



Author: David Kapral  
Founder/CEO: Brewing Consulting Services, LLC  
Nationally known, Award-winning Brewmaster and Lecturer

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## MILLING

My editor has informed me that we have (apparently) made it through the Projected Mayan Doomsday, so we cautiously welcome you to topics on Practical Brewing for 2013 (in case they missed the date)! Our first topic for the year is about the practical aspects of **grains milling**. Most of this discussion centers on milling for standard mash tub and lauter tub operation. It is also oriented toward craft brewers and others having deep grain beds and brewers making a wide variety of products. In simplest terms, milling prepares the grain for mashing by exposing the starchy endosperm of the malt kernel for enzymatic action in the mash tub. Finer grinds are supposed to provide faster mashing cycles while coarser grinds “may slow the mashing process but may be beneficial to wort separation”.

Beyond the simple purpose of milling lies a great variety of sophisticated offerings. Vendors offer “malt conditioning” upstream of the mills to improve lautering by expanding the husk. Other vendors offer wet mills to reduce oxidation and explosion potential. CO<sub>2</sub> blanketing is offered for mills and scale hoppers to reduce oxidation and explosion potential. Mash filters are quite different. The grist for **mash filters** is usually very fine and is prepared with hammer mills. The extreme fine grind shortens mashing cycles while the mash filter aggressively separates the wort from the spent grain bed, increasing throughput and efficiency. Reduction of oxidation potential with an extreme fine grind is a concern. Vendors, such as Meura, have addressed through thoughtful design. Grist Profile: We measure the milled grist by using **U.S. standard sieves** and a **sieve shaker**. Sampling provides us with an **analytical method** to evaluate mill grinds.

- Why evaluate the grist?
  - Brewers will follow standards they put in place or that “others” specify.
  - Milling standards YOU follow should support your process objectives! Changing the grist profile can have an identifiable cause and effect relationship.
  - Having a record of grist profile shows mill repeatability or points to problems upstream.
- Selection of “full height” sieve trays and 12inch diameter sieves is most helpful!
- The brewing industry uses up to seven sieves, plus a pan. Six sieves are common. Four is less common. In this writer’s opinion, seven sieves are very desirable for evaluating grist used for lautering. At a minimum, consider having the #10, # 18, #30, #100 and the pan. New sieves and a matching shaker are available from companies such as Seedburo. Used equipment can occasionally be found e-bay.



**Table 1: U.S. Sieves**

## U.S. Sieves Commonly Used In the Brewing Industry

| U.S. Sieves... Common Brewing Selections |                                      |                                      |
|--|--------------------------------------|--------------------------------------|
| U.S. Std Sieve#                          | Sieve Opening<br>Dimensions (metric) | Sieve Opening<br>Dimensions (Inches) |
| #10                                      | 2.00 mm                              | 0.079                                |
| #12                                      | 1.70 mm                              | 0.067                                |
| #18                                      | 1.00mm                               | 0.039                                |
| #30                                      | 600um                                | 0.023                                |
| #60                                      | 250um                                | 0.010                                |
| #100                                     | 150 um                               | 0.006                                |
| <b>PAN</b>                               | none                                 | none                                 |

From [www.Seedbuero.com](http://www.Seedbuero.com) online catalog

### Sieve Shaker with Seven Sieves and a Pan:



From [www.Seedbuero.com](http://www.Seedbuero.com) online catalog

### Sieve Sampling Basics:

- Clean the sieve screens and pan. Empty the sample tube before grabbing the sample
- Grab about 100 to 120 grams of grist, but do not overflow the sample tube.
- Drop sample onto Kraft paper or equivalent collection surface, and transfer to the top screen of the shaker. Use a brush to get the entire sample. The reason for using a full height sieve screen or 1 inch diameter screens becomes immediately clear during this step.
- Close the device and turn it on. Shake for about 8 minutes
- Weigh contents of each sieve and the pan contents and calculate percentage. Double check to assure that the percent total of all sieves and the pan actually equals 100%.



**Table 2: Three Grind Samples.**

The table below shows grind samples from two operating plants and the MBAA recommended particle distribution.

| US Sieve #    | Brewery # 1<br>Coarse Grind<br>Actual | Brewery #2<br>Coarse Grind<br>Actual | MBAA<br>Recommended Grind |
|---------------|---------------------------------------|--------------------------------------|---------------------------|
| #10           | 23.68%                                | 50.00%                               | 13.00%                    |
| #14           | 33.90%                                | 19.20% *                             | 20.00%                    |
| #18           | 20.53%                                | 12.00% *                             | 32.00%                    |
| #30           | 10.53%                                | 8.00% *                              | 24.00%                    |
| #60           | 6.23%                                 | 6.50%                                | 6.00%                     |
| #100          | 2.08%                                 | 1.70%                                | 2.00%                     |
| PAN           | 3.05%                                 | 2.60%                                | 3.00%                     |
| <b>Totals</b> | <b>100.00%</b>                        | <b>100.00%</b>                       | <b>100.00%</b>            |

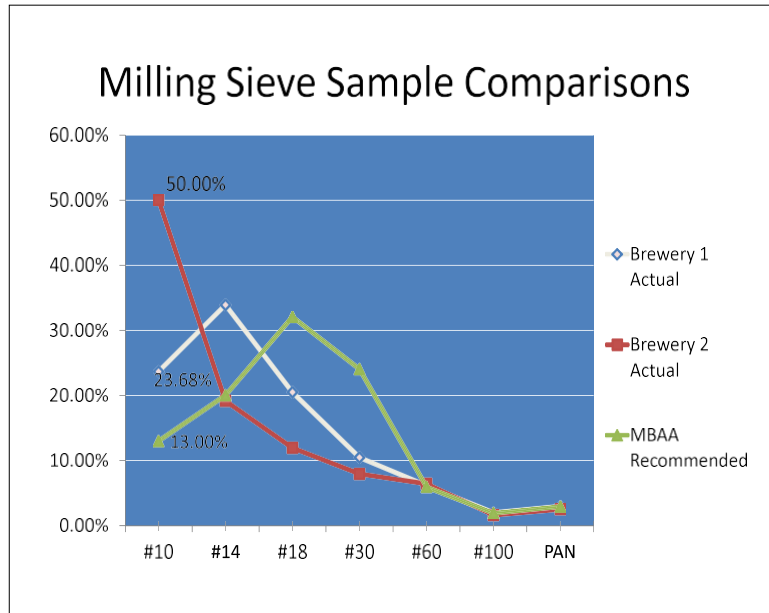
\* Extrapolated visually

Brewery # 2 data courtesy of DFH Craft Brewery

Brewery # 1’s grind is coarse. It was developed as part of an effort to increase throughput (capacity). The grind changes helped shorten the cycle time from 165 min to 150 minutes, while simultaneously increasing the brew size from 690 bbl / brew to 920 bbl / brew. Additionally the *net-to-cellars* yield was increased from 88.5% to 92%. Coarsening the grind was important but it was only one of many enablers leading to the project’s success.

Brewery # 2’s grind is exceptionally coarse. 50% of the sample weight on the # 10 Screen. The sample contained **no** whole or un-milled grains. This mill setting was for a product with a heavy grain bill and a deep bed in the tub. The coarse particle distribution enabled a reduction in runoff time from 145 minutes to 107 minutes without losing yield. The yield was maintained by making adjustments in sparge control.

**Table 3: Graph of Particle Distribution on Sieve Screens**



**Using Mill Settings:**

In our world of brewing, we have to look at milling as a tool we can use to meet defined brewing objectives. As part of this, we have to understand and justify why we mill to certain specifications and why this may vary by grain type. Further, we need to be aware that there are forces affecting our ability to mill properly that can negatively influence flavor, sanitation, runoffs, and balling of our wort! Negative impacts are opportunities in disguise. We use them as justification for projects that will improve our processes and help us meet objectives.

We refer to using milling as a tool to support objectives. Specifically we can create grists that may help achieve better **flavor**, meet **RDF targets**, and meet **brewhouse capacity targets**.

- **Flavor:** Work with flavor matching has shown that darker malts benefit from a coarser grind to prevent harshness and astringency in wort and beer. The impact of this is that some brewers use two mills, with one at a very coarse setting for the dark malt fraction. Harshness and astringency are sensory impacts easily indentified in wort and can carry over to the finished product.
- **RDF:** The right milling profile can help us meet RDF targets in the mash tub. A coarse grind can compensate when using a protein-rest mashing scheme, particularly when a mash tub has a slow temperature ramp rate or programming that affects the ramp rate negatively.
- Meeting Brewhouse **Capacity** and **Yield** Targets:



- A coarser grind is one enabler of faster run off with fewer cuts. Proper mash conversion, wort temperature, sparge water temperature, rake height and rake rotation rate are other key factors we need to control in order to minimize the cycle time.
- Yield can likely be maintained or improved with attention paid to the factors mentioned above, and other factors such as sparge start timing, water to grain ratios, using meters for water chases along with other adjustments.
- The brew kettle cycle is usually the longest cycle of all and can be the limiting factor for throughput. By making adjustments to milling we have an enabler for faster throughput in both lautering and kettle operations. By making other process adjustments such as those mentioned above we can potentially fill the kettle faster, thereby potentially shortening its cycle. The writer is aware that there are other factors at work, such as single steam lines servicing the brewhouse at some plants.

What can go wrong? Milling adjustments are not always the answer. Sometimes there are issues upstream of the mill affecting our grain:

1. Grains Unloading Systems: Our unloading system and elevation system should deliver malt to the mill intact and in as good a condition as it arrived in the truck or railcar. We do not want malt 'pre-milled' by the unloading or elevating equipment. When this happens, we generate a lot of dust, increasing losses and we find that silos may plug and even deliver lower balling wort as the silo level nears empty. One brewmaster, new to our plant, wanted to know how much we adjusted the grain bill as the silo emptied. His question was based on experience in another brewery with a particularly rough pneumatic system. That plant increased the grain weight set points to account for the increase in damaged low yield malt husks as the silo emptied. Our plant had a mechanical unloading and elevating system that delivered the malt to the mill very gently, without damage, and no adjustments to the grain bill were required as silo levels fell. If considering adding a malt conditioning system be aware that its success depends on processing **intact** grain kernels.
2. It is desirable to have mill sampling capabilities. Cost sometimes drives mill selection, and a mill without sampling capability can save a few dollars on upfront costs. A consistent grind influences repeatability, yield, balling and other parameters. Regardless of how many rolls the mill has, it is desirable to know what it is doing and that the performance is repeatable. Our process depends on this (and other operational factors).
3. Breweries with dry mills frequently pre-grind malt for the first brew following a shut down. Sometimes this is done 8 hours or more in advance of mash in. Under these circumstances, the ground malt is subject to oxidation and it can pick up moisture from the air, especially in high humidity areas. This came to light in one plant when the brewer asked which scale hopper weight should be officially recorded: the originally ground weight from the midnight grind in or the much higher weight at mash in time (9 AM). Not only did the weight increase under



these circumstances but also the scale hopper did not drop properly and needed to be beaten to start flow. We changed the procedure but it would have been interesting to see if the first brew set tasted different from the subsequent sets. It is recommended we follow a 'just in time' milling regimen.

4. The malt itself should be inspected and tasted as it arrives. Probe samples can be helpful to assure uniformity throughout the container. Look for fine/coarse differences, friability and fresh taste.
5. Replace flow control valves on the discharge of pumps with variable frequency drive control on the pump where pumping mash. The FCV's can damage your precisely ground malt resulting in additional cuts during wort separation.
6. Understand your mash tub operating parameters and the cause and effect relationships with milling. We want to minimize damage to the malt which can happen in a mash tub under certain circumstances.
7. Milling to different gap settings can be useful based on the type grain being milled. Larger dry mills may have 'delineators' which can automatically adjust the gap to the grain type. Dark malts generally should be ground coarsely to avoid development of harsh astringent characters. For this reason, plants using wet milling often have a separate dry mill their dark grains fraction for Porters and Stouts, adding the dry milled dark grains to the mash tub separately.
8. Mill rollers wear out with use. They can become non-parallel if adjustments are made externally without feeler gauge checks. As rollers wear, they cannot achieve the desired grind profile. They will need occasional resurfacing by the OEM. Use feeler gauges to assure the following:
  - Verify rolls are **evenly parallel** across the entire surface width, not canted /biased. Some mills have external adjustments to set gap width, but confirmation of parallel settings is only truly accurate with a feeler gauge. Training can be arranged.
  - Verify if rolls have **uneven openings**, usually in the center, indicating wear
  - Verify that the feed rollers or feed baffle is feeding across the entire width of the rollers. This can often be done visually without a gauge. This helps assure uniform wear on the rollers.
9. **EXPLOSION DANGER! Malt dust is explosive.** It is desirable to have a malt cleaner with magnets that are regularly cleaned! The malt cleaner can remove stones and trash while the magnetic section can remove some trash metals. Inspect the cleaner discharge regularly. Clean the magnets regularly. **Verify the dust collection system is properly functioning to avoid explosive conditions.**





In summary, managing the mill grind is an important contributor to our brewhouse success. Mill grind contributes to achieving the right RDF, the right wort flavors, colors and ballings and in addition, the right grind sets the stage for repeatable yields and process throughput. Other systems and factors sometimes prevent us from using milling as a tool for process control.

Keep the mill and correct the other problems where possible, though sometimes replacing the mill is the right answer.

*David Kapral*

Brewing Consulting Services, LLC

[www.davidkapral.com](http://www.davidkapral.com)

If you would like to discuss any aspect of this article or if you would like to engage the assistance of David Kapral of Brewing Consulting Services, LLC or Edward Michalski of PRO Engineering and Manufacturing, Inc., please contact either or both gentlemen using the contact information listed below.



**David Kapral, Founder of  
Brewing Consulting Services, LLC**

The author, David Kapral, has over thirty years of brewing experience. Some of his credentials are:

- Experienced Brewmaster, with 8 years consulting experience to craft brewers across the U.S.
- Beer Steward Certification Trainer for the MBAA
- Practical Brewing lecturer at MBAA's annual Brewing course in Madison, WI
- Member of the InTota Expert network
- Received the "Inge Russell Best Paper Award" for a complex fermentation topic

Additionally, Mr. Kapral founded Brewing Consulting Services, LLC.





**The company provides a wide range of practical operational advice and solutions to clients in the Craft Brewing industry.** The group includes the David Kapral and Associates Mark Sammartino and Pat Frost. Collectively this group has 100 years of experience in the industry.

Contact David Kapral if you would like to discuss the issues raised in the article or if you want to explore further assistance from his firm:

(208) 938-2064

[kbrewconsult@q.com](mailto:kbrewconsult@q.com)

[www.davidkapral.com](http://www.davidkapral.com)



**Ed Michalski (left) with brother Dave, checking specs for a customer**

**Ed Michalski, CEO / PRO Engineering and Manufacturing, Inc**

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**Contact Ed Michalski at:**

Contact Ed Michalski at: (414) 362-1500 e  
[ed.michalski@prowm.com](mailto:ed.michalski@prowm.com)

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