side* of the process (mashing, sparging, heating, chilling, and boiling). Air (specifically oxygen) introduced into hot wort can react with wort compounds to oxidize wort or to predispose it to premature staling. Avoid splashing hot wort -- handle your mash gently without glopping it around, recirculate and sparge without splashing the wort into the receiving vessel. Wort over 80F or so should be considered to be susceptible to HSA.

Chilling -- Rapid chilling minimizes the available time for bacteria and wild yeast to take hold before the "good yeast" you pitched gets to work. It also prevents the buildup of DMS, a chemical created from substances found in malt that can leave a cooked-vegetable aroma and flavor. Wort should be at least partially uncovered when boiling to further reduce DMS buildup.

Wort Aeration -- Just before or just after pitching your yeast, be sure to introduce as much air or (better) pure oxygen into your CHILLED wort as possible. Yeast need ample free oxygen in order to maximize their health and vigor, decreasing lag time during which infections could set in. A number of methods from simple to complicated are detailed in most homebrewing books. This is the ONLY time wort should be intentionally aerated!

Yeast -- Try to use a starter if using 50 ml "smack-pack" liquid yeast cultures, instead of just dumping it straight into the wort. A starter is just a mini batch of beer with the sole purpose of multiplying the yeast. Pitching more yeast into well-aerated wort results in faster onset of fermentation (thereby inhibiting bacterial infection sooner) and fewer off-flavors in the finished product. Also, consider using dry yeast for some of your recipes. I've used dry yeast from Danstar and DCL with excellent results; use at least 10 grams and follow the directions on the package. This will give you adequate pitching rates without fussing with a starter. The main disadvantage is that the variety of the available dry yeasts is much more limited compared with liquid cultures.

Fermentation Temperature -- Arguably the Number 1 flaw with homebrew is a solventy, overly-fruity character caused by a too-warm fermentation. Lagers should be fermented between 45 and 55 degrees Fahrenheit, ales between 60F and 70F or so, certainly no warmer than 75F except in special cases. Set the fermenter in an insulated ice chest filled with water, in which you place frozen water jugs or “blue ice” to keep the water cool. Change the ice frequently to maintain a relatively constant temperature. Or see my web page⁴ for a “Fermentation Chiller” you can build yourself. There are a number of other tricks you can use to manage fermentation temperature that have been presented in the homebrewing literature.

Potential Pitfalls

Even though partial-mashing is not difficult once you get the hang of it, there are a few things that can get in the way of a smooth all-grain to extract recipe conversion and brew session. Let’s look at a few:

Gummy Mashes -- A high percentage (greater than 50%) of huskless (e.g., wheat) or flaked grains may cause a dense, gummy, non-porous grain bed, resulting in a “stuck mash”. To avoid this, be sure that more than half of your mash is husked grain. If you encounter a stuck mash during sparging, clamp the drain shut, stir the mash to loosen the grain, recirculate (to clear up the stirred wort), then resume sparging. Also, be sure to always maintain about 1/2" of liquid above the grain, to keep it buoyant.

Extracts have a Different Flavor than Grain -- Let’s face it, malt extract is a processed, prepared ingredient, so it’s reasonable to expect that it might produce different flavors than the “real” all-grain wort you make fresh at home. Also, you may be limited in choice when trying to match an extract to a particular kind of grain (Pilsner, pale ale, etc). Choosing the best brand of extract and trying to match the grain *type* as closely as possible are your best assurances that the flavors you obtain will be as “authentic” as possible.

Amylase Enzyme Powder -- I have to admit that as of this writing I have a beer in the NHC Second Round that was made with grains that were “mashed” by steeping in water with a little amylase powder added. True, you can convert starch to sugar with this stuff, but a little goes along way and can “over-convert” your grain to very fermentable sugar, robbing much of the character you were trying to achieve in the first place. If you follow the directions in this seminar, you shouldn’t need to use it.

Darker Color -- Even the lightest extract (reputed to be Alexander’s) will probably produce wort darker than the classic examples of Pilsner and other light-colored beers. This is due to many factors possibly including oxidation, aging, kettle reactions (especially in concentrated-gravity boils typical with extract brewers), and extract processing by the manufacturer. Keep in mind that an extract conversion of an all-grain recipe is likely to be darker than the original.

Sweeter or Drier Finish -- Extract-based worts can be more- or less-fermentable than their all-

grain counterparts. This is determined largely by the manufacturer and his processes. The table in Appendix I has some information on relative fermentability of various extract brands, and additional information can be found in Ray Daniels' book Designing Great Beers⁵. Keep your end product in mind when selecting extracts -- for example, if your beer is intended to be dry, don't use Laaglander, but if you're looking for a full-bodied, sweet finish, Laaglander might be a good choice.

Less Control over Wort Production -- As in the example above with the porter recipe, using the specialty extracts resulted in the "base malt" portion to be quite different than we would have liked, because of the munich and vienna malts used to make those extracts would lend a different character than the pale-ale malt in the original recipe. The more grain you mash yourself, the more control over the wort composition you have.

Hop Utilization -- The typical concentrated-gravity extract wort will not *utilize* (dissolve) as much bitter alpha acid from the hops, and so an extract beer brewed this way would be lower in bitterness than one brewed with a full-volume boil. As a start, figure on increasing your hops by 10% to account for this, if your wort boil volume is less than 80% of the final batch (recipe) volume.

Appendix I -- Malt Extract Database

The First State Brewers homebrew club of Delaware have posted this information on their web page at <http://triton.cms.udel.edu/~oliver/firststate/tips/maltext.html>. Oliver Weatherbee of the First State Brewers kindly granted me permission to reproduce the information here, and I encourage you to visit their web page as they have a lot of great tips and information as well as links to other brewing-related sites.

The following tables are an attempt to compile information from various sources in order to provide a better understanding of the characteristics and differences of the various liquid and dry malt extracts that are commonly used by homebrewers. These are base malts, I do not include kit beers here.

Please help us develop this database with additions, corrections, and comments (contact oliver@triton.cms.udel.edu)

There are several general recommendations for obtaining the best results when using malt extract:

- Use plain light extract and get color through specialty malts (steeping) and use hops for bitterness/flavor/aroma.
- Be aware of the amount of unfermentable sugars that might affect your finishing gravities. If you brew an American Pale Ale you wouldn't want to use something like Laaglander DME which has a high amount of non-fermentables and would be better suited to a maltier beer.
- It is often suggested that it is best to use a malt extract from the same area as the beer style you are trying to emulate, e.g. German extract for German or continental lagers. There are always exceptions.

Table Key:

- **Brand** - obviously the brand name. If available, there will also be an address of any related website for this company.
- **100% Malt?** - although this is no longer as much a concern as it used to be some extracts are said to contain non-malt derived sugars and we would like to identify those brands.
- **FG** - This is a relative ranking of how much non-fermentables are in this brand of extract. Those ranked "Low" will ferment dry (less residual sweetness) and have a lower finishing gravity than those ranked "Avg" (average) or "High".
- **Comments and Available Styles** - The types of extract available by this producer and general characteristics known about this brand. We would like to be able to provide such information as the grains used, taste characteristics, and color (Lovibond/SRM) ratings.

Liquid Malt Extract

<u>Brand</u>	<u>100% Malt?</u>	<u>FG</u>	<u>Styles and Comments</u>
Alexanders (<i>US</i>)	Yes	Low	High quality and very fermentable. Made with Klages 2 row. Often referred to as "neutral" i.e. no characteristics therefore will take on flavor of steeped or partially mashed grains.
<u>Unhopped extracts:</u>			
<ul style="list-style-type: none"> • Pale (100% Klages 2row; ~ 10 L - Reportedly lightest colored malt extract available) • Amber (2row +crystal) • Dark (2row +crystal +chocolate +other dark malt) • Wheat (60% wheat +40% 2row) 			
Bierkeller (<i>German</i>)	?	?	High Quality, often recommended for German lagers
<u>Unhopped extracts:</u>			
<ul style="list-style-type: none"> • Light • Amber • Dark 			
Blackrock (<i>New Zealand</i>)	?	?	
<u>Unhopped extracts:</u>			
<ul style="list-style-type: none"> • Light • Amber • Dark 			
Briess / Northwestern (<i>US</i>)	Yes	?	Conflicting reports as to whether this extract is made using American 6-row or 2-row malt.
Northwestern repackages Briess extracts www.nwextract.com			
<u>Unhopped and Hopped extracts:</u>			
<ul style="list-style-type: none"> • Gold (5-10 L) • Amber (10-15L) • Dark (15-20L) • Wheat (65% Wheat; 6-10 L) • Midwestern Light (80% barley, 20% rice; 4.8-8 L) 			

Coopers (Australia)	Yes	?	
<u>Unhopped extracts:</u>			
<ul style="list-style-type: none"> • Light • Amber • Dark 			
Edme (UK)	?		High Quality, very dependable.
<i>www.ip7.co.uk/edme/</i>			
		?	<u>Unhopped extracts:</u>
			• Light (3.7-6 L)
			• Amber (11-13 L)
			• Dark (18.2-30.3 L)
			• Wheat; (4.3-6.15 L)
		Low	• DMS (Diastatic - contains enzymes to convert starch into fermentable sugars and therefore good for hybrid steeping/partial mashes, light probably ≥ 5 L)
		High	• SFX (Non-diastatic and higher in dextrans, dark probably > 15 L)
		Med	• Maris Otter (100% Maris Otter 2-row malt extract; 4.3-8.6 L)
Geordie (UK)	Yes	Low	Relatively inexpensive, ferments dry.
<u>Unhopped extracts:</u>			
<ul style="list-style-type: none"> • Light • Amber • Dark 			
Glenbrew (Scotland)	?	?	
<u>Unhopped extracts:</u>			
<ul style="list-style-type: none"> • Light • Amber • Dark 			
Ireks (German)	Yes	?	High quality. Ireks Weizenbier is the only 100% wheat extract currently available.
<u>Unhopped extracts:</u>			
<ul style="list-style-type: none"> • Munich light • Munich amber • Weizenbier (100% Wheat) 			

John Bull (UK) Yes High Dextrinous but possibly less so than LaagLander.

Unhopped or Hopped extracts:

- Light
- Amber
- Dark

Marie's Munich (US) Yes ? This extract is available only through St. Patricks Homebrew Supply. Unhopped Munich extract (50% Munich malt (20L) and 50% lager malt)

Morgan's (Australia) Yes ?

www.morgansbrewing.com.au

Base Extracts: (all hopped ~ 15 IBU):

- Light Barley (100% "Pale Barley" malt, 3.5 EBC)
- Dark Barley (Munich and Light Crystal malts, 20.5 EBC)
- Wheat Malt (60% Wheat, 40% Pilsner malt, 5.5 EBC)
- Rice Malt (35% Rice, 65% Pale Barley Malt, 2.5 EBC)

Kettled Extracts: (Unhopped, made using 100% 2-row malts)

- Extra Pale (3.0 EBC)
- Pale (5.0 EBC)
- Amber (12.0 EBC)
- Dark (50 EBC)

Master Blends: (1 KG Specialty Blends)

- Beer Enhancer (2-row Pale extract, ***Glucose, and Honey***; 1.2 EBC)
- Lager Malt (100% 2-row Lager malt; 2.4 EBC)
- Caramalt (60% Caramalt and 40% Pale malt; 12 EBC)
- Dark Crystal Malt (60% Dark Crystal and 40% Vienna malt; 38.4 EBC)
- Wheat Malt (60% Wheat and 40% Pilsner malt; 3.2 EBC)
- Chocolate Malt (15% Chocolate and 85% Munich malt; 21.6 EBC)
- Roasted Black Malt (12% Roasted Black malt and 88% Munich malt; 50.8 EBC)

Munton & Fison <i>(UK)</i>	Yes	Med	Traditional favorite, one of the most consistent malts available. More fermentable than John Bull.
	No	Low	<u>Unhopped and Hopped extracts:</u> <ul style="list-style-type: none"> • Extra Light (Uses adjuncts to lighten color and body.) • Light • Amber • Dark • Wheat (55% Wheat)
Superbrau <i>(US)</i>	?	?	
<u>Unhopped and Hopped extracts:</u>			
<ul style="list-style-type: none"> • Light • Amber • Dark 			
Telfords <i>(Scottish)</i>	?	High	Dextrinous, recommended for Scottish ales.
<u>Unhopped extracts:</u>			
<ul style="list-style-type: none"> • Extra Pale • Amber • Dark 			

Dried Malt Extract

<u>Brand</u>	<u>100% Malt?</u>	<u>Available Styles</u>	<u>FG</u>	<u>Comments</u>
Briess <i>(US)</i>	Yes	Unhopped light, amber, dark, wheat	Med	Made from American 6-row.
Geordie <i>(UK)</i>	Yes	Unhopped light, amber, dark	Low	Relatively inexpensive, ferments dry
Laaglander <i>(Holland)</i>	Yes	Unhopped light, amber, dark	High	Lightest Color DME available. Also the most dextrinous
Munton & Fison <i>(UK)</i>	Yes	Unhopped or Hopped light, amber, dark, wheat (55% wheat)	Med	Traditional favorite, one of the most consistent malts available.

Appendix II -- Converting Grain to Extract: The Uncut Version

Different grains supply different amounts of sugar. In order to figure how much extract is equivalent to a given amount of grain, we must know how much sugar that grain is supplying to the wort. Associated with each type of grain is a figure called "potential extract", which tells how much sugar can potentially be extracted. This is given by the specific gravity contributed by one pound of grain in one gallon of wort. The Great Grain Issue of Zymurgy (1995 Special Issue) has a very comprehensive table of grain data, including potential extract. "Potential extract" is based on a 100% efficient laboratory-grade extraction process ("Congress Mash"). Most homebrewers achieve efficiencies in the range of 70% to 80% of these potentials.

To figure the conversion based on "exact" figures, the following method is used. If we define a unit of specific-gravity "points" as being the decimal part of the specific gravity, so that 1.045 is equivalent to 45 "points", then we can use the units of "points per pound per gallon" (pt/lb/gal), or how many gravity points one pound contributes to one gallon of wort, to describe extraction. The actual extraction is then the potential extraction times the efficiency:

$$\text{Actual Extraction points} = \text{Potential Extraction points} \times (\% \text{ eff} / 100)$$

Now we know how to calculate the amount of sugar contributed by each grain. All that remains is to figure how much extract is required to supply the same amount of sugar. This also can be tricky since not all extract syrups have the same gravity yield. However, a figure of 36 pt/lb/gal is a good average for liquid extracts if you don't know the actual number. Dry malt extract (DME) usually supplies 42 pt/lb/gal.

Now, the conversion factor (number of pounds of extract per pound of grain) is found by:

$$\begin{aligned} \text{Conversion Factor} &= \text{Actual Extraction points} \div 36 \\ \text{Conversion Factor} &= \text{Actual Extraction points} \div 42 \end{aligned}$$

You should find the conversion factor to be close to the "short answer" figures given earlier. The main difference here is that different grains will have different potential extract figures. Using this method can (theoretically) get you "closer" to the original recipe's balance. However, considering all the factors involved in the conversion, there are enough "unknowns" to make the simpler "one size fits all" method in the main text "good enough".

Appendix III -- Partial-Mash Equipment

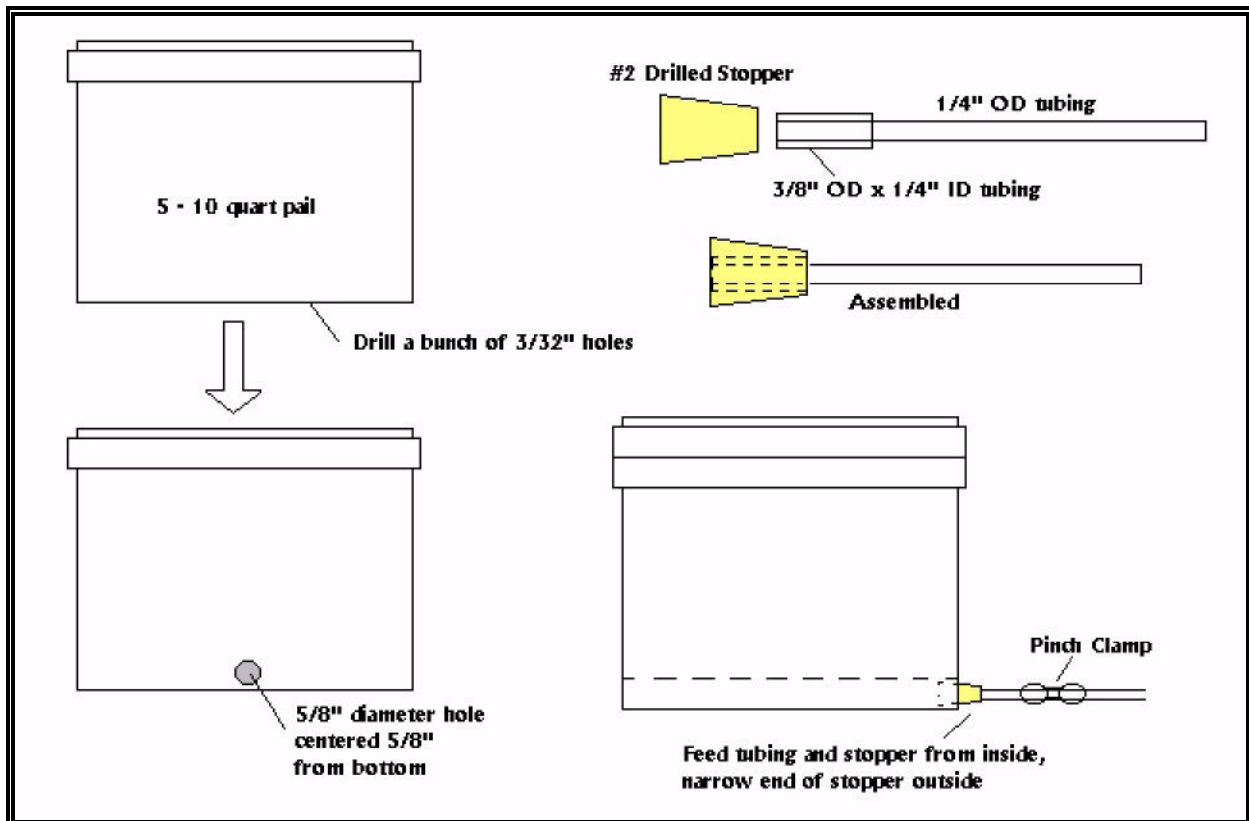
Detailed here are two designs for partial-mashing. The first uses two 2-gallon or 10-quart buckets (I got two 10-qt buckets from Builder's Square, and two 2-gallon buckets from my local homebrew supply store). Whichever buckets you choose should have straight sides and flat bottoms, and there should be a gap of one to two inches between their bottoms when "nested" together. The second uses an Igloo Legend 2-gallon beverage cooler. The bucket design is very simple, and quick & inexpensive to rig up (about \$10), but it requires that you manually maintain the mash temperature in a separate stockpot and transfer the mash to the buckets for sparging. The Igloo design is self-contained as it will do a fair job of holding temperature, but it is a bit more complicated and somewhat more costly to build (about \$20). Either unit will give you excellent performance when used with careful technique.

The bucket design is similar to the full-size unit popularized by Charlie Papazian in "The New Complete Joy of Homebrewing". It consists of two plastic buckets nested together such that there is a space between their bottoms. The inner bucket's bottom is drilled with numerous holes, and the outer bucket has a single large hole drilled to accommodate an outlet. The inner bucket serves as a "false bottom", a strainer which in conjunction with the grain forms a nice filter for running off clear wort. The hole in the outer bucket is sealed with a drilled #2 stopper which has a length of tubing stuffed in it; this along with a simple pinch clamp serves as a controlled wort delivery system to your kettle. Two 5-quart buckets can be used to comfortably hold 3 lb of grain and a gallon of mash water; a 2-gallon version holds 5 lb grain and 7 quarts of mash water. Two 10-quart buckets will allow you to mash 6 lb of grain with two gallons of water. Considering it typically takes 10 lb of grain to brew a full 5 gallons of a 1054 wort, you can see that it is simple to get up to half of your fermentables from grain *without* complicating your extract brewing setup.

You'll need two small buckets as described above, a #2 drilled rubber stopper (the size that fits into the mouth of a 12-ounce bottle), a 2" length of 3/8" OD by 1/4" ID vinyl tubing, a 3-foot length of 1/4" OD vinyl tubing, and a pinch clamp. You'll also need a drill with a 3/32" bit and a 5/8" wood-boring blade bit (or some other way to make a *clean, accurate* 5/8" diameter hole in the bucket).

1. Drill a *bunch* of 3/32" holes in the bottom of one bucket. Drill *LOTS!* Space them more or less uniformly around the entire bottom surface. Remove the handle from this bucket.
2. Drill a 5/8" hole in the side of the other bucket centered 5/8" from the inside bottom, using flat wood-boring bit (or a sharp hobby knife) to get a *clean, round* hole.
3. Cut a 1" length of 3/8" OD x 1/4" ID vinyl tubing, and fit it flush over the end of the 1/4" OD tubing. A little food-safe silicone sealant smeared on the outside of the 1/4" tubing will lubricate and seal the connection.
4. Insert the 3/8" OD end of the tubing assembly into a #2 rubber stopper, flush with large end and sticking out small end.
5. Insert tubing and stopper assembly from *inside* of second bucket through the 5/8" hole (installing it in this direction prevents accidental unplugging of the stopper!). Press firmly

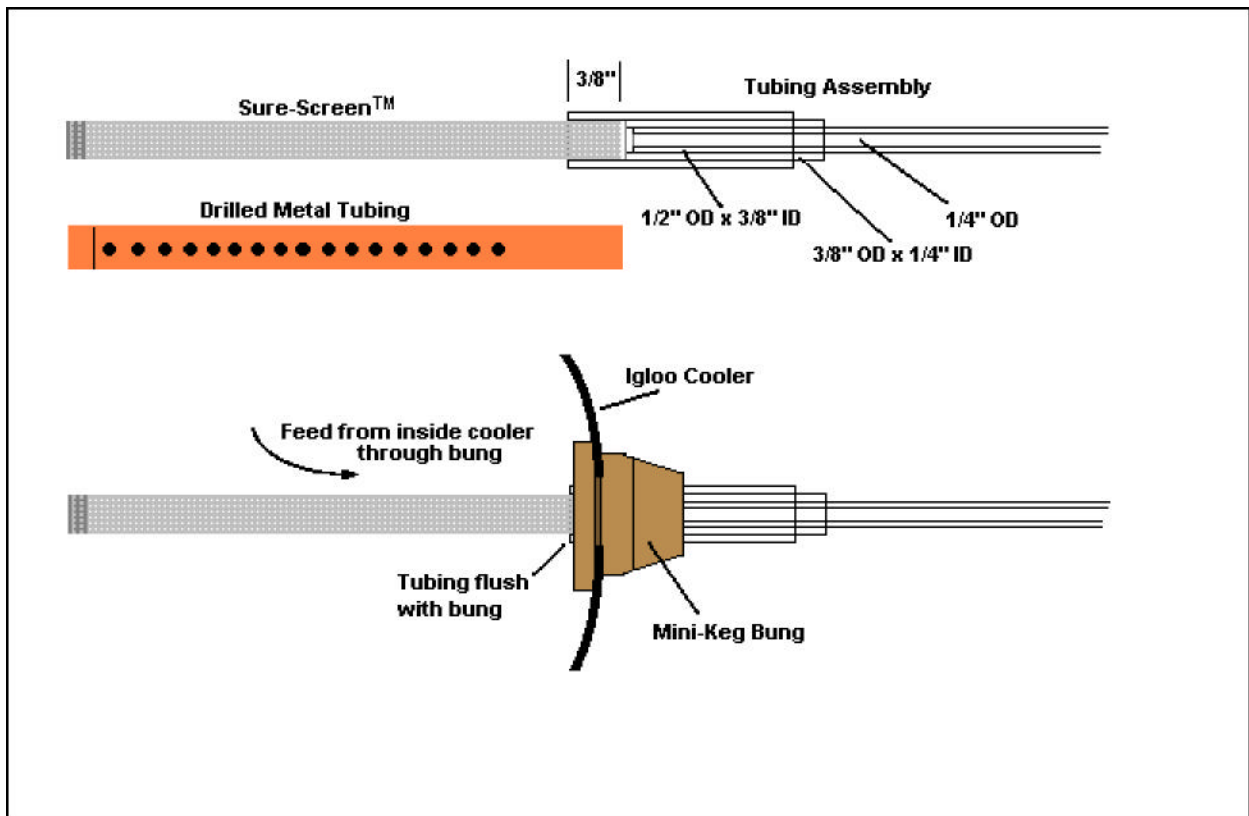
- into hole to seal, about halfway or so.
6. Place first (drilled) bucket inside second bucket. The inner bucket should not hit against the stopper.
 7. Install a plastic pinch clamp on the tubing for flow control.
 8. You can store the stopper, clamp, and tubing in the space between buckets (to prevent losing them), and the handle that you left on the outer bucket makes it easy to carry.
- For the Igloo partial-masher, you'll need an Igloo "Legend" 2 gallon (7.6L) beverage cooler, a



rubber mini-keg bung (available at most homebrew shops), a 1-1/2" length of 3/8 ID x 1/2" OD vinyl tubing, a 1-1/4" length of 1/4" ID x 3/8" OD vinyl tubing, a three-foot length of 1/4" OD vinyl tubing, a pinch clamp, and a Sure-Screen™ from Sheaf & Vine (ask your homebrew supplier or see <http://www.brewinfo.com/brewinfo/surescreen.html>). This pre-welded rolled stainless steel screen is sturdy and is ideal for this application. Or, you can substitute a 5-1/2" length of 3/8" OD copper/brass/stainless/aluminum tubing crimped shut at one end and drilled through with 3/16" holes every 1/4" (start 1" from the open end). Also, any insulated cooler with a 7/8" diameter spigot hole will work with the mini-keg bung if you can't find the Igloo Legend.

1. Remove the factory-installed spigot from the cooler.
2. Remove the hard plastic plug from the bung and install the bung into the spigot hole, with the large flat end facing inside the cooler. Work the bung into position so that the groove

- around the bung “locks” around the edge of the hole.
3. Insert the open end of the Sure-Screen™ or copper tube 3/8" into the open end of the 1/2" OD tubing. This will be a tight fit but that's what we want.
 4. Insert the 3/8" OD x 1/4" ID tubing into the 1/2" OD tubing. Use some food-safe silicone sealant to lubricate and seal the connection.
 5. Insert the 1/4" OD tubing into the 1/4" ID tubing, again using silicone sealant.
 6. Feed the assembly, 1/4" tubing first, through the bung from the *inside* of the cooler. Work the assembly in so that the end of the vinyl tubing is just flush with the end of the bung inside the cooler. Use pliers to *carefully* pull the tubing from the outside if you must, gripping only the 1/2" OD tubing, to position the assembly.
 7. The bung will continuously press inward on the layered tubing as well as on the Sure-Screen™ or metal tubing, sealing the connections for leak-free mashing.



Appendix IV -- References and Further Reading

Cited References:

1. Mary Anne Gruber, Briess Malting Company, personal communication, 5/22/98
 2. Charlie Papazian, The New Complete Joy of Homebrewing, Avon Books, NY, NY, Second Edition, pp. 289-291
 3. <http://triton.cms.udel.edu/~oliver/firststate/tips/maltextract.html> (also see Appendix I for a transcript)
 4. <http://home.elp.rr.com/brewbeer>, my web page
 5. Ray Daniels, Designing Great Beers, Brewers Publications, Boulder, CO, 1996, pp. 11-18
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Here is a short list of other information you can check out related to this seminar:

Web Sites:

<http://www.morgansbrewing.com.au>, Morgan's Brewing
<http://www.briess.com>, popular American maltster, lots of data on various grains
<http://www.brewsupply.com>, malt analysis data (see "Grain Profiles").
<http://www.conbev.com/index.html>, Moray Firth / Beeston Malting Company
<http://www.paulsmalt.co.uk>, Paul's Malts
<http://www.EDME-beer.com>, Edme
<http://www.nwextract.com>, Northwestern
<http://brewery.org>, The Brewery, homebrewing information site

Publications:

1995 Special Issue, Zymurgy 18 (4), American Homebrewers Association, Boulder, CO, 1995
Brian Dixon, "Tools for Recipe Conversion -- All-Grain to Extract, Extract to All-Grain",
Brewing Techniques 6 (2), New Wine Press, Inc., Eugene, OR, March/April 1998, pp. 42-51
Al Korzonas, Homebrewing Vol I, Sheaf & Vine, Palos Hills, IL, 1997
Dave Miller, The Complete Handbook of Homebrewing, Storey Communications, Pownal, VT,
Sixteenth Printing, 1994, pp. 102-106

Appendix V — Water Chemistry & Optimizing your Mash

If you performed the mashing steps described above with tap or bottled water, you should end up with a decent product. You can however improve even further on your beer by taking simple steps to consider the chemistry of the water you use for mashing and sparging.

There are two somewhat overlapping aspects of mashing that deserve special attention. One is the chemical makeup of the *mash* water and its impact on mash conversion efficiency. The other is the chemical makeup of the *sparge* water and its potential to extract harsh compounds from the grain.

Practically any water you normally would use for brewing should be suitable for mashing. The exception would be pure distilled or RO (reverse-osmosis filtered) water. Using pure water in a mash results in the *pH* of the mash being somewhat higher than optimum. pH is simply a measure, on a 14-point scale, of the mash's relative acidity ($\text{pH} < 7$) or alkalinity ($\text{pH} > 7$). Mash enzymes are most effective when the pH is around 5.3 or so. A pure-water mash will probably end up closer to 5.8. How can you optimize this without complicating your life?

One way is to add calcium to the pure water. Calcium reacts with the mash to lower the pH to the correct range. One source of calcium is good ol' gypsum. Simply add $\frac{1}{4}$ teaspoon of gypsum to each gallon of distilled or RO water used for mashing. This should get you to the correct level of calcium. If using tap water, you probably have enough calcium in it already, but you can add the gypsum if you wish, just to be "sure".

The downside to using gypsum is that it also adds sulfate, which can harshen hop bitterness in some cases. You can use calcium chloride (CaCl_2) in the same amount to avoid going overboard with sulfate. Calcium chloride is a bit harder to find than gypsum, but more and more brew supply shops seem to be carrying it, and your local supplier can probably order you some.

*But Wait -- There's an even **SIMPLER** way!*

Another even simpler method, which avoids these hassles, is to simply add 1 tablespoon or so of malt extract to each gallon of distilled or RO water you use! The malt extract acts as sort of a "snapshot" of the chemistry of the mash it was created from, and enough of this chemistry "comes over" with the extract to set an optimum pH without fussing with salts or acids. Note that adding extract to tap water probably won't have the same effect since the minerals and alkalinity in tap water (which are absent in distilled and RO water) will counteract the ability of this small amount of extract to set the right pH. Be sure to use only RO or distilled water when using this method.

The concern over pH is especially important when sparging, as water of pH 6.0 or higher can extract astringent flavors from the husks. Note that adding gypsum or calcium chloride to water *does not change the water's pH*; it simply provides calcium which chemically alters the *mash's* pH. Thus, adding these salts to *sparge* water will *not* set the correct pH. Adding extract,

however, *does* alter the pH of pure water and therefore can be an extremely simple yet effective tool to optimize your brewing water.

Even if you decide to use tap water for mashing, I strongly recommend that you use distilled water plus extract for sparging. This will ensure that you set the correct pH conditions without hassling with acid adjustments and pH measurements. And as long as you're using distilled water plus extract for sparging, why not use it for mashing as well?

Of course, you *can* add lactic or phosphoric acid to the sparge water to set its pH, but this requires careful measurement with a pH meter or good-quality pH strips and again complicates your brewing. It's so much easier to just add a little malt extract to distilled water!

Tip: Add 1 tablespoon of extract per gallon of distilled or reverse-osmosis (RO) water, to create water that is ideal for mashing and sparging. This way you can optimize the water chemistry without fussing with acids, salts, or pH measurements.

No matter which approach you use for water chemistry management, *always* use chlorine-free water for brewing to prevent off-flavors. Since more and more municipalities are using chloramines instead of free chlorine to disinfect tap water, a charcoal filter (faucet-mount, undersink, or even in the refrigerator water line) is a *must* for brewers using tap water; the old boil and stand method is much less effective with these new additives.

Finally, if you like to add other brewing salts to your brew to emulate various water styles of the world, you can add them all into the boiling wort after mashing. As long as you've taken care of the mash and sparge chemistry using pure water and extract, the brewing salts will not be necessary in the mash (in fact, adding too much chalk or baking soda to the mash will actually *hinder* optimum conversion).