Espresso: The Toughest Grind to Properly Achieve

The grind can make or break an espresso brew, and yet espresso grinds are one of the most difficult to achieve consistently. Utilizing the correct grinder can help ensure a quality brew. By Daniel Ephraim

Without a doubt, espresso is one of the toughest grinds to achieve on a consistent basis. As anyone who has observed a barista working his/her craft over a period of time can attest, the periodic readjustment of the grinder is undertaken to ensure the consistent, optimal brewing of the coffee in the espresso brewer. First off, let's compare an espresso grind application against that of a 12-cup brew method (see Figure 1).

As can be seen, we use less weight, brew faster and utilize a finer grind as well as higher pressure to produce an espresso coffee as compared to a standard brewed coffee. But it's more complicated than this. We are not just grinding the coffee to a particular particle size with a defined average. We need to achieve two unique objectives in grinding.

The graph in Figure 2 represents a typical ground coffee particle size with a single "peak," or average, which is often referred to as a monomodal distribution. The particular challenges in espresso grinding are related to the following:

1) On the one hand, we are trying to achieve a short percolation, or brewing time.

2) On the other hand, we are trying to obtain a high concentration of soluble solids. These might otherwise be categorized as mutually exclusive dynamics.

Espresso vs. Fresh Brew Performance Comparison

Brewing Dynamics	Espresso (Single/Double Shot)	Fresh Brew	Ratio
Coffee Weight	10 – 12 grams/20 – 25 grams	3.75 oz.	1/12th the weight
Water Pressure (psi)	70 – 100 psi	Gravity: 0.1 – 0.5	+200 times the water pressure
Brew Time	20 sec.	4 – 6 min.	1/15th the time
Grind Size (microns)	200 – 300 µm	750 – 850 µm	1/3 the grind size

Figure 1

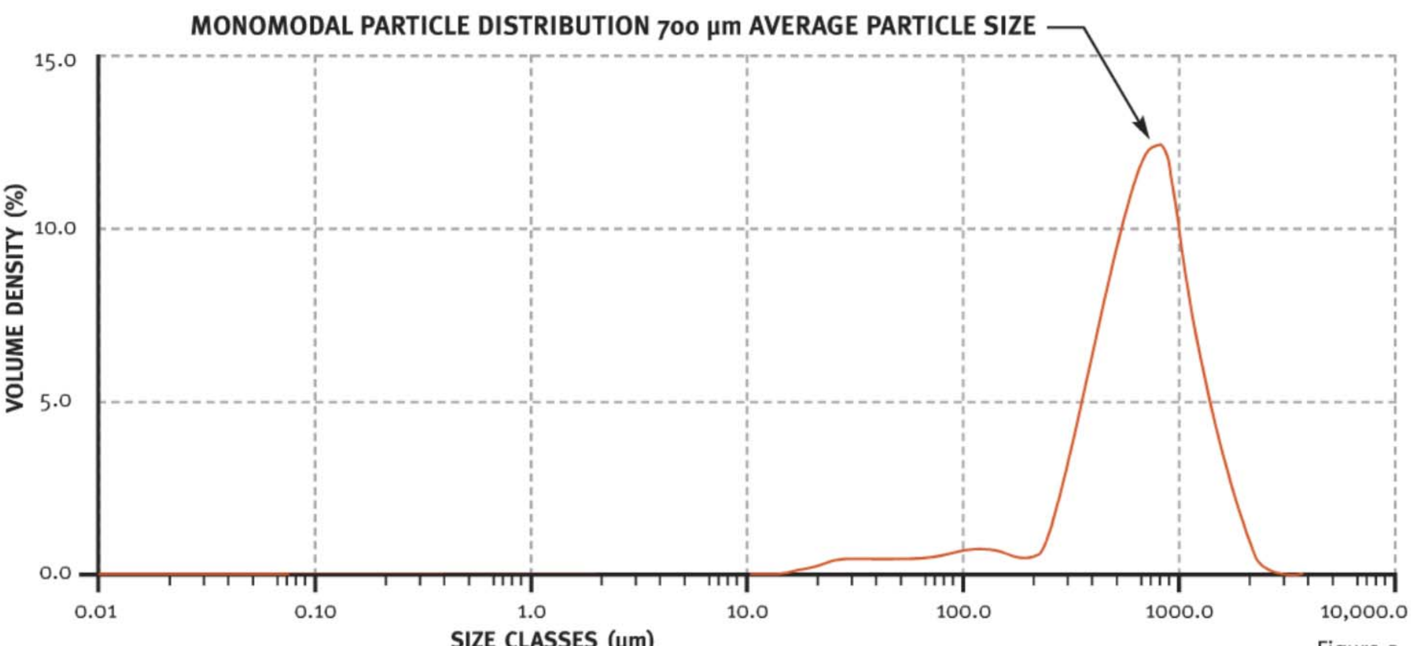

Figure 2

Both figures courtesy of Modern Process Equipment, Chicago, USA

That is, these objectives are physically opposed to each other.

Quite simply, if we try to brew espresso with a gravity-brew method, there would be no flow through the portafilter. If we ground and brewed coffee in an espresso machine with a monomodal type of grind, such as that which is typical for brewed coffee, even at a ground particle size of, say, 250 microns (μm), the brew would be rapid (5 sec.) and the extraction weak.

To understand the physics behind this challenge, let's take a look at the architecture of grinds. The exposed surface area, and its relationship to extraction in coffee brewing, is the "Holy Grail" of grinding and brewing good coffee, whether it is urn, drip, filter fine, espresso or Turkish. Figure 3 shows the relationship between particle size and exposed surface area.

Once we see how the surface area increases as we cut, or grind, the coffee into a greater and greater number of particles, it makes sense that various grinds would be necessary to utilize the exposed surface area for both the specific grind as well as the specific brewing method (Figure 4). For instance, the faster the brew cycle, the finer the grind… and vice versa.

As shown in Figure 5, as the average

Effect of Grind Size on Surface Area

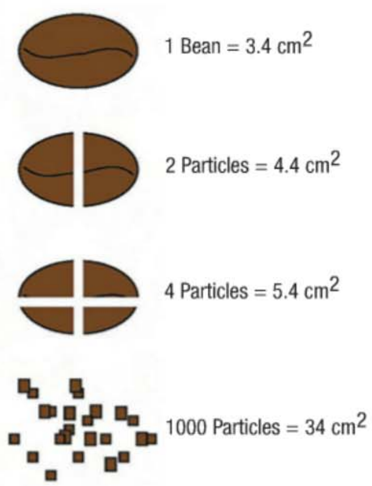

Figure 3

Comparison of Ground Particles per Bean

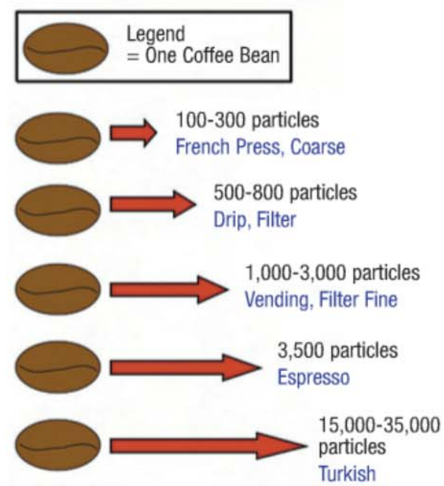

Figure 4

Average Size vs. Surface Area (1 Bean = 3.4 cm^2 = Size of a Postage Stamp)

Surface Area Increases as Brewing Time Decreases!

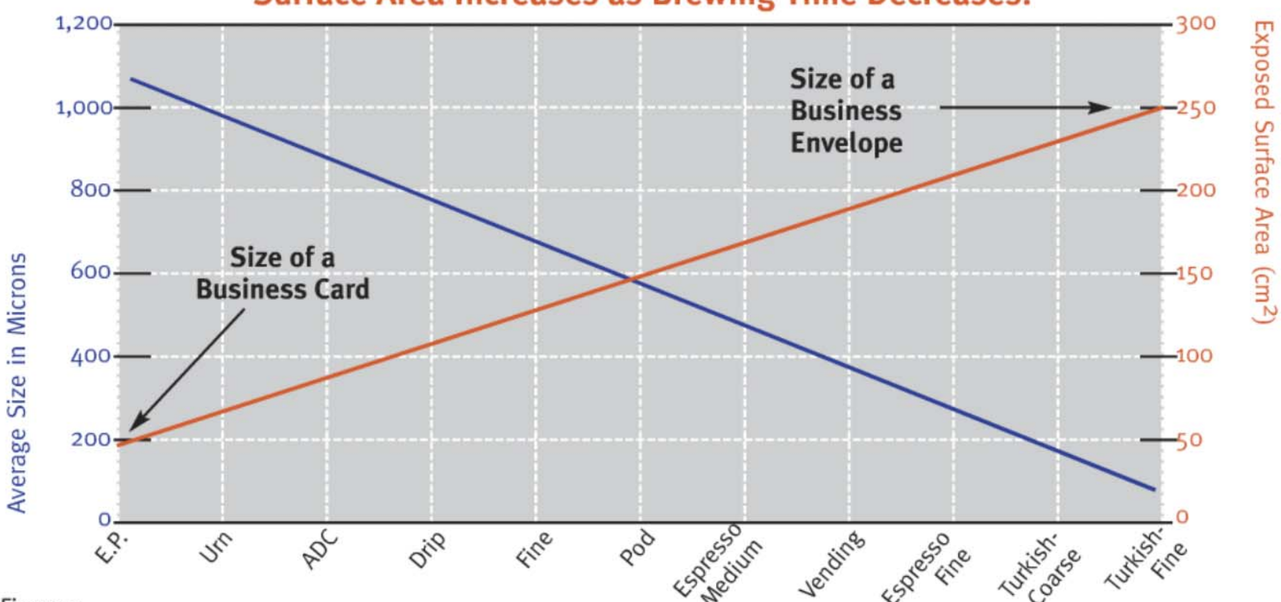

Figure 5

All figures courtesy of Modern Process Equipment, Chicago, USA

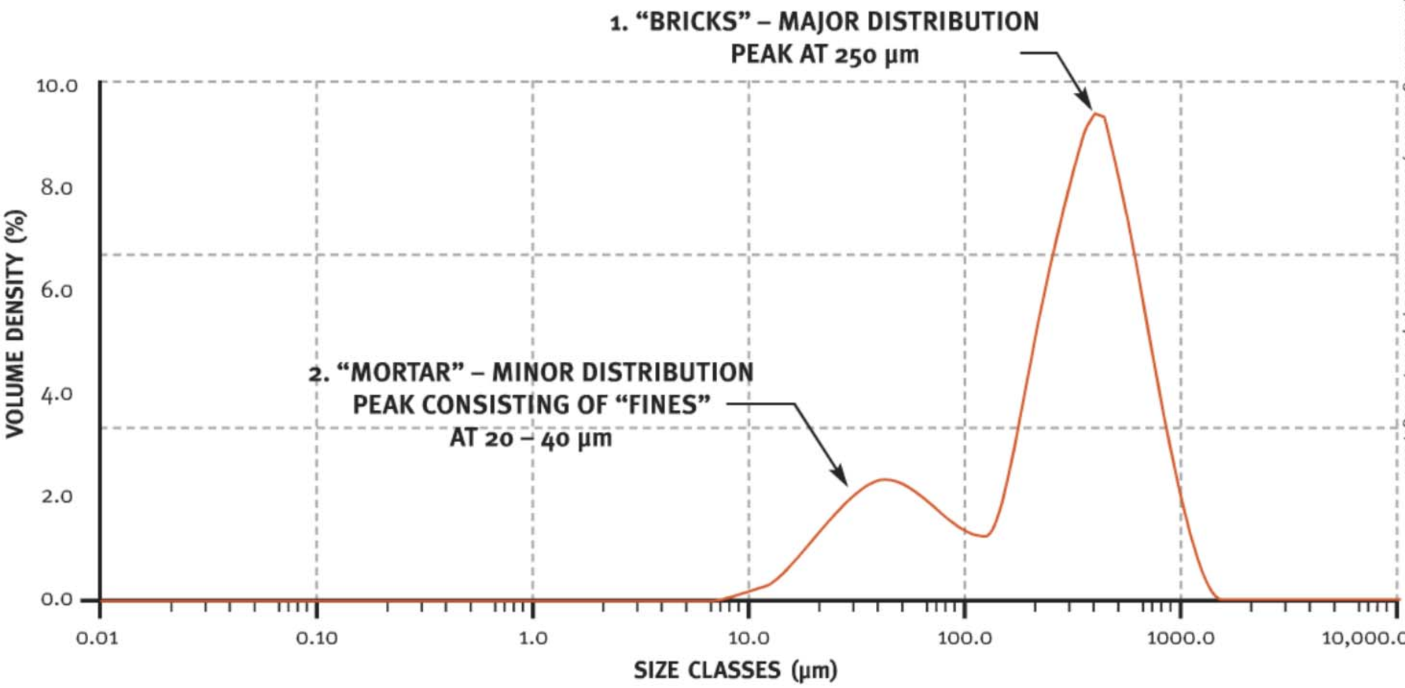

Figure and image courtesy of Modern Process Equipment, Chicago, USA

Figure 6

particle size is reduced for various types of brewing methods, the brewing cycle required to extract the optimum soluble solids is reduced accordingly. With espresso, due to its increased surface area, it can achieve the same total extraction in 20 seconds as a drip method can achieve in four minutes (and as an urn method can achieve in eight minutes). However, it cannot rely on gravity anymore to draw the coffee through the coffee brewer; rather, pressure is now required.

(As a side note, if we grind a Turkish-type grind at 100 µm for example, there is an incredibly high exposed surface area, but due to the near impermeable structure of the ground coffee, it cannot be brewed through a brewing device and must be prepared by mixing directly into hot water.)

So far, so good. But now we have an additional problem in that if a coffee is ground to a particular monomodal espresso grind, 250 µm for example, it will not brew successfully. The grind must be bimodal, wherein the particle size distribution has, essentially, two peaks–a major and a minor particle size distribution profile.

The first, or major, peak has an average particle size of 250 µm while the minor peak is ideally around 30 percent of the total grind distribution with a distribution average of 30-50 µm. The coarse particles can be considered the "bricks," which allow for the correct flow through the coffee "cake."

On the other hand, the finer particles can be considered the "mortar," or "cement between the bricks," and have a very high exposed surface area, which permits the extraction of a large amount of soluble and emulsifiable material(s). The "brick" particles have a further effect in that they seem to behave as a self-filtering structure, which retains the "fines" that have been displaced by the flow (Figure 6).

Figure 7 shows an electron microscope picture of an espresso grind. Note that the "superfine" particles in the range of 30-50 µm (at a percentage of approximately 30 percent of the total grind) achieve a proper espresso extraction. Without the fines, the brew will be too fast, too weak and the

Figure 7

froth, espuma, tiger skin, etc. will not develop fully.

The superfines provide the intense extraction that we love with espresso coffee due to their increased exposed surface area as a function of their particle size. So, if we think back to our barista, he or she was not adjusting the grinder to achieve the primary particle size in his (monomodal) grind but, rather, he or she was adjusting to control the superfine portion of the grind–that 30-50 µm particle size at a 30 percent proportion for example, which is the most critical element in the espresso grinding process.

The Challenges Associated with Expanding to Larger Production Capabilities

Point-of-sale grinding for espresso, whether it is associated with the brewing unit or sale to retail customers, is oftentimes achieved utilizing a disc-style grinder, which is an attrition-type apparatus. Through attrition friction and heat are generated during grinding, with the first resulting in the natural generation of our superfines and the second being the enemy of all coffee grinding (heat), since aromas and volatiles evaporate at very low temperatures (100 degrees F).

Generally, as production requirements for espresso increase, the use of a roller-style grinder (Figure 8) is employed. This is the typical design that is utilized for virtually all the coffee manufacturing facilities producing standard roast and ground coffee on a larger production basis.

Because of the efficiencies and designs of the roller grinder, the cool grinding of coffee is achieved; however, by

Figure 8, MPE Supernova Roller Grinder Cross Section

Courtesy of Modern Process Equipment, Chicago, USA

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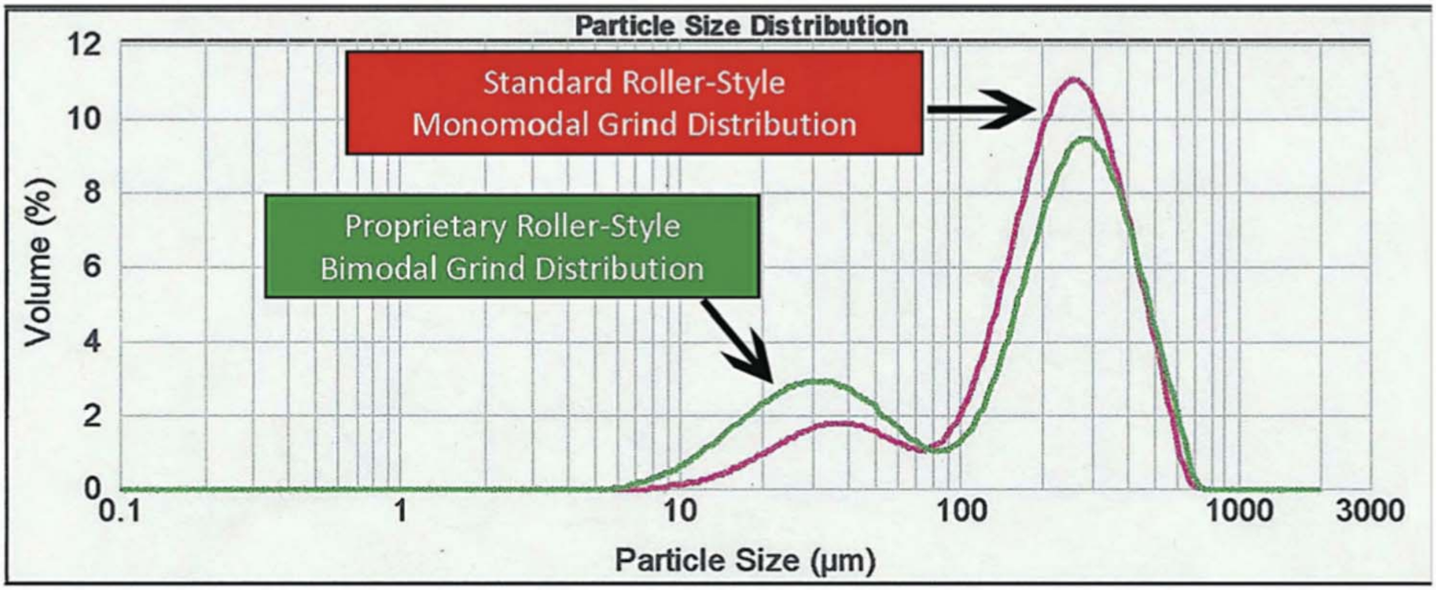

Figure 9

design, the roller grinder will naturally produce a monomodal grind. Monomodal grinds are ideal for all brewing methods above an espresso grind size; consequently, MPE's proprietary-type technology, for example, achieves both the "fine grinding" of espresso as well as the superfines, as shown in the graph above (Figure 9).

In the case of the Model IMD 889 FX (espresso) roller-style grinder (see Figure 10, page 61), a proprietary design is employed to achieve not only a standard roller-type monomodal grind, but also the desired bimodal grind without the friction and constant adjustments necessary and associated with a typical disc-style grinder. As the need for increased capacity develops, the introduction of a roller-type grinder, such as the water-cooled Model IMD 889 FX, would be logical.

Figure 10

Courtesy of Modern Process Equipment, Chicago, USA

The Resulting Quality

In conclusion, the espresso grind will make or break the quality of an espresso brew, regardless of the coffee origin, roasting technology or brewing method, etc. It is the single most critical element that ensures that the enjoyment of the beverage meets expectations.

At the retail and barista levels, disc-style grinders produce a natural espresso grind due to friction, albeit with increased heat and periodic adjustments being the challenges. As production technology is utilized, special designs must be incorporated into the grinder to ensure the ideal espresso particle distribution, or grind.

With experience in the coffee business for more than 30 years, ***Daniel Ephraim*** *has been active in the development and design of coffee grinding and other related processing equipment. He has been a frequent presenter at coffee conferences and symposiums around the world and has conducted hundreds of coffee-grinding seminars at coffee manufacturing facilities in North America and overseas. He is based in Chicago, Ill.*