Rapid Total Solids Analysis for Household Cleaning Products

Introduction

Most household cleaning products are comprised of a mixture of high-cost active ingredients and low-cost filler, such as water. Accurately verifying the total solids content is the key to minimizing material costs per batch, which should be performed as quickly as possible to expedite batch release and minimize production down time. Because of the wide variety of volatile components present in a given sample, solids testing has traditionally been performed in an air or vacuum oven, which is effective at drying all sample types, but takes hours to complete. Infrared-only analyzers reduce the time it takes to analyze products, compared to air oven methods, but can still take up to 25 minutes to completely dry liquid detergents and softeners, which tend to re-condense inside the drying cavity, due to a lack of active ventilation. Microwave-only analyzers can perform a total solids test in minutes, but the presence of glycerin tends to result in sample scorching. Furthermore, microwave-based analyzers are ineffective at completely drying certain products that contain non-aqueous volatile components which are not excited by microwave energy. Indirect techniques, such as NIR and FT-IR have been introduced to perform rapid analysis, but require costly calibrations and are sensitive to slight variations in color and formulation.

The SMART 6™ total solids analyzer is uniquely designed to handle a wide variety of household goods and their ingredients, whether they are water-based, contain a mixture of volatile components, or are a high-solids paste. The SMART 6 utilizes dual-frequency energy, specifically microwave and infrared, to rapidly analyze solids content. Low frequency microwaves penetrate the entire sample to rapidly remove bound moisture through dipole rotation, while high-frequency infrared energy evenly heats the surface through molecular vibration. The two energy sources work in unison, providing benefits over microwave-only and infrared-only analyzers, with results in less than 4 minutes.

This study demonstrates that the SMART 6 can rapidly analyze a wide range of household goods for total solids with an average difference of less than 0.08 % compared to reference methods.

Key System Benefits

- **Direct loss on drying** – Direct analysis of any sample without the need for expensive, time consuming calibrations.
- **Versatile** – Analyze any wet or dry product, including powders, in-process mixes, pastes, and gels.
- **Reliable** – Worry free analysis without discrepancies due to variation in color, density, consistency, or formulation.
- **Simple** – Intuitive touchscreen user interface facilitates rapid analysis regardless of operator experience level.

Experimental

To evaluate the performance of the SMART 6 total solids analyzer, four different household goods were commercially obtained: dish detergent, dish paste, laundry detergent, and fabric softener. For solids determination, a 1.00 to 2.00 gram sample of each product was analyzed in the SMART 6 using a combination of microwave and infrared energy for rapid and consistent drying. Reference testing for solids content was performed in triplicate in an air oven at 100 °C for 4 hours to establish a basis of comparison.

Results

Results for percent solids using the SMART 6 ranged from 0.04 – 0.08 % difference compared to oven methods, demonstrating the high degree of accuracy of the SMART 6 analyzer, as shown in **Table 1**. **Table 2** highlights the precision of the SMART 6 dual frequency drying capabilities, which was ≤ 0.12 % standard deviation for all samples analyzed.

Conclusion

The SMART 6 total solids analyzer, using dual-frequency energy, completely dried samples in 4 minutes or less without scorching, regardless of consistency or volatile contents. Total solids results compared favorably to reference testing, with an average difference of less than 0.08 %. By combining microwave with infrared energy, the benefits of both sources are realized and the result is rapid, complete drying for all sample types with excellent precision and accuracy.

Table 1: Accuracy of SMART 6 Technology Compared to Reference Methods

	Percent Solids		
Sample	**SMART 6**	**Oven**	**Difference**
Dish Detergent	28.53	28.57	0.04
Dish Paste	78.50	78.42	-0.08
Laundry Detergent	10.50	10.55	0.05
Fabric Softener	3.28	3.33	0.05

Table 2: Precision of SMART 6 Technology

	Percent Solids Replicates												
Sample	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Average**	**Range**	**Std. Dev.**
Dish Detergent	28.46	28.48	28.61	28.55	28.60	28.50	28.47	28.50	28.70	28.45	28.53	0.22	0.08
Dish Paste	78.42	78.56	78.57	78.54	78.40	78.50	78.34	78.60	78.60	78.54	78.50	0.25	0.08
Laundry Detergent	10.61	10.33	10.50	10.65	10.50	10.50	10.52	10.50	10.20	10.55	10.50	0.37	0.12
Fabric Softener	3.20	3.24	3.27	3.27	3.26	3.32	3.33	3.33	3.35	3.25	3.28	0.15	0.05

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