Moisture and Solids Analysis of Dairy Powders and Ingredients

Introduction

Rapid and accurate moisture and solids determination are critical measurements for dairy powder manufacturers. These metrics are used to control blending formulations, minimize energy costs of dryers, and confirm finished product specifications. Dairy powder manufacturers analyze a variety of wet and dry samples, including incoming raw materials, in-process slurries, and dry finished products. Deviations in blending formulations can lead to inefficiencies in pumping and spraying of in-process slurries as well as discrepancies in moisture contents of finished products. Moisture variances in finished dairy powders can compromise taste and nutritional quality, and more importantly, lead to microbial spoilage if levels are too high.

Traditional moisture/solids analysis techniques have fallen short in their abilities to analyze both wet and dry products in a single instrument. Infrared balances are capable of analyzing dry finished products but face challenges with high moisture samples (i.e. cream, milk, liquid whey) since they only penetrate the surface of the sample. Alternatively, microwave only systems can rapidly measure moisture in wet raw materials but are prone to burning and product degradation of dry, low moisture powders.

The SMART 6 Moisture and Solids Analyzer utilizes dual-frequency energy to rapidly analyze any product, wet or dry, in 3 minutes or less. By combining microwave and infrared, the SMART 6 harnesses the advantages of both technologies to rapidly drive off moisture in any product. The low frequency microwaves penetrate the entire sample and rapidly remove free water through dipole rotation, while infrared evenly heats the surface and removes bound water through molecular vibration. The two energy sources work in unison, providing significant advantages over infrared only and microwave only instrumentation.

To demonstrate the ability of the SMART 6 for rapid moisture and solids analysis, an assortment of 20 incoming liquid dairy products, in-process slurry, and dairy powder samples were analyzed. The liquids and in-process slurry spanned a range of ca. 6.0 – 47.0 % solids, while the finished product dry powders ranged from ca. 1.5 – 6.5 % moisture.

Key System Benefits

- Rapid, ≤ 3 minute analysis
- Analyze both wet and dry dairy products on a single system
- Direct moisture and solids determination through loss on drying
- AOAC approved methodology for dairy products- AOAC PVM 1:2004

Sample Preparation and Analysis

Various dairy products were analyzed using the SMART 6 Moisture and Solids Analyzer. Each sample was mixed using a spatula prior to analysis or gently tumbled for liquids.

Notes:

Powders:
For best results, dairy powder samples should be stored in an airtight container that contains no spaces or cracks and has the least amount of headspace possible.

Cream:
For best results, cream samples (particularly unhomogenized cream) should be obtained and analyzed as closely as possible to the production date. If significant amounts of solids are visible when sampling cream, it may be difficult to obtain a representative sample (even after tempering).

Figure 1. SMART 6 Moisture and Solids Analyzer

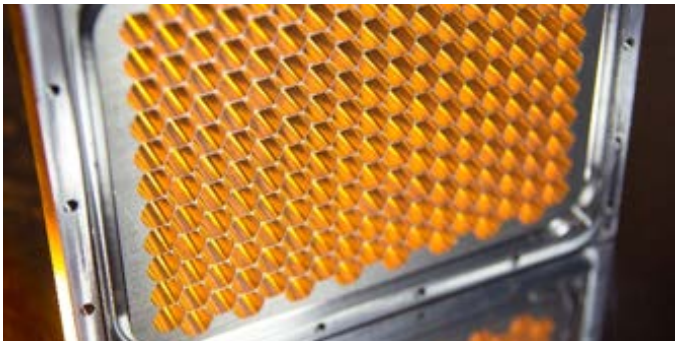

Figure 2. Multiple technological advancements are built into the SMART 6. Its honeycomb lattice, for example, provides collimated infrared radiation for sample heating, therefore avoiding stray light. This allows for highly accurate temperature control.

Results and Discussion

The accuracy and precision of the SMART 6 Moisture and Solids Analyzer for various incoming liquid dairy products, in-process slurry, and dairy powder samples are demonstrated in Tables 1 through 4. The average of three SMART 6 replicates are compared with moisture or solids values obtained following AOAC 927.05 (Moisture in Dried Milk) for powders and AOAC 990.20 (Solids in Milk) for liquids.

Table 1 and **Table 2** demonstrate the accuracy of the SMART 6 for the 20 dairy products analyzed, while **Table 3** and **Table 4** highlight its precision. The difference between the SMART 6 and oven was 0.00 – 0.09 % solids for incoming liquid dairy products and in-process slurry as shown in **Table 1**, and 0.01 – 0.15 % moisture for dairy powders as shown in **Table 2**. The standard deviation of the SMART 6 for incoming liquid dairy products and in-process slurry ranged from 0.02 – 0.14 % solids as shown in **Table 3**, and 0.01 – 0.10 % moisture for dairy powders as shown in **Table 4**.

Table 1. Accuracy of SMART 6 for Solids in Incoming Liquid Dairy Products and In-Process Slurry

	% Solids		
Sample	**SMART 6**	**Oven**	**Difference**
Cream	46.88	46.79	0.09
Creamer Slurry	43.84	43.77	0.07
Milk (Whole)	11.88	11.89	0.01
Whey (Liquid)	6.38	6.38	0.00
		Average	0.04

Table 2. Accuracy of SMART 6 for Moisture in Finished Dairy Powders

	% Moisture		
Sample	**SMART 6**	**Vacuum Oven**	**Difference**
Cheese Powder 1	2.91	2.94	0.03
Cheese Powder 2	4.93	4.79	0.14
Cheese Powder, Nacho	4.08	4.06	0.02
Creamer Powder, ~0.5% Butterfat	5.35	5.32	0.03
Creamer Powder, ~27% Butterfat	4.03	4.11	0.08
Creamer Powder, ~72% Butterfat	1.52	1.66	0.14
Lactose Powder 1	5.33	5.48	0.15
Lactose Powder 2	4.14	4.00	0.14
MPC 85	5.13	5.17	0.04
MPI 90	5.14	5.21	0.07
Nonfat Dry Milk Powder	2.06	1.97	0.09
Sweet Whey Powder	5.60	5.57	0.03
Whey Powder	2.76	2.65	0.11
Whey Protein Concentrate	6.21	6.33	0.12
Whey Protein Isolate	6.07	6.09	0.02
Whole Milk Powder	4.78	4.77	0.01
		Average	0.08

Table 3. Precision of SMART 6 for Solids in Incoming Liquid Dairy Products and In-Process Slurry

	Replicates (% Solids)					
Sample	**1**	**2**	**3**	**Average**	**Range**	**StDev**
Cream	46.86	46.90	46.88	46.88	0.04	0.02
Creamer Slurry	43.69	43.96	43.87	43.84	0.27	0.14
Milk (Whole)	11.86	11.87	11.91	11.88	0.05	0.03
Whey (Liquid)	6.33	6.39	6.41	6.38	0.08	0.04

Table 4. Precision of SMART 6 for Moisture in finished Dairy Powders

	Replicates (% Moisture)					
Sample	1	2	3	Average	Range	StDev
Cheese Powder 1	2.92	2.93	2.89	2.91	0.04	0.02
Cheese Powder 2	4.95	4.96	4.88	4.93	0.08	0.04
Cheese Powder (Nacho)	4.12	4.08	4.05	4.08	0.07	0.04
Creamer Powder ~0.5% Butterfat	5.42	5.33	5.29	5.35	0.13	0.07
Creamer Powder ~27% Butterfat	4.08	4.02	4.00	4.03	0.08	0.04
Creamer Powder ~72% Butterfat	1.50	1.53	1.54	1.52	0.04	0.02
Lactose Powder 1	5.28	5.34	5.38	5.33	0.10	0.05
Lactose Powder 2	4.19	4.13	4.10	4.14	0.09	0.05
MPC 85	5.15	5.27	5.09	5.17	0.18	0.09
MPI	5.31	5.19	5.13	5.21	0.18	0.09
Nonfat, Dry Milk Powder	4.84	4.75	4.76	4.78	0.09	0.05
Sweet Whey Powder	5.57	5.69	5.53	5.60	0.16	0.08
Whey Powder	2.82	2.79	2.67	2.76	0.15	0.08
Whey Protein Concentrate	6.17	6.14	6.33	6.21	0.19	0.10
Whey Protein Isolate	6.06	6.06	6.08	6.07	0.02	0.01
Whole Milk Powder	2.07	2.06	2.06	2.06	0.01	0.01

Conclusion

These results indicate that the SMART 6 is able to reliably match existing reference methods for moisture and solids analysis of a variety of incoming dairy liquids, in-process slurry, and dairy powders. This makes the SMART 6, with its combined use of microwave and infrared technology, an ideal solution for any powder manufacturer seeking rapid, reliable results.

United States (Headquarters)
800-726-3331
704-821-7015
Fax: 704-821-7894
info@cem.com

France
33 (01) 69 35 57 80
Fax: 33 (01) 60 19 64 91
info.fr@cem.com

Germany, Austria, Switzerland
(49) 2842-9644-0
Fax: (49) 2842-9644-11
info@cem.de

Ireland
+353 (0) 1 885 1752
Fax: +353 (0) 1 885 1601
info.ireland@cem.com

Italy
(39) 35-896224
Fax: (39) 35-891661
info.srl@cem.com

Japan
+81-3-5793-8542
Fax: +81-3-5793-8543
info@cemjapan.co.jp

United Kingdom
(44) 1280-822873
Fax: (44) 1280-822873
info.uk@cem.com

www.cem.com