Minding Your Machines

TURNING **ESPRESSO EQUIPMENT** KNOWLEDGE INTO BEVERAGE QUALITY

by Dr. Joseph John

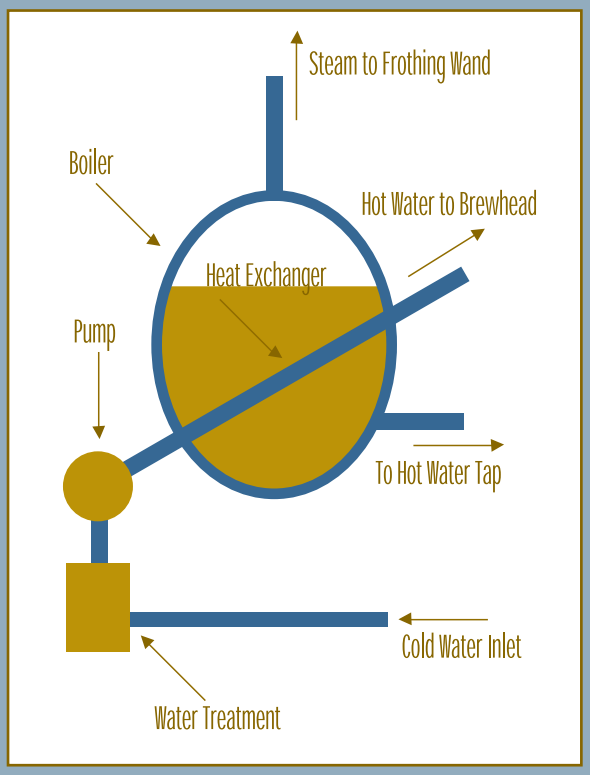
When Italian coffee professionals discuss espresso, they identify four key components of preparation as being crucial to achieving superior quality. There's *miscela*, the correct blend of coffees; *macerazione*, the proper grind; *macchina*, the machine; and *mano*, the hand, or in this context, the barista. While these four elements certainly shape the ground rules for producing espresso, counting the various intricate steps involved in preparing a high-quality beverage can sometimes seem like a feat fit for a mathematician. From seed to cup, proper espresso preparation requires skill, discipline and artistry. But among the chief duties of any quality-minded retailer should be to learn the ins and outs of his or her espresso equipment, specifically the espresso machine and grinder. How well do you really know your espresso equipment? Can you determine why there is a bitterness in the cup today that wasn't there yesterday? Do you know why your pour is slightly off from shot to shot? Become well versed and experienced in espresso technology and usage, and you'll be able to identify equipment problems—and solutions—easily.

Basic Principles of Espresso Machine Operation

In a typical espresso bar, the espresso machine represents a significant financial investment, and it is truly the heart of the operation. Basically, the espresso machine is designed to perform three simple, but critical, functions. It heats the brew water to the appropriate temperature, it delivers a premeasured quantity of water to the brew head, and, most importantly, it delivers the premeasured amount of hot water at a pressure of 8 to 10 bars. Delivery of hot water at this high pressure is the primary reason for using this kind of machine to produce espresso. There is simply no other way to accomplish the task more economically or efficiently.

The crux of the espresso machine is a boiler in which water is maintained at boiling point using an electric heating element. This boiling water turns out to be too hot for brewing; otherwise we would use water straight from the boiler to make espresso. To avoid this problem, cold water is brought in through a metal tube that is immersed in the hot boiler water. It is then heated to the appropriate temperature before being used for brewing. This brew water does not mix with the boiler water, but it does absorb heat from it; hence the name, "heat exchanger."

A pump used to force the brew water through the heat exchanger is also used to pressurize that water. The temperature of the brew water emerging from the heat exchanger depends on a number of factors, including the boiler water temperature, the temperature of the incoming cold water, the time taken by the brew water to traverse through the boiler, and the heat exchanger's efficiency.



A schematic of the interior of an espresso machine.

Because steam from the boiler is required to texture milk, it is collected and stored above the water in the boiler. By allowing the steam to build up some pressure, opening a valve to the steaming wand will cause the steam to blow out through the tiny holes at the tip of the wand. As the pressure builds in the boiler, the boiling point of water rises. In other words, water under pressure must be heated to a temperature higher than 212 degrees Fahrenheit before it will boil; the higher the pressure, the higher the boiling point. In most modern espresso machines, boiler water temperature is well above 212 degrees Fahrenheit, and it can be adjusted by varying the steam pressure in the boiler using a "pressurestat," or pressure gauge. On a properly functioning machine, this gauge should read between 1.2 and 1.5 bars.

If an espresso machine is allowed to idle for 10 minutes or longer, water in the heat exchanger will ultimately approach the boiler water temperature, and it will be too hot for brewing espresso. However, if the machine is used continuously, water in the heat exchanger will not have enough time to absorb heat from the boiler water to reach proper brewing temperature. Thus, for a given combination of boiler size, boiler temperature (or steam pressure), input water temperature, and heat exchanger design, there is a production rate (the number of espressos produced per hour) for which the brew water is at the "correct" temperature. But any change in this production rate will make the brew water temperature deviate from its optimum value.

Every espresso blend performs best when brewed within a narrow range of temperature around a well-defined average. But this ideal temperature varies from blend to blend. Once the pressurestat is set to deliver brew water at the correct temperature, it should remain as consistent as possible. As the espresso production rate changes, any variation in brew water temperature is undesirable. Temperature deviation varies from machine to machine, and it should be a critical consideration when selecting an espresso machine.

Pressurized Water Is Key

When hot water comes into contact with ground coffee in the portafilter, about 20 percent of the coffee dissolves in the water. Up to this point, the result is ordinary "brewed" coffee. It is not espresso—yet. But when coffee is ground finely enough and packed tightly enough, the resulting "puck" will not permit water to speedily make its way through the portafilter. Instead, the water flow will be impeded and hot water will be forced into the interior of the ground coffee particles. Under the intense pressure generated by commercial espresso machines, oils are extracted from ground coffee, formed into microscopic droplets and suspended in liquid coffee concentrate. This colloidal dispersion is what makes espresso espresso.

But all of the energy packed into the pressurized water must be expended during the emulsification of oils. The resulting espresso oozes, often with considerable hesitation and sometimes in clumps, out of the espresso machine portafilter like warm honey. A quality espresso should consist entirely of crema as it flows gently out of the portafilter spout. The emulsified oil markedly impacts an espresso's mouthfeel, density, viscosity, wetting power, and foaming ability. Because it captures the intense coffee flavors, crema is as critical as the concentrated liquid coffee underneath. In fact, crema is the single most important indicator of a well-made espresso.

Crema consists of tiny bubbles containing the vapors released during extraction by the ground coffee particles. These vapors contain the aroma molecules responsible for the flavor sensation experienced while drinking espresso. Much of that flavor comes more from the aroma sensation in the nose than from the taste sensation in the mouth. The role of crema is to capture that aroma and deliver it to the nose.

Choosing an Espresso Machine

Because an espresso machine is often the centerpiece of a modern coffee bar setup, visual appearance is undeniably important. And considering how much it costs, it should look fantastic. Machine manufacturers can tell you about all the charming and attractive features of their machines, but certain issues that are key to producing quality espresso in a commercial environment don't always get the attention they deserve.

The first critical issue in choosing an espresso machine is temperature stability, sometimes referred to as temperature recovery. Most espresso machine designs originate in Europe, where caffé espresso is the drink of choice. In Italian cafés, for example, most customers order straight espresso, a few drink cappuccinos—but only in the morning—and lattes are seldom ordered. In North America, on the other hand, the latte is extremely popular, and espresso machines are used primarily to steam massive quantities of milk. When steam is drawn from the machine's boiler, pressure inside drops and the pressurestat is triggered to turn on the heating element to boil more water and regenerate steam. Cold water is then admitted into the boiler to restore the water level to its original preset value. This addition of cold water into the boiler temporarily lowers the boiler water temperature, which in turn lowers the brew water temperature. The point at which milk has been steamed and the barista is ready to make espresso is precisely when brew water temperature is at its low point. It will take several minutes, depending on the wattage, for the heating element to bring the brew water temperature to its optimum value. For optimum espresso extraction, a machine should ideally recover the brew water temperature in less time than it takes to wipe, dose and tamp the portafilter.

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There are several ways to achieve temperature recovery or otherwise minimize temperature loss. One way is to request an oversized boiler or to select a machine with a larger capacity (e.g., a three-group machine when a two-group would suffice). Some machines circulate water from the boiler around the group head and maintain its heat in order to prevent brew water from cooling upon entering the brew head. A straightforward but more expensive approach is to use two separate boilers, one for steaming milk and the other for brewing espresso. This way, you can stabilize the temperature of the brew water regardless of how much milk steaming you need to do.

However you choose to maintain the brew water temperature, you must measure its stability under real-world operating conditions, particularly when the machine is run at "full throttle" during peak hours. Don't rely on a product brochure to find this information. If you are serious about producing quality espresso, you'll make actual measurements based on your operation's volume and pace.

The second important consideration in choosing an espresso machine is its ability to pre-infuse or pre-moisten the "cake." During pre-infusion, a small quantity of hot water is introduced into the portafilter to wet the ground coffee, before the actual extraction begins a few seconds later. The resulting espresso will yield a richer flavor and better body (or mouthfeel) due to improved extraction caused by a swelling of the ground coffee bed during pre-infusion.

Ground coffee is like peat moss. If you spray water on it, it just slides off like water on a duck. Once moistened, however, it will absorb all the water it can get. Some espresso blends are drier than others, and a fine film of oils coating the ground coffee particles inhibits them from getting wet easily. Pre-infusion will help. Unfortunately, not all espresso machines are capable of performing this process. And manufacturers of machines without pre-infusion capability often claim that it is unnecessary. As a coffee shop owner, it should be your choice as to when you employ pre-infusion and with which espresso blend. Whatever you do, don't abdicate that right to a machine manufacturer.

Most modern espresso machines are equipped with a *gicleur*, also called a jet or choke nozzle. Unfortunately, this is sometimes confused with an arrangement for pre-infusion. The gicleur is actually a pinhole through which pressurized water must flow before it reaches the ground coffee. This nozzle slows down the initial buildup of pressure in the group head. Even in a primitive setup in which a simple tube links the pump to the group head, pressurized water does not enter the extraction chamber instantaneously when the pump is turned on. Starting the pump creates a transient pressure front that takes a finite time to reach the ground coffee.

The third and final consideration in purchasing an espresso machine is the willingness of a supplier to adequately train you to perform emergency repairs. If your espresso machine breaks down, you will essentially be out of business—at least, a major segment of the business. And no matter how impressive a service network, you can't expect a service person to come to your shop the instant you call about a breakdown. So what do you do until the service person finally does arrive a few hours or days after you call? You should be equipped with the product know-how to perform temporary repairs so that your machine can at least limp along until the service person arrives to make a permanent fix. If an espresso machine supplier has your best interest in mind, he will be more than happy to provide such training.

Grinders: The Unsung Heroes

Although grinding is integral to the coffee-making process, discussions of espresso preparation are often confined to the espresso machine and its role in producing a quality drink. In my view, however, the grinder is far more critical than most coffee operators think, and it truly is the unsung hero of espresso-making.

The role of the grinder is to transform roasted coffee into a powder, thereby vastly increasing the surface area available for hot water to interact with the coffee and extract the solubles and

emulsifiable oils into the beverage. The coffee bean is made up of layers of tissues composed of cells of different shapes filled with sugars, proteins, chlorogenic acids, and lipids within walls made of polysaccharides. Ideally, the grinder blades shave thin layers of coffee across the cell walls and expose all the contents of these cells.

You might assume that an ideal espresso grinder will produce ground coffee with a uniform particle size. Surprisingly, this is not the case. A perfectly made espresso is a balance of two opposing demands: a short extraction time for the finest flavor and a long extraction time to achieve a high concentration of dissolved solids. As a result, the ideal espresso grind should have a distribution of particle sizes rather than particles of a single size. This particle size distribution permits proper packing in the basket of the portafilter. More importantly, the finer particles enhance the exposed surface for greater extraction, while the coarser particles permit faster flow of water through the coffee bed.

There are two primary categories of commercial grinders distinguished by the shape of the cutters, often called burrs, used to break up the bean. The more common grinder type uses flat burrs, which incorporate a couple of flat disks mounted on a common axis, one held stationary as the other spins at high speed. Coffee beans are first crushed when they enter the space between the burrs, and they are later sheared as the pieces travel to the outer edge of the burrs. Particle size is controlled by varying the spacing between these disks.

The second grinder style uses conical burrs with a male conical wheel rotating co-axially within a static, cone-shaped cavity. As with a flat-burr grinder, particle size is adjusted by varying the gap between the cutting surfaces. Conical burrs tend to be larger and heavier than flat burrs. As a result, flat burrs tend to get hotter than conical burrs while grinding the same quantity of beans. But when properly designed, both types of burrs can do an adequate job.

A well-chosen, properly maintained grinder can mean the difference between a mediocre espresso and a truly outstanding one, assuming that all other parameters are being properly controlled. Unfortunately, this fact is lost on most espresso practitioners in North America. The sad truth is that many retailers spend an enormous amount of money on an espresso machine only to pair it with the cheapest grinder available.

Sharpness of Burrs Is Paramount

In order to achieve a proper grind, the grinder blades must be extremely sharp. With usage, blades lose their sharpness and tend to generate more heat during the grinding process, thereby raising the temperature of the ground coffee. When ground coffee is heated, the aromatic compounds vaporize and escape into the atmosphere, which means less of these favorable compounds will be available when the espresso is actually extracted. More importantly, as grinder blades dull, they lose their ability to shave across the cell walls of the coffee beans; instead, they crush the beans and crack them along the cell walls, resulting in poor extraction.

Flat burrs typically need replacement after 500 to 800 pounds of coffee beans have been ground under normal operating conditions. This range reflects the various sizes of flat burrs in common usage. Conical burrs can grind twice as many beans before they need attention. Replacing burrs in grinders is a minor investment if you aim to serve a superior espresso.

Find a Grinder Capable of Choking the Espresso Machine

Most grinders in use today in North America do not grind coffee fine enough to properly slow the pour of espresso. Inexpensive grinders quickly shift out of adjustment, causing the burrs to be misaligned. As a result, when the grinder is adjusted for a finer grind, one edge of the burrs will touch while the other edge will still be some distance away. In this case, the finest grind possible will often not be fine enough to produce espresso. A simple way to check whether your grinder is equipped to produce espresso is to set it for the finest grind and see if it is fine enough to choke the espresso machine. If it is, little or no liquid will pour out of the portafilter, even after waiting for 30 seconds. For a good grinder, you may need to back the burrs off five to seven notches to reach proper grind for a 30-second extraction time.

Ideally, operators will come to understand why espresso machines and grinders are so vital to an espresso business. It's critical to demystify these mechanical devices in order to encourage operators to make the desirable adjustments regularly and keep them tuned for top-notch performance.

This is your equipment. Keep it operating the way you know it should. Open it up, study what's inside and learn to make emergency repairs yourself. You'll taste the results in the cup, see it in your customers' appreciative faces and benefit from it in your business' success.

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