



BALANCING EFFICIENCY *and* QUALITY

*Identifying the
Optimal Batch Size
for Your Roast*

By Kat Melheim



ABOVE
Gwilyn Davies of Naughty Dog Coffee getting ready to roast in the Czech Republic.
Photo by Scott Rao

PRECEDING PAGE
Kate Avansino loading coffee at her roastery, Cafebré in Oaxaca, Mexico. Photo by Scott Rao

MANY VARIABLES GO INTO creating the perfect roast profile—equipment, the green beans, charge temperature, development time and more. One variable often overlooked is batch size. Batch size is just as it sounds—the size of the batch of coffee you are roasting, or how many pounds (or kilos) of green coffee you load into your roasting machine at a time. Roasting machines come in various sizes, and they are typically named to reflect drum capacity, or maximum batch size. For example, Loring’s S15 Falcon is a 15-kilo roaster, Diedrich’s IR-12 has a capacity of 12 kilograms, the SF-75 is San Franciscan’s 75-pound/35-kilo machine, and Mill City’s machines are all labeled with the drum size in the name. Most roasting machine manufacturers follow this naming convention with at least some of their popular models.

However, the stated capacity for each roasting

machine is not necessarily the ideal batch size for a particular offering. Other considerations come into play—your daily roasting needs, your machine’s heat source and power supply, green coffee density and other factors. In this article, we will explore these considerations and gain insight from roaster consultants, working roasters and machine manufacturers. The goal is to equip you, fellow roaster, with the knowledge, tools and skills you need to determine your batch sizes in the most efficient, effective way possible.

CONVENTIONAL WISDOM

You may have heard a few numbers thrown around suggesting relative minimum and maximum batch sizes. Maximum batch capacity is generally suggested

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Shelby Williamson of Huckleberry Roasters roasting a batch. Photo courtesy of Huckleberry Coffee

to be 80 percent of the drum capacity. So, a 5-kilo roaster should be loaded with 4 kilos of coffee at the max. Minimum batch capacity is more disputed. I have heard 20 percent, 25 percent, or even 40 percent as recommended minimum batch sizes. But where do we get these numbers? And do these parameters always produce the best results? Conventional wisdom can provide a good starting point, but practical experience provides an important complement.

PRACTICAL APPLICATION

Coffee roasting consultant Anne Cooper says, “I have always traditionally worked on the ‘25 percent of the rated drum size is the ideal minimum batch size’ and ‘80 percent of the rated drum size is the ideal maximum batch size’—in theory.” However, Cooper notes that she doesn’t always stick to these theoretical recommendations in practice. “If a machine has the heat transfer abilities and is managed properly, then it is very capable of doing full size batches. I do full-size batches all the time, but it does tremendously depend on the desired roast profile/cooking strategy.”

Cooper isn’t alone in suggesting that you should start with your desired roast profile and find a batch size that allows you to achieve it. Shelby Williamson,

head roaster at Huckleberry Roasters in Denver, does this as well. “For me, batch size itself is arbitrary,” she says. “All of these numbers are arbitrary, so we need to talk about what’s actually going on when we’re making these changes. I have a certain style of roasting that I like to adhere to for most of my coffees. Typically, my single origins are between 8 and 10 minutes [roasting time]. And then we have coffees that are for blenders, they’re a little darker, they’re meant for espresso. Those are more in the 10- to 13-minute range. That’s just my style of roasting. So, when I’m choosing batch sizes, typically I’ll choose them so that I can adhere to the time limits that I have set for myself.”

Cameron Heath, the environmental health and safety manager at Counter Culture Coffee, based in Durham, North Carolina, takes a practical approach: “We have a 90-kilo machine and we put in roughly 195 pounds [88.5 kilos] just for efficiency’s sake, and you can still manipulate that well.” He mentions that for Counter Culture, getting more coffee through the roasters is crucial to keep up with required production volume. “You’re relying more on good sourcing practices and longstanding relationships,” he says. “You have good quality coffee. That way you don’t have to mask any kind of imperfection [with roasting].” Heath’s objective is pushing out the most coffee he can, so he uses the heaviest batches that his machines can handle to accomplish the goal of volume.

Based on the principles of heat transfer, author and coffee roasting consultant Scott Rao has a mathematical method to determine maximum batch size a roaster should consider in any given drum roaster. Through years of observation and cross-referencing a more controlled study, Rao devised a calculation that uses a machine’s burner output. He explains the formula as, “5,000 BTUs per hour burner capacity gives you the capacity to roast about a pound of green per batch. It’s a very fuzzy calculation, because I’m making an assumption of, let’s say, like a 12-minute roast. In the metric system, that’s about 11,600 kilojoules per hour per kilogram of green.” Note, this calculation is applicable to traditional drum roasters such as Probat, Diedrich and San Franciscan, but not to fluid-bed or air roasters such as Loring or IMF. It is also important



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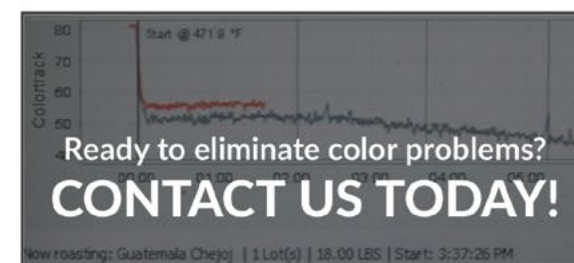
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to remember that this calculation is a starting point, not a hard and fast rule. “I think of that calculation as telling you the largest batch size you should consider, but not necessarily the optimal batch size,” he says. It is still important to observe how your roasts are going and adjust as needed to hit your goals.

In addition to Rao, a number of professionals I spoke with mentioned the difference between traditional drum (single-pass-through roasters) versus fluid-bed (recirculating machines). Firstly, fluid-bed or air roasters, which primarily use convection (hot air) as the heat source, can often handle larger batches in less time. These machines lose less heat because they recirculate hot air through the machine and drum rather than pushing it all out through the chimney, thus preserving more heat within the roasting system. Many of the roasters I spoke with also mentioned that

air roasters may produce fewer physical roasting defects such as tipping, scorching and facing because the drum surface in those machines often does not get as hot as in single-walled traditional drum roasters.

FIXED VERSUS VARIABLE BATCH SIZES: MAXIMIZING EFFICIENCY, CONSISTENCY AND QUALITY

Whether you set out to create a 10-minute roast profile or to push 1,000 pounds through your machine per day, batch size is a critical variable in achieving your roasting goals. You can conceive of batch size in two ways: fixed or variable. As a real-world roaster, you must balance best practices with practical considerations and do what is best for your operation.

● **Fixed Batch Size:** With a fixed batch size, a roaster will use the same batch size roast after roast. You can use one batch size for all coffees (i.e., always roasting 4 kilos in a 5-kilo machine). Or you can keep a consistent batch size for each coffee but use different batch sizes for different coffees (for example, always roasting Colombian coffees in 10-kilo batches, Ethiopian coffees in 11-kilo batches, etc.). Using a fixed batch size helps maintain consistency, limits roasting variables, and allows the roaster to tweak other aspects of the roast. The main downside is that you might end up with overage (i.e., roast more coffee than you need). If you get an order for 2 kilos of a coffee but your batch size is set to 4 kilos, you will end up with twice as much coffee as you need. If you have an outlet for this coffee, this is no problem. At Huckleberry, Williamson mentioned a “Coffee Club”



Scooping and weighing green coffee. Photo by @coffeeandlucas, courtesy of Scott Rao

An advertisement for Java Jacket coffee sleeves. On the left, there is a stylized illustration of a coffee cup with a green coffee sleeve. The sleeve has a tree-like shape with coffee beans as leaves. Text on the sleeve reads "THE BEST INSULATING, GREEN COFFEE SLEEVE ON THE PLANET!". To the right of the cup, the Java Jacket logo is displayed in a green, stylized font. Below the logo, the website "www.javajacket.com", phone number "1-800-208-4128", and email "info@javajacket.com" are listed. Further down, four benefits are listed with corresponding icons: "Earth Friendly" (recycling symbol), "Satisfaction Guaranteed" (star), "Two Different Sizes" (two cups), and "Custom Printing" (cup with text). At the bottom, "Same Day Shipping" is listed with a right-pointing arrow icon.

An advertisement for CYA Asset Tracking and Service Management Software. The top half of the ad shows a close-up of coffee roasting equipment, including a brass valve, a pressure gauge, and various tools like wrenches and screwdrivers. Below this image, the CYA logo is shown, featuring a stylized coffee cup and the text "CYA Cover Your Assets." and "224.600.3264 • cya.coffee". To the right of the logo, the main headline reads "YOU FIX THINGS: DO IT FASTER, SMARTER, MORE EFFICIENTLY". Below the headline, it says "Asset Tracking and Service Management Software for the coffee industry, by coffee people."

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LEFT
Roasted coffee.
Photo by @coffeeandlucas,
courtesy of Scott Rao

RIGHT
Roasting operations
at Sweet Bloom in
Colorado. Photo courtesy
of Sweet Bloom Coffee
Roasters

where the company sells its overage at a discount to subscribed customers. Some roasters will create blends from their extra coffee, donate it to local food pantries, or give it to friends and family. However, if you run tight margins or can't find a way to offload extra roasted coffee, you could end up with excess that takes a toll on your bottom line.

- **Variable Batch Size:** Some roasters determine batch size based on their roasted coffee needs. Andy Sprenger, founder of Sweet Bloom Coffee Roasters in Lakewood, Colorado, says he starts with a baseline batch range that the company has determined for each of its machines (40 to 45 pounds in a 75-pound San Franciscan and 45 to 55 pounds for a Loring 35-kilo) and adjusting from there. "We aim for every roast to fall inside the optimal batch range, and since we roast to order, this can be challenging," Sprenger says. "But we can tweak batch sizes by roasting extra for the following day and use our own cafes for overages." Varying your batch size allows for more control over how much roasted coffee you will end up with. However, changing the batch size affects everything else about roasting, so other adjustments will be required to achieve consistent roasting results.



SCALING PRODUCTION: HOW TO UPSIZE/DOWNSIZE YOUR BATCH

When changing batch size, certain adjustments must be made to compensate for the difference in weight. A larger batch requires more energy to roast than a smaller batch of the same coffee. This can be done through a variety of means:

- Higher charge temperature. Cooper recommends adjusting the charge temperature by 10 degrees C [18 degrees F] for every 1 kilo [2.2 pounds]. But be careful not to heat the drum too much (especially in a single-walled drum roaster) or you run the risk of scorching/facing.
- Higher burner settings throughout the roast, so more heat is added to the system overall.
- A shorter "soak" period (i.e., time without heat at the beginning of the roast), so you are adding heat earlier.
- A slower roast overall, so the coffee spends more time in contact with heat.
- Using a transitional between-batch protocol to increase the thermal mass within the roaster when going from a smaller to larger batch.

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All these adjustments can be made in reverse when going from a bigger to smaller batch size.

After scaling your batch size up or down and making the subsequent adjustments, how can you tell if your coffee is roasting consistently? Pay attention to the timing. Cooper says, "Sometimes on the Probat [P12], I would do a 4-kilo batch size to test a coffee and then batch-up to a full 12-kilo batch size. The only area of compromise I have is the time to yellow, maybe a 30-second difference, but after yellow everything—time in Maillard, first crack time, development time and development degrees post first crack—has to be exactly the same, along with the end roast color. As long as the cooking strategy/time is the same from yellow onwards, then the flavors will taste similar or, ideally, the same."

Williamson echoes this focus on time, pointing out that probes and temperature readings can be misleading at drastically different batch sizes. Talking about going from a full batch to a half batch, she says, "When you have that dramatic of a difference in weight, the probes are going to read a little bit differently. I might finish at 440 degrees F (227 degrees C) for our darker coffee in the full batch. It might be 435 degrees F (224 degrees C) in the half batch. I use a combo of trying to hit the same markers of hitting yellowing around the same time, hitting first crack around the same time and visually checking the coffee as it comes out."

And of course, taste your coffee. Sensory analysis via brewing is the ultimate test of whether you are successfully roasting consistently.

THE RISKS OF BIG BATCHES

Big batch roasting can allow you to roast more coffee in less time, but there are also risks involved.

● **Roast defects.** Defects such as facing, tipping and scorching can occur from an overloaded single-walled traditional drum roaster because the beans spend more time pressed up against the hot metal surface. Nearly all the professionals I spoke with mentioned this, and many noted that it is more common for natural- and honey-processed coffees, as they tend to be less dense

and more prone to heat damage.

● **Uneven development in the cup.** The increase in convective heat of a big batch can cause the outside of the bean to roast more quickly than the inside of the bean, meaning the surface will get darker while the inside remains underdeveloped. Sprenger notes, "If we push above our optimal batch size range, the off flavors we get are a more one-dimensional, slightly underdeveloped roasts. Baking is another potential downfall."

● **Damage to the machine itself.** Cooper mentions that exposing the roaster to the excessive heat required to roast an overloaded batch can dry out the grease within the bearings of the machine. If you are not regularly checking and maintaining these bearings, they can fail more frequently, leading to inconvenient and costly repairs.

● **Potential fire hazards.** Some roasters might be concerned that an overfilled roaster could lead to a roaster fire. However, batch size alone won't cause a roaster fire. "Fires are directly related to the temperature of the bean, so if you get the bean to a combustible temperature, it doesn't matter what the batch size is," says Bill Kennedy of San Franciscan Roaster Company. "But I will say, the more fuel you have, the bigger the fire." If you are roasting dark, keep an eye out for fires. Also be aware of your chaff levels, because bigger batch sizes do lead to more chaff build-up, and chaff is highly flammable.

PROBLEMS WITH SMALL BATCHES

Smaller batch roasting often gives you more control over a roast, but if you go too small you run the risk of compromising repeatability and losing control completely. When roasting smaller batches, you need to make sure the thermocouple or bean temperature probe is fully immersed in the bean mass, otherwise the reading will be incorrect and misleading. The risk is, if your coffee comes out tasting great, this profile will be nearly impossible to replicate.

Another thing to consider is your machine's construction. Williamson says that when trying to match profiles on Huckleberry's 15-kilo Giesen, if she

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LEFT
Shelby Williamson
assessing her roast as it
drops. Photo courtesy of
Huckleberry Roasters

RIGHT
Author of this article,
Kat Melheim, scooping
a batch at Black & White
Coffee Roasters. Photo by
Jen Hall

tries to roast less than 5 pounds, she has to turn down the burner and the airflow significantly, but “if you lower the airflow too much,” she notes, “the flame doesn’t have enough oxygen, so it just snuffs.” You are then left with no heat source, and you can’t roast coffee without heat.

EXPERIMENTS TO TRY IN THE ROASTERY

Maybe you are happy with your current batch size and you want to stick with it. Great! Or maybe you are curious to try something new. Here are a few trials to find out more about how your machine handles different batch sizes.

1 Load your machine to the stated capacity. If you have the green to spare, load your machine to its “full” capacity and let it rip. Is your machine able to keep up with your desired curve, or does it fall significantly behind and the roast takes twice as long as you intended? Either way, make sure you taste the coffee to assess the results where it matters most—your palate.

2 Add a pound or two to a roast profile you want to slow down. Williamson says she uses batch size as a variable in stretching out a roast. “Sometimes when I have a profile that I’m like, ‘I really love this profile, but I wish I could slow it down,’ rather than trying to force it through the airflow and the gas, what I’ll do is I’ll add a pound to the batch size.” She then makes gas



and air adjustments at the same temperatures as she would with the regular batch size and observes what happens.

3 Increase convective heat transfer by reducing your batch size. Fewer beans means more air space. “If you have coffee to play around with, it would be worth playing,” says Heath. “You could, say, under-batch by a certain percentage and see if more convective heating will brighten up a coffee, clean up a coffee.” Adjusting batch size can change the proportions of convective (air) versus conductive (touch) heat transfer.

As with most variables in coffee roasting, there is no one perfect or universal answer. Ultimately, the batch size (or sizes) you choose should allow you to consistently roast your coffee the way you want to roast it. Whether you shoot for precision control, cranking out high volumes, or producing lightning fast roasts, batch size is one variable that you can manipulate to achieve your roasting goals.



KAT MELHEIM is a roaster, barista, writer and artist. She founded *Coffee People Zine*, an art and coffee publication, and can be found on Instagram @roasterkat where she posts roastery behind-the-scenes and educational content. Through all her work, Melheim strives to entertain, educate, and ultimately connect people to one another.



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