HORIBA Scientific

Application Note

Particle Characterization of Coffee

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Quality beans ground to the ideal size produces a perfect cup of coffee. It sounds like a simple process, but there is a great deal that takes place before a single drop is brewed. This note focuses on how the size of the grind affects the flavor of the coffee and the reasons the HORIBA LA-960 Laser Diffraction Analyzer offers undeniable advantages in measurement accuracy and speed over historical sieving techniques.

Introduction

Coffee is one of the world's most traded and valued commodities, since a good cup of coffee is an integral part of everyday life for many people. Coffee enjoys special status as one of the most universally popular beverages, transcending both ethnicity and class distinctions. In countries fortunate enough to have the right growing climate, it is also of great economic importance.[1] Coffee growers, suppliers, manufacturers, distributors, and baristas all know the importance of providing a high quality product and the price premium it can support.

Quality is Flavor and Flavor is Size

What many people fail to consider is that coffee is the seed of the coffee plant. Where the coffee is grown, the amount of sun and rainfall that plants receive, how the "coffee cherries" (which is what the fruit of the coffee plant are called), are picked and processed to get to the stage where the seed is separated from the rest of the fruit, all factor in the flavor of the final product. After separation, the seeds are referred to as "green beans" and are generally sold to manufactures for roasting, packaging and distribution.

Naturally, the goal during the roasting process is to maintain and enhance the quality of the beans and here size plays an important role. The beans need to be sorted by size before roasting because both time and temperature affect the flavor. This is due in part to a chemical reaction in the amino acids of the beans, called the Maillard reaction, which gives brown food a distinctive flavor at elevated temperatures. Interestingly, the beans actually double in size during the roasting process due to the expansion of the cellulose structure, in spite of losing 10-20% of their weight at the beginning of the process.[2]

After the roasting process, coffee is typically consumed in one of two ways: either the bean is ground to a specific grain size and brewed with hot water, or the bean is ground, brewed, and then dried to produce instant coffee. Each method is optimized with the help of state-of-the-art particle size analysis.

Coffee Grinds and Particle Size

The traditional method of brewing coffee involves grinding the roasted beans and then passing hot water over the granules to extract flavor, caffeine, and various other compounds. Several different techniques are popular for brewing the ground coffee particles including the French press, automatic drip machine, and espresso maker. Each technique works best with a different size of coffee grounds; coarse sizes for the French press, medium sizes for the drip maker, and finer sizes for espresso. The size of coffee grounds is determined by the time spent in the grinder, the grinder settings, and the grinder design.

Smaller particles expose a greater surface area per unit volume than larger particles and this leads to faster flavor extraction. Too fine of a grind may produce a flavor that is too strong and may create issues by clogging the filters or passing through the filter into the cup. If the grind is too coarse, it will produce a weak flavor. Understanding the relationship between the desired flavor and the size necessary to obtain it is a key factor in quality assurance. The particle size specification that develops from this understanding will typically emphasize control over fine particles, coarse particles, and therefore state a target size distribution with specific width (i.e. range of sizes).

Ground coffees sold to the consumer typically exhibit a wide size range between tens of microns and a few millimeters. The HORIBA LA-960 Laser Diffraction Analyzer is ideal for the size measurement of ground coffee because of its industry-leading dynamic range and state of the art PowderJet Dry Feeder accessory (Figure 1). Capable of measuring the grounds in the "as-is" dry form, the LA-960 sidesteps any problematic interactions with a liquid measurement medium.

Figure 1: The HORIBA LA-960 Particle Size Analyzer with PowderJet Dry Feeder accessory.

The PowderJet uses finely controlled compressed air to de-agglomerate (separate) clumped coffee grounds and then measure the particle size distribution (Figure 2) using the laser diffraction technique. The automatic feeder control of the PowderJet leads to unmatched repeatability, reproducibility, and objectivity since results are not dependent on how the sample is placed in the feeder. Not even the highest quality sieves and best practices can match laser diffraction for precision, speed, and return on investment. Data from several coffee samples collected from 2 different grinders with multiple settings were measured on the LA-960 PowderJet and are displayed in Figures 3 and 4. Note the overlay of multiple measurements for each sample and the high precision those overlays represent. The observed particles sizes range from less than 20 microns to over 4500 microns.

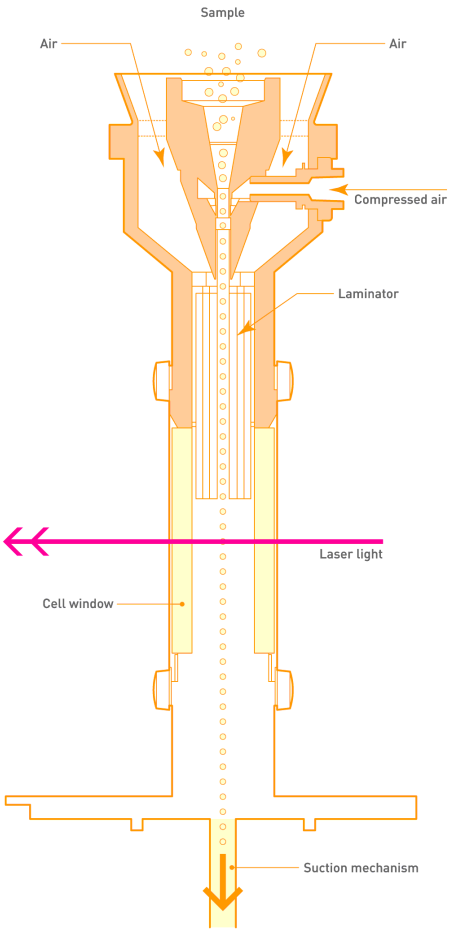

Figure 2: Cross-section of the PowderJet measurement cell. The vertical design eliminates many of the problems found in horizontal designs such as cross-contamination and clean-up.

The LA-960 can measure dry particles with sizes up to 5000 microns (5 millimeters) - a capability not available in other analyzers - ensuring the accurate representation of those largest particles which determine water flow during the brewing process. Measurement duration is on the order of seconds as opposed to the minutes that a sieve run requires. The time savings become significant when making dozens of measurements each day. Laser diffraction is replacing traditional sieves as the preferred sizing technique of ground coffee for everyone from the smallest specialty roaster to the largest multinational companies.

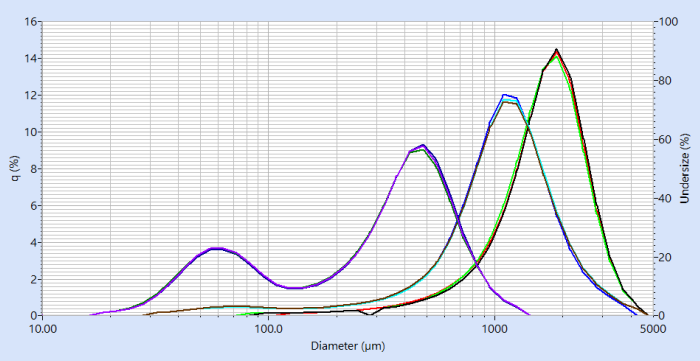

Figure 3. Coffee samples were from grinder settings of Coarse, Medium and Fine using Grinder 1. Each sample was measured 3 times to show the excellent reproducibility. Also note that the maximum measured particle size was over 4500 microns.

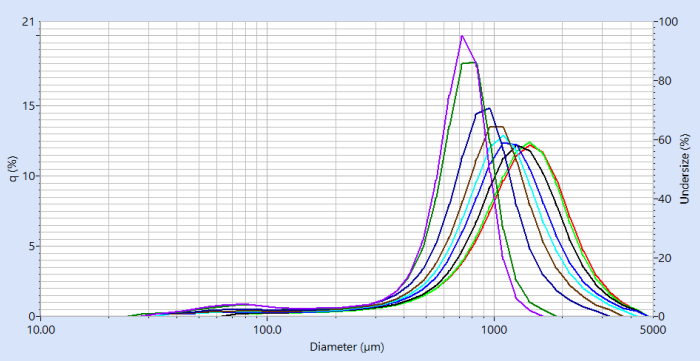

Figure 4. Coffee samples were collected from 9 settings of Grinder 2. In this case, the differences between settings are small. For example, the peak size at setting 4 was 90 microns and at setting 5 was 100 microns. Due to the high repeatability, even subtle differences in samples are apparent.

Conclusions

New technologies have matured in the last decade to replace the traditional technique of sieving for coffee particle size measurement. The HORIBA LA-960 laser diffraction particle size analyzer can cover all sizes of coffee grounds. Using laser diffraction leads to significant time and labor savings in addition to a more objective, reliable, and robust measurement.

HORIBA Instruments provides state of the art solutions for coffee particle size analysis and the expert training and support necessary to take full advantage of the instrument.

References

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