Application Note

Study of Particle Size in Food Industry: Wheat Flour

AN238

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Particle size determination is an important parameter for any particulate system and it plays a vital role in the quality of diverse products manufactured by the food industry as well. In this study, particle size of wheat flour is measured by laser diffraction technology that has emerged as the most important and effective technique in the world of particle size analysis. When compared with traditional sieve method, laser diffraction is fast, non-destructive, and provides automated measurement through a simple measurement workflow for routine production and quality control (QC) operations enabling improved consistency of the product in a shorter time span.

Introduction

The particle size distribution of particulates has been studied for a wide variety of food and beverages, such as coffee, sugar, flour, chocolate, milk powder, and spices. The size not only affects taste, but also appearance, stability, processability, and functionality of the finished product. Although traditional sieving method has provided a means of differentiating particle sizes with simplicity at low cost, the technique has pronounced drawbacks such as long analysis time, low repeatability and reproducibility of results, which make it less-suitable for supporting high productivity in modern manufacturing.

Alternatively, one can adopt the **laser diffraction (LD)** analyzer that has emerged as one of the most important and effective techniques in the world of particle size analysis. Further, ISO 13320 comprehensively describes the LD methodology effectively to ensure increased throughput with high productivity. HORIBA Scientific has over 40 years history in particle characterization, offering high precision particle size measurement instruments for suspensions, emulsions, powders, pastes, creams, and gels.

Milling of grains is a continuous process in food industry and it needs to be controlled with high throughput techniques. Wheat flour is one such giant industry where optimization of wheat particle size is an essential parameter to be monitored at different milling stages. Traditionally, mills employ sieve method to identify particle size range to decide the final product. Since sieving involves human intervention and longer measurement time, this conventional particle sizing process adds more complexity to achieving desired uniform product quality in all the mills.

Figure 1. Partica LA-960V2 laser scattering particle size distribution analyzer.

In this study, we show the quick analysis of wheat flour with HORIBA Partica LA-960V2 laser diffraction particle size analyzer (Figure 1) that provides a wide dynamic range from 10 nm to 5 mm to study particles distribution. The LA-960V2 is the latest evolution in the Partica LA series that advances scientific knowledge for tomorrow's world through intuitive software, unique accessories, and high performance.

Instruments and methods

LD methodology uses Mie theory to derive particle size which requires information on optical properties of the material. For this, the user is requested to input refractive index (RI) of material to be measured as well as for the dispersant. In this study, wheat flour was measured in both dry and wet mode with the following analytical test settings:

Wet mode Measurement Conditions:
RI(Particle): 1.56 – 0.0i; Dispersant: Ethanol (RI=1.360)

Dry mode measurement condition:
RI(Particle): 1.56 – 0.0i; Feeder Speed: Auto
Air Pressure (dry): 0.35 MPa

The LD result was then compared with the sieve result.

Results and Discussion

In the wet mode, ethanol was used as a dispersant as flour particles are known to show swelling properties in water.

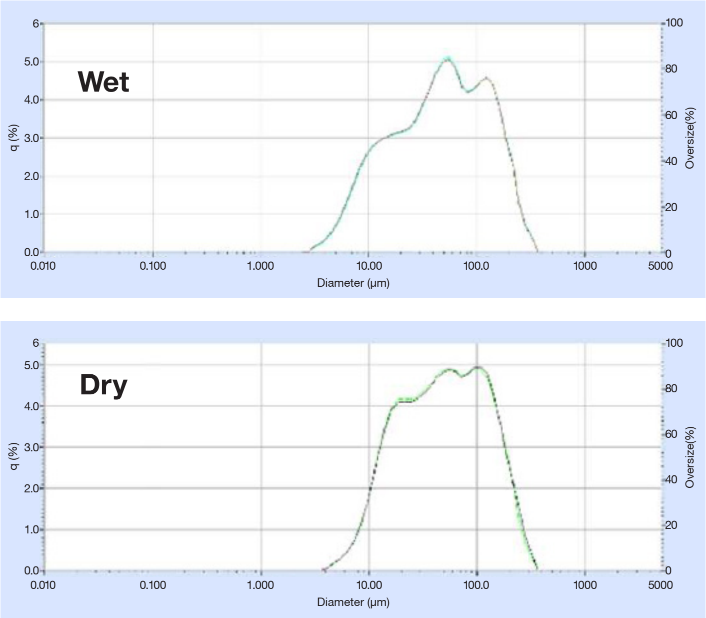

Figure 2. Particle Size Distribution profile for analysis of wheat flour in wet and dry mode respectively.

Figure 2 shows the overlay of size distribution profiles obtained in repeatable runs from both wet and dry measurements, confirming the excellent repeatability of the obtained data. The system reports data in the form of cumulative percentage over the reported particle size as shown in Table 1. For instance, D10 shows that 10 percent of particles are above the reported size of 243 micron in wet method and above 248 micron in dry method. The two analysis modes, wet and dry, showed no significant deviation for the reported values of D10 to D90 confirming a good correlation. This further ensures the proficiency of both the application modes of laser diffraction in efficiently analyzing wheat flour.

Cumulative %	Oversize Data (µm)	
	Wet	Dry
D10	243.27	247.76
D20	177.99	181.26
D30	130.46	136.95
D40	95.93	102.15
D50	73.32	76.88
D60	54.82	57.00
D70	38.04	40.96
D80	24.67	29.01
D90	15.45	20.01

Table 1. Cumulative % at given diameter data derived from laser diffraction analysis of wheat flour in both wet and dry mode.

A comparison made between the traditional sieve method and the advanced laser diffraction technology is shown in Table 2. A notable difference can be observed amongst the data that can be majorly attributed to the difference between the two technologies. The sieve method employs vibration forces that often break down larger particles, allowing them to pass through small size sieves. This is clearly evident from the data where the percentage of coarser particles in sieve is less, while that for finer particles is more, compared to the data obtained from laser diffraction technology.

Size (µm)	Sieve Data (%)	LD Data (%)	
		Wet	Dry
+425	0.08	0.74	0.945
+315	0.64	3.30	3.71
+212	8.13	10.14	10.00
+150	14.01	11.44	12.11
+118	13.27	7.49	8.35
-118	63.87	66.89	64.88

Table 2. Comparison of Sieve vs. Laser Diffraction (wet and dry) data for wheat flour.

Moreover, sieving is not a suitable technique for measuring fine particles typically < 30 µm. A minimum of 30 minutes analysis time is required for a single measurement which further delays the milling process. Laser diffraction technology however ensures increased throughput and high productivity with far more rapid analysis time of a few seconds. A big advantage of the technique is the enormously wide measurement range, extending high accuracy towards finer particles typically below 1 micron. Therefore, as a technique that measures particle size distribution for both wet and dry dispersions, LD offers many advantages over traditional methods: high precision, fast response time, high potential for the repetition of results, reduced manual interventions, and a wide measurable particle diameter range.

Conclusion

The LA-960V2 system delivers actionable results in less than one minute and reliable measurement of particles with wide size range for wheat flour analysis. The study clearly indicates that the technology allows us to overcome the limitations of traditional sieving methods and supports the food industry to enhance productivity in a shorter span of time.