SINGLE DECOCTION

Defining Basic Decoction

Decoction in its simplest form is the scooping-up of a certain volume of mash slurry (grain and wort together), boiling separately, and then returning it to the mash tun. That's it. This will raise the overall temperature of the mash, add unique flavors via maillard and maltose caramelization as well as add a few other benefits. The word decoction literally means "to return cooked" so in brewing it is the returning of cooked mash back to the mash tun. This document is designed to illustrate the steps required to perform a simple single decoction and presumes you have already performed the initial dough-in.

The Importance of Decoction: A Cool Historical Look

Decoction has been around for a *very* long time. The Sumerians used decoction to make "strong" beer (kas-kal[1]). The use of beer permeated every aspect of Sumerian culture so they had quite a bit to say about it. They had wheat beer, barley beer, golden beer, red beer, light beer, dark beer, sweet beer, beer bread, breweries, beer halls, and detailed cuneiform descriptions on method including malting, roasting, and decoction (ì-áb-sè-ga and šeg[2]). It is interesting to note that Sumerian culture existed over 5500 years ago, (3000 - 3500 B.C.), and that their language predates dynastic Egyptian proto-hieroglyphics (3200 B.C.). Sumerian beer making predates pre-Hellenic and Etruscan viticulture by 2500 years. The point being that the benefits of decoction, (and beer), were discovered very early in recorded history and it has been validated as beneficial and carried forward ever since. Of these benefits there are two that stand out[3]. First, decoction adds flavor and darkens color. This is the result of caramelized maltose and Maillard compounds. Second, decoction improves the efficiency of the mashing process by opening up grains for greater conversion. The ancient Sumerians did not measure the increase in maltose, (as far as we know), but they knew boiled mash created great flavor and resulted in a better yield. The continental Europeans also 'discovered' decoction, (of course this was thousands of years later). The pinnacle of use for decoction appears to be in Trappist Belgian ales. It is no wonder that Belgian ales are consistently rated the finest in the world[4]. Decoction plays a role in many of these world class ales.

First Step: Calculating Decoction Volume

The temperature to which we raise our mash using decoction is governed by the decoction volume itself. There is a basic formula for this. At this stage all we're looking for is a simple

[1] Halloran, John, "Sumerian Lexicon", © 1996, p. 109.
[2] Ibid. p.102 & p.26 respectively.
[3] Mosher, Randy. "Radical Brewing", Brewers Publications, © 2004, pp. 108-110.
[4] Hieronomous, Stan. "Brew Like a Monk", Brewers Publications, © 2005, pp. 78-79.

percentile based on a current temperature and the temperature to which we wish to raise our mash. No measured volumes are needed at this point. We're only looking for a percentage, a factor if you will. The next step is to get the actual volume of decocted mash to remove in order to make this formula work in the real world. We will need to solve for the percentage of the total mash volume first. In the formula below we solve for xVolPercentile:

$$\text{xVolPercentile} = \frac{\text{nTargetTemp} - \text{nCurrentTemp}}{\text{nBoilingTempConstant} - (\text{nCurrentTemp} - \text{nTempLossEstimate})}$$

$$\text{xVolPercentile} = \frac{147\text{F} - 122\text{F}}{210\text{F} - (122\text{F} - 3.5\text{F})}$$

xVolPercentile = .2732 (or 27.32%)

So, in the end, the total decoction mash volume *percentile* will remain the same across increasing batch sizes. For the given input variables the outcome will become a constant assuming no changes to equipment, factors, and heat loss. It is important to note that as you increase the heat loss variable, (nTempLossEstimate), the calculated decoction volume will rise to compensate.

Second Step: Calculating Total Mash Volume

Now that we have the percentage of decoction mash calculated, we also need to have a total mash volume to apply it for an actual volume of mash to scoop out. This total mash volume can be calculated with the grain weight and the dough-in water volume:

For example 12 lbs of grain + 6.0 gallons of water will equate to the following, (assuming Palmer's volume factor of nGrainVolFactorPerPound = 0.078 or 9.984 fluid oz/lb):

xTotalMashVolume = (nGrainWeight * nGrainVolFactorPerPound) + nInfusionVolH2O
xTotalMashVolume = (12.5 * *0.078*) + 6.0 [0.078 *Palmer's grain factor volume/lb*]
xTotalMashVolume = 6.975 gallons

Third Step: Calculating Decoction Volume

Using the decoction percentile we discovered above in the first equation, we follow the sample to completion by multiplying it with the total mash volume we just calculated to arrive at our decoction volume:

xDecoctionVolume = xTotalMashVolume * xVolPercentile
xDecoctionVolume = 6.975 * 0.2732
xDecoctionVolume = 1.91 gallons

This is a process of determining how much mash we need to remove and boil for a single decoction. To simplify this we can put together a spreadsheet that accepts variables for water volume, grain weight, temperatures, and temperature loss estimate, and it will return decoction volumes on the fly (see Table 1.0 below):

MASH DECOCTION CALCULATOR

FACTORS	VARS
ENTER Water Volume	6.00
ENTER Total Grain Weight	12.50
Grain Volume Factor	0.078
Total Mash Volume (gal)	6.975
ENTER Mash Start Temp (F)	122
ENTER Target Temp (F)	147
Boiling Temp (F)	210
ENTER Heat Loss Factor (-F)	3.50
Fraction of Total Mash	0.2732
Decoction Volume (gal)	1.91
Decoction Volume (quarts)	7.62
SIMPLE DECOCT VOL (0% THERMAL LOSS)	1.98

Table 1.0

A Simple Decoction Step-by-Step

1. Note the grain bill total weight to be used in the first rest
2. Note the initial mash water volume to be used
3. Calculate total mash volume and add 10% volume[5]
4. Note current mash rest temp
5. Note target mash temp
6. Calculate the decoction mash volume to boil
7. Remove and boil decoction mash + 10%
8. Carefully return boiling mash back to the main tun until target temp is achieved
9. If there is remaining mash, cool it to target temp and return remainder

[5] Thermal loss, ambient room temperature, time moving mash from decoction kettle to mash tun all play havoc on 'exact' temperatures. It is always recommended to add an additional amount of decoction volume so the re-entry of mash to the tun can be varied until the target temperature is reached. Then if there is remaining mash to return it can be cooled to exact temperature and returned.

Or

1. Plug in the numbers to your spreadsheet to get the decoction mash volume
2. Perform decoction as above

A decoction of this small size takes a variable amount of time to bring to boil based on the heat source and boil-kettle heating surface. After the completion of the first rest the decoction process begins. Have a pan ready that can handle a minimum of twice the volume you are boiling. Scoop the decoction volume amount out and put it into the boil pan. When the decoction comes to a boil you can return it to the mash tun or let it boil longer depending on your preference of flavor and color. If you do not have agitation of some sort it is recommended that you stir the decoction mash to keep it from burning. When the boiled mash has been returned to the mash tun, measure the target temperature. If the temperature is low then make a note to raise the Heat Loss Factor variable the next time. If it is high then lower the Heat Loss Factor variable. Keep good records of ambient temperature, tun size, mash size, and kettle sizes. These will play a role in zeroing-in on the exact heat loss factor for ideal decoctions with specific equipment.

Conclusion

A decoction mash can be enhanced into multiple rest steps, varying boil temperatures and durations, charring, crash deglazing[6], or a combination of any or all of these techniques. However, every decoction begins with the basic decoction principles outlined above. Becoming comfortable with performing decoction is the first step. The mistake most make in their first decoction is worrying about over-timing the first rest from which the decocted mash is taken. This concern can lead to a frenetic rush which can lead to mistakes (I can attest to this). It is very calming to note that a beta glucan or protease rest that goes over 15 or even 30 minutes will have no detrimental effect on your ale. As a trial run, a brewer can use old grains to practice the process before using a premium grain bill.

[6] "Crash Deglazing" in a decoction is the pre-heating of the decoction kettle beyond the maltose caramelization temperature, (356F), in order to create a very slight charring and subtle caramelization of the mash on impact. This "crash" creates a unique flavor that pairs well with many Belgian style ales including Westvleteren 12.