



Compositional Analysis

Dairy Industry



Moisture/Solids

Fat

Protein

Who we are

At our core, we are Chemists, Engineers, and Manufacturers, all under one big roof. Together, we passionately design and develop laboratory instruments that are used by major companies, prestigious research institutes, and universities around the world. We are proud of what we do, and we hope it shows. With over 50,000 instruments sold, you've probably used a product that has been tested with a CEM instrument. That fact motivates us to push harder to create better instruments, to help solve more problems for the scientific community of tomorrow.



Founding Fathers (circa 1980)

Chemist: Dr. Michael J. Collins (Middle)

Electrical Engineer: Ron Goetchius (Left)

Mechanical Engineer: Bill Cruse Jr. (Right)



Greetings.

I feel very fortunate to be living the American Dream. In 1978, CEM started in a garage with two other people, and has grown into a major global scientific instrumentation company, now employing over 300 people worldwide. We have shipped more than 50,000 systems, which are being used in laboratories throughout the world. Our success is based on introducing new “disruptive” technologies, which have created significant value for the customers we serve.

Our approach is focused on developing the absolute best technique possible for the compositional analysis of dairy products. When using our products, you can have confidence that you will obtain extremely accurate and repeatable results. Compared to reference techniques, our technology is much easier and safer to use.

Compared to other rapid techniques, our technology is more accurate and robust, while maintaining very rapid test times. For these reasons, we've sold thousands of compositional analysis systems, used in most of the top global dairy companies.

I am excited about the future and look forward to working with all of you as we continue to bring major new innovation to the food industry and the various other markets we serve.

Sincerely,

A handwritten signature in black ink that reads "Mike Collins". The signature is written in a cursive, flowing style.

Michael J. Collins PhD
President and CEO

Instruments



SMART 6

Microwave + Infrared Moisture & Solids Analyzer

The gold standard in moisture and solids analysis.

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ORACLE

Rapid NMR Fat Analyzer

The first ever rapid fat analyzer with no method development.

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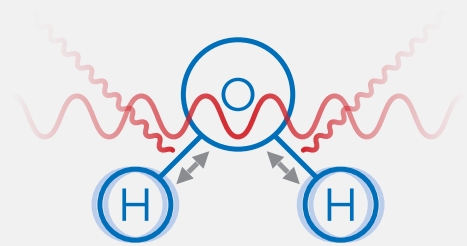
Sprint

Rapid Protein Analyzer

For rapid, safe and direct determination of protein.

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Key Technologies

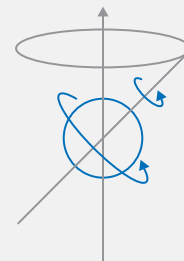


Dual-Frequency Drying

Innovative Heating Process

Analyze wet and dry samples with unmatched speed.

p.9

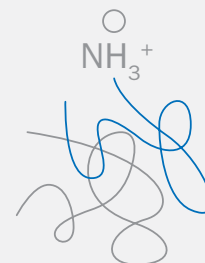


NMR Technology

Universal Fat Analysis

Get more repeatable results, than with wet chemistry reference methods.

p.14



iTag

Protein Binding Process

Get results faster and more accurate than with Kjeldahl or combustion techniques.

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The Most Accurate Analysis of Fluid, Semi-Solid, and Solid Dairy Products

- CEM's fat and solids technology is more accurate than NIR/FT-NIR systems
- Analyze any type of dairy product on the same instrument
- Eliminates recalibration and results drifting over time

With mid-infrared (FT-IR) based methods being unable to analyze more viscous dairy products, NIR/FT-NIR has been used as an alternative technology with its fast analysis time. However, a major weakness of NIR is that its signal is based on overtones of the fundamental bands, which reside within the mid-infrared wavelength. Therefore, its signals are weak and difficult to separate, requiring the use of complex method development and calibration. Maintaining accurate results is also difficult as the analysis is susceptible to even small changes in sample composition, which makes NIR use often unreliable.

Our technology overcomes the limitations of NIR technology for compositional analysis of any dairy product, while still being based on simple, safe, and rapid approaches. Moisture/solids results are obtained in minutes by iPower®, a dual-frequency drying process that removes moisture and provides a direct measurement. Fat analysis is performed by a revolutionary NMR based process, developed in 2016, that directly and unambiguously detects fat molecules in dairy products. This 30 second method is completely free of calibrations. Additionally, the entire sample is analyzed instead of a small area, which protects against inhomogeneity issues.

Accuracy

Accurate Moisture/Solids and Fat in < 5 Minutes

	Moisture/Solids			Fat		
Sample	SMART 6	Oven	Difference	ORACLE	Mojonnier	Difference
Skim Milk	9.28	9.26	0.02	0.19	0.18	0.01
Yogurt	20.69	20.56	0.13	1.17	1.15	0.02
Low Fat Milk	10.95	10.91	0.04	2.00	2.01	0.01
Whole Milk	11.88	11.89	0.01	3.20	3.18	0.02
Ice Cream	39.13	39.07	0.06	13.52	13.56	0.04
Half and Half	18.44	18.47	0.03	10.08	10.08	0.00
Processed Cheese	41.58	41.50	0.08	30.98	31.02	0.04
Natural Cheese	37.07	37.03	0.04	32.74	32.72	0.02
Cream Cheese	65.44	65.40	0.04	22.85	22.91	0.06
Cream	46.88	46.86	0.02	41.54	41.58	0.04
Sour Cream	26.48	26.54	0.06	17.76	17.67	0.09
Average			0.05	Average		0.03

* Moisture/solids analysis with SMART 6 in 2-3 minutes

** Fat analysis with ORACLE in 30 seconds

Peer Reviews

“CEM’s rapid analysis platforms and excellent customer service have had a positive impact on nearly every aspect of our business, from accounting and quality, to research and development. No other technology has allowed us to achieve these benefits across all our products, from milk and cheese, to concentrated milk powders.”

Chalmer Wren IV / Instrumentation Specialist:
Analytical Services
Leprino Foods

“The CEM ORACLE Fat Analyzer has demonstrated the ability to eliminate daily calibrations used with previous technology for a broad range of samples while maintaining high sample accuracy and precision. As one of the global leaders in food testing this is very beneficial for our testing needs.”

Timothy Lumb / Chemistry Manager, Food & Pharmaceuticals
ALS

“While using the CEM NMR based system, we have accurate fat and moisture analysis. The CEM NMR based system is convenient and easy to use with repeatability also better compared to other systems. This allowed us to optimize our process by having consistent results from raw to finished product.”

Nathan G. Labante / Quality Assurance Supervisor
Saputo Dairy Foods USA, LLC

“We use the CEM SMART with NMR technology for fat and moisture determination in all our ice cream mix produced; raw material and semi-finished materials as well. A considerable time saving and excellent reliability are major advantages of this instrument.”

Piero Scotto / Quality Analyst
Unilever Ice-cream Plant (Algida)



Analyze Fluid and Viscous Dairy Products Without Homogenization

- ORACLE and SMART 6 eliminate clogging and cuvette damage (associated with FT-IR technology)
- Exceptional repeatability for fat and solids analysis

Analysis of liquid milk samples has traditionally been performed by FT-IR based methods. This process is based on a transmissive infrared measurement that requires uniform particle sizes to avoid light scattering. For this reason, FT-IR systems utilize an initial sample homogenization to obtain uniform fat globule sizes, while also eliminating entrapment of protein. However, many types of non-standard milk samples now exist, which contain added ingredients that are problematic for the complete homogenization that is essential for FT-IR analysis. This includes milk products containing DHA, chocolate milk, and sweetened or condensed milk. These additives can cause significant wear on the instrument from the need to forcibly pump the sample through an extremely small opening ($\leq 50 \mu\text{m}$) for measurement.

Incomplete homogenization results in significant costly risks to the instrumentation, as well as affecting sample calibrations from the wearing of the flow cell wall. In fact, complete homogenization is so critical that monitoring by routine light-scattering particle size analysis of homogenized milk samples is recommended when using FT-IR systems¹.

Analysis of these samples by our technology is simple and easy, without the need for any homogenization. Regardless of the type of added ingredients to a dairy sample, the analysis is accurate and repeatable without risk of damage to the instrumentation. Accuracy can match the results of FT-IR, while exceeding less accurate NIR/FT-NIR methods.

¹Marzo, L.D.; Barbano, D.M.; *J. Dairy Sci.* 99, 9471-9482 **2016**

Repeatability

Repeatable Moisture/Solids and Fat in < 5 Minutes

Sample	Component	Replicates			Average	Range	Std. Dev.
		1	2	3			
Skim Milk	Moisture/Solids	9.27	9.28	9.28	9.28	0.01	0.01
	Fat	0.17	0.19	0.20	0.19	0.03	0.02
Yogurt	Moisture/Solids	20.69	20.73	20.65	20.69	0.08	0.04
	Fat	1.20	1.15	1.15	1.17	0.05	0.03
Low Fat milk	Moisture/Solids	10.94	10.95	10.97	10.95	0.03	0.02
	Fat	2.01	2.00	2.00	2.00	0.01	0.01
Whole Milk	Moisture/Solids	11.86	11.87	11.91	11.88	0.05	0.03
	Fat	3.21	3.19	3.21	3.20	0.02	0.01
Ice Cream	Moisture/Solids	39.16	39.16	39.06	39.13	0.10	0.06
	Fat	13.56	13.46	13.54	13.52	0.10	0.05
Half and Half	Moisture/Solids	18.42	18.48	18.41	18.44	0.07	0.04
	Fat	10.13	10.04	10.08	10.08	0.09	0.05
Processed Cheese	Moisture/Solids	41.47	41.63	41.63	41.58	0.16	0.09
	Fat	30.97	30.99	30.99	30.98	0.02	0.01
Natural Cheese	Moisture/Solids	37.05	37.00	37.15	37.07	0.15	0.08
	Fat	32.72	32.87	32.64	32.74	0.23	0.12
Cream Cheese	Moisture/Solids	65.43	65.42	65.48	65.44	0.06	0.03
	Fat	22.91	22.82	22.82	22.85	0.09	0.05
Cream	Moisture/Solids	46.86	46.90	46.88	46.88	0.04	0.02
	Fat	41.55	41.54	41.53	41.54	0.02	0.01
Sour Cream	Moisture/Solids	26.47	26.45	26.51	26.48	0.06	0.03
	Fat	17.76	17.77	17.75	17.76	0.02	0.01

* Moisture/Solids analysis with SMART 6 in 2-3 minutes

** Fat analysis with ORACLE in 30 seconds

Peer Reviews

“We use CEM’s SMART 6 with NMR instrument 24/7 for milk based liquid products as well as almond products. The testing is very simple and new hires catch on pretty quickly. It is low maintenance and we rarely see issues with it that cause production to slow down.”

Maria Yepez / Assistant QA Manager

HP Hood LLC

“Our CEM SMART 6 and NMR systems have provided consistent and repeatable moisture/solids and fat results for our fluid milks, ice creams, buttermilks, half & half, and heavy cream. It was easier to calibrate and yielded more consistent results than the FT-IR systems I have used in the past. Additionally, the system is simple to use and train new employees.”

Timothy Melin / Assistant QA Manager

Upstate Niagara Coop Inc.

“Our infrared (IR) system had difficulties obtaining good calibrations with cultured products, and we also struggled with any flavorings or inclusions (ex. fruit pieces) in our yogurt and other cultured products... CEM’s NMR technology is easier to calibrate, provides directly measured solids results (as well as fat contents), and does not require dilutions or other significant sample prep. The system gives extremely rapid results, more accurate than our standard method (Gerber) we used for flavorings and inclusions, while also having better precision when used by plant operators.”

William E Ellison II / Quality Assurance & Compliance Manager

Kemps Farmington Cultured Products



Safe and Easy Alternative to Kjeldahl for Protein Analysis with Sprint

- No harsh chemicals
- Rapid test with minimal training required
- Not fooled by adulterants

The Kjeldahl method has been used for determination of protein content in dairy products since its development in 1883. This method is undesirable because it requires the use of heated sulphuric acid and sodium hydroxide in a multi-step process. However, it is currently a standard method for reference analysis of dairy products.

Our Sprint® system is a breakthrough for protein analysis of dairy samples. It is an AOAC approved method and has demonstrated great success in replacing Kjeldahl for routine analysis. The system is extremely simple to use, binds only to protein, and doesn't use any harsh or dangerous chemicals.

	CEM Sprint System	Kjeldahl	Dumas Combustion
Sample Types	Any dairy product	Any dairy product	Dry products (powders)
Harsh Chemicals	X	✓	X
Rapid	✓	X	✓
Analyze Entire Sample	✓	✓	✓
Repeatability	High	Lower	Lower
Susceptible to Adulteration	X	✓	✓

Safe Alternative to Kjeldahl

Accuracy of Sprint for Crude Protein in Finished Yogurts

Sample	% Protein		Difference
	Sprint	Kjeldahl	
Yogurt 1, Plain	3.56	3.50	0.06
Yogurt 2, Plain	4.07	4.07	0.00
Yogurt 3, Plain	4.29	4.33	0.04
Yogurt 1, Fruit	3.18	3.11	0.07
Yogurt 2, Fruit	3.57	3.60	0.03
Yogurt 3, Fruit	3.76	3.71	0.05
Yogurt, Greek, Plain	10.15	10.20	0.05
Yogurt, Greek, Honey	8.32	8.28	0.04
Yogurt, Greek, Blueberry	8.50	8.54	0.04
Yogurt, Greek, Peach	7.18	7.15	0.03
Yogurt, Greek, Pineapple	7.17	7.13	0.04
Yogurt, Greek, Strawberry	8.11	8.18	0.07
Average			0.04



Peer Reviews

“...The plant uses the instrument running over 100 samples on a daily basis to screen & test raw milk, pre-pasteurized standardized milk, whey permeate and finished products such as yogurt & ice cream. The Sprint unit has excellent repeatability and is invaluable in terms of maximizing profitability & obtaining consistency in terms of maintaining the standard specifications of finished products & raw materials.”

Roland Klimm / Director of Cultured Products

Fairlife, LLC

“We use the Sprint for protein analysis of a variety of dairy products. The Sprint system is a MUCH safer and simpler way to test protein contents than the method we previously used.”

Cynthia Kallstrom / Quality and Technical Manager

Kerry Inc.

“The Sprint instrument is very easy to use. Because of this the operator can check the recipe to adjust the production. The final product is always in the specifications since we use the Sprint.”

Marie-Eve Gauthier / Quality Supervisor

Parmalat Canada Inc.

“The Sprint has provided accurate and consistent protein determination for our milk products used for cheese production. We love the system and have found it user friendly, efficient, and reliable.”

Tracy Kruger / Assistant Laboratory Manager

Lactalis American Group

“The Sprint is used to determine the protein content of incoming ingredients, intermediate products/work in progress, as well as finished products. It has been a very helpful instrument in providing process control for our products.”

Laura Sinclair / Corporate QA Manager

Gay Lea Foods Co-operative Ltd.



SMART 6™

Rapid Protein Analyzer

The gold standard in moisture/solids analysis.

Overview

The SMART 6™ is the most technologically advanced system in the world for rapid moisture/solids analysis. The system is based on the revolutionary new breakthrough called iPower for sample drying. This patented, dual-frequency energy source provides the most rapid and complete drying available, for the widest range of sample types.

Features

- Up to 40 % faster than CEM's SMART 5 Turbo™
- Analyze both dry and wet products on one system
- Preprogrammed methods for all sample types
- Compact and lightweight for easy at-line placement

Validation

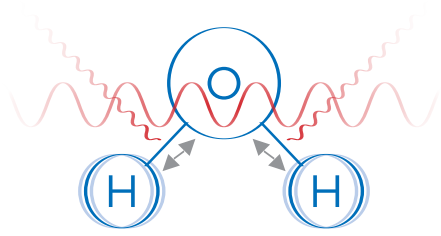
- 985.14 (AOAC)
- AOAC 2008.06
- AOAC PVM 1.2004



Over 11,000 moisture analyzers sold worldwide

Key Technologies

Dual-Frequency Drying

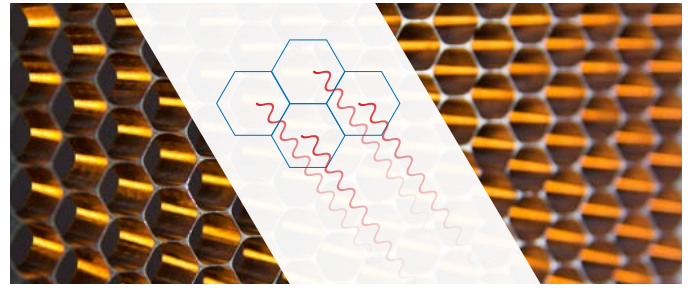


Analyze wet and dry samples with unmatched speed.

An innovative heating process based on the use of a dual-frequency energy source controlled by an intelligent processing system. This prevents burning or incomplete drying, which can arise from other drying technologies. The result is a direct method for virtually any type of sample, with faster drying than traditional microwave or infrared based systems.

- Analyze wet and dry samples with unmatched speed
- Eliminates surface burning
- Little to no “cool down” time between tests

Collimated Energy

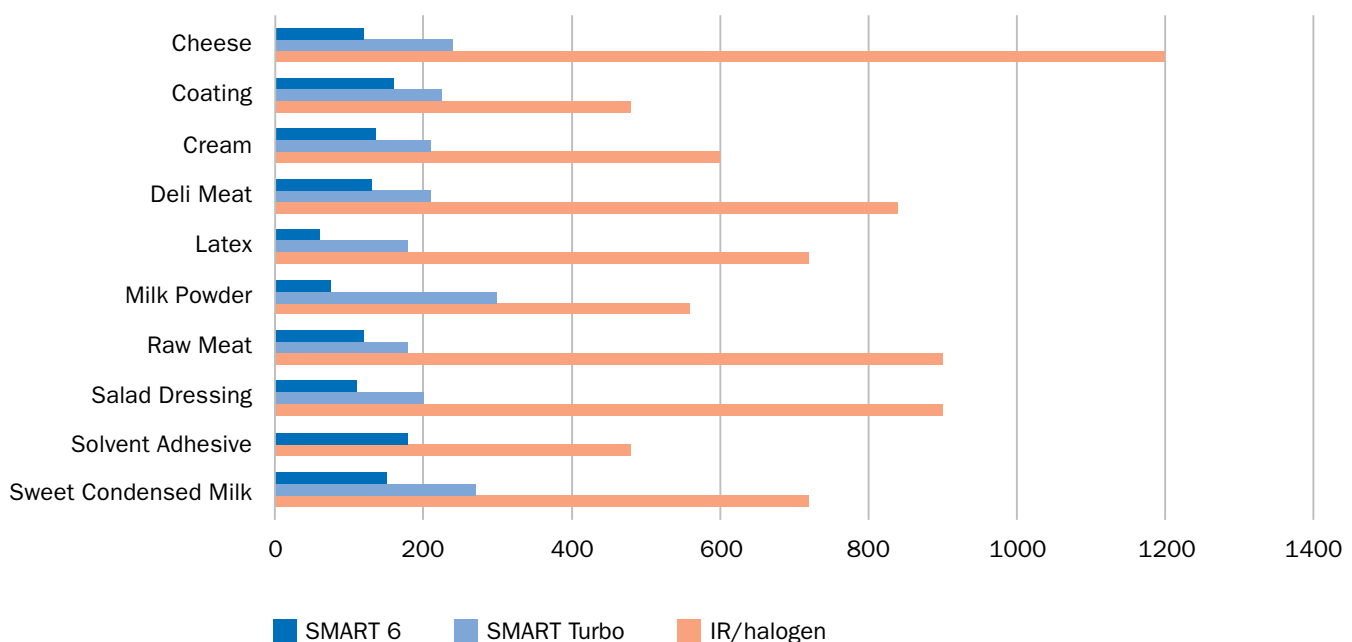


Accurate and repeatable results come standard.

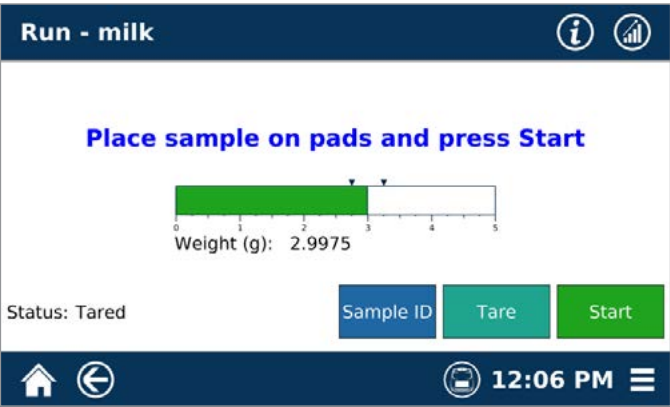
Stray infrared irradiation can negatively impact sample temperature readings with the use of infrared temperature sensors. SMART 6 has a unique honeycomb lattice, providing collimated infrared irradiation for sample heating, hereby avoiding stray light. This provides highly accurate temperature control.

- Extremely uniform drying
- Unmatched reproducibility

Time Comparison



Easy-to-Use



Simply add sample to balance and press “Start”.

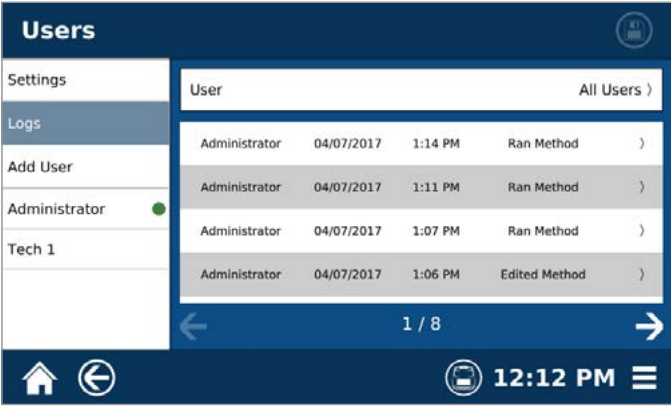


Access real-time run data.

Full 21 CFR Part 11 Compliance



Protect data and methods with a hierarchy of user levels.



Review a complete audit trail with printable records.

Monitor Production Trends



Create SPC charts with user specified limits.



Visualize trends directly on SMART 6 or LIMS network.

Accessories

Internal Printer

Thermal impact printer for printing sample results directly from the SMART 6. The printer is located inside the unit thereby not requiring extra space.

Monitor Kit

Specialized solution with measured reference value for verifying SMART 5 or SMART 6 system performance.



AutoCal

Simple and fast NIST traceable calibration for
SMART 5 or SMART 6 IR temperature sensors.

Exhaust Tubing

Exhaust tubing that can be connected to the back of the SMART 6 to remove volatile fumes to a desired location.



ORACLE™

Rapid NMR Fat Analyzer

The first ever rapid fat analyzer with no method development.

Overview

ORACLE is the first ever rapid fat analyzer that requires absolutely **no method development** for fat only analysis. At the touch of a button, ORACLE can analyze fat in any food sample with reference chemistry accuracy, without any prior knowledge of the sample matrix or composition. Simply press the run arrow and ORACLE delivers an exceptionally accurate and precise fat result in 30 seconds. Alternatively, ORACLE can be paired with the SMART 6 for combined rapid fat and moisture/solids analysis in less than 5 minutes.

Features

- Rapid- 30 second analysis
- Analyze any sample from 0.05 – 100.00 % fat
- Direct isolation and measurement of hydrogen protons on fat molecules
- Precise- better repeatability than wet chemical extraction techniques

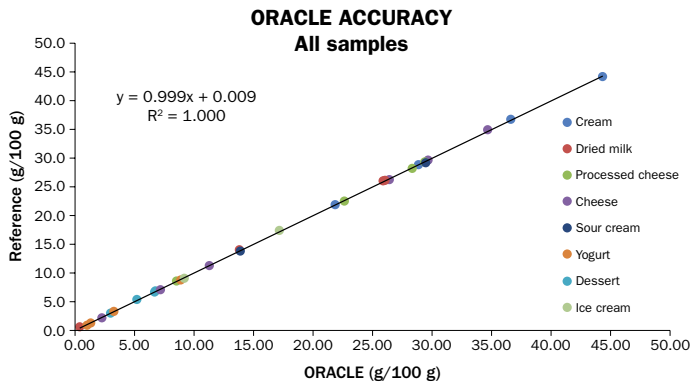
Validation

- AOAC Official Method 2008.06 (Moisture and Fat in Meats)
- AOAC PVM 1:2004 (Moisture/Solids and Fat in Dairy Products)

Awards

- 2017 IFT Food Expo Innovation Award
- Top 3 New Products at PITTCON 2017

Benefits



Accurate and Repeatable Fat Results in 30 Seconds.

ORACLE underwent an extensive dairy evaluation at Actalia Cevalait¹ (Poligny, France) with exceptional results.

Several matrices were examined, including: cream, powdered milk, processed and natural cheese, sour cream, yogurt, dessert, and ice cream, spanning a range of ca. 0.5 – 45.0 % fat. Actalia concluded that the ORACLE was able to match reference chemistry (within error) and was more repeatable than reference chemistry for all samples.

¹ Actalia is a COFRAC accredited laboratory that specializes in providing technical and scientific input into the validation and unification of analytical methods, with expertise in dairy analysis.

No Method Development

ORACLE is the first rapid fat analyzer that requires absolutely no method development, when used as a stand-alone system. At the touch of a button, ORACLE can analyze fat in any food sample with reference chemistry accuracy, without any prior knowledge of the sample matrix and composition. Simply press the run arrow, and in 30 seconds the ORACLE delivers an exceptionally accurate and precise fat result. It's really that simple.



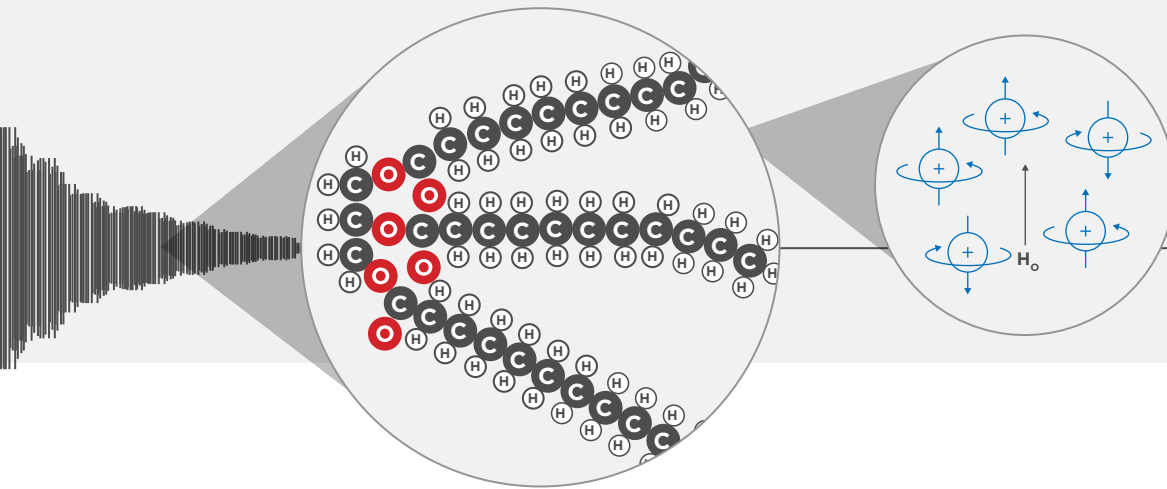
Rapid Moisture/Solids and Fat Analysis

Pair the SMART 6 with the ORACLE for rapid moisture/solids and fat in one combination system. 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 two energy sources work in unison and provide significant advantages over infrared-only and microwave-only technologies.



A Major Breakthrough in NMR Technology

This newly developed technique, achieved in 2016, completely isolates the detection of the proton signal in fat molecules from all other compositional proton sources (i.e. protein, carbohydrate, ash) making universal fat analysis possible. Alternative rapid techniques are unable to fully isolate fat from other components, which is why extensive calibration development is often required.



Consistent

All ORACLE systems are manufactured and designed to produce the same results worldwide, making the system an ideal solution for corporations seeking to standardize rapid instrumentation. Alternative rapid fat analyzers are susceptible to differences in optics and system components, which prevents them from transferring methods between various locations. That means that each system requires unique method development, which ultimately translates to extensive time and capital costs. Plus, there's no guarantee that the results will match. Not so with the ORACLE.

Versatile

ORACLE is designed to operate in any lab setting, from process control in food production sites (at-line and in-lab) to certified testing laboratories. For labs seeking rapid moisture/solids analysis, in addition to fat analysis, the ORACLE can be paired with the newly developed SMART 6 analyzer for moisture/solids results in about 5 minutes. Alternatively, labs who run 50 or more samples per day may choose the stand-alone ORACLE high throughput solution, where samples are dried in an oven overnight, and subsequently run through the ORACLE in batch mode.



ORACLE
Rapid NMR Fat Analyzer



SMART 6
Microwave + Infrared
Moisture & Solids Analyzer

Accessories

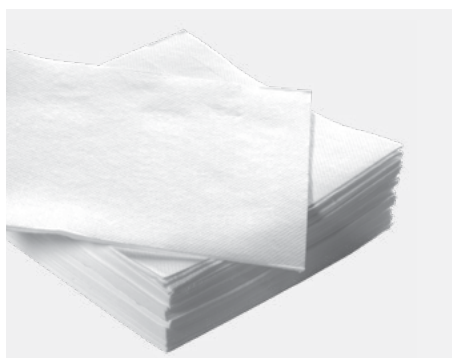


Automated High-Throughput Processing

Process up to 100 samples unattended. Analyze large batches on the ORACLE with the high-throughput robot accessory. The robot can be used with two high-throughput sample conditioning blocks. Data analysis is stored for each sample and can be reviewed at any time.

High-Throughput Sample Conditioning

This accessory is effective for temperature conditioning large batches of up to 50 samples. Pre-dry large batches in a vacuum or convection oven, and condition in a 50 place high-precision heater block. Individual samples can then be run sequentially on the ORACLE in less than 30 seconds.



Sample Pads

These pads are tested to ensure they meet the requirements for absorbency, moisture content, and mechanical strength. They are approved for use in AOAC methods.



Trac Film

Our proprietary Trac Film™ sample wrap consists of proton-free components designed to be used with the ORACLE system. Trac Film ensures an absolute minimum interference for fat determination by NMR. Each batch is individually tested to ensure that this standard is continuously met.



ORACLE Tubes

These specialized tubes are for holding samples in the ORACLE.

Like Trac Film, ORACLE tubes are designed to minimize interference and ensure accurate fat analysis.



Sprint®

Rapid Protein Analyzer

For rapid, safe,
and direct protein
determination.

Overview

The Sprint® is an advancement for protein analysis based on a rapid green chemistry process allowing for direct protein detection in less than 5 minutes. It replaces the conventional Kjeldahl method for analysis of dairy and meat products. Using the Sprint is as simple as weighing the sample, placing it in the system, and pressing "Start".

Features

- Direct method for protein determination (not nitrogen conversion)
- Remarkably easy to use
- More repeatable than Kjeldahl & combustion techniques

Validation

- Automates AOAC Methods 967.12 (Milk), 930.33 (Ice Cream & Frozen Desserts), and 930.29 (Milk Powder)



Awarded the Presidential Green
Chemistry award in 2009 through the US
Environmental Protection Agency (EPA)

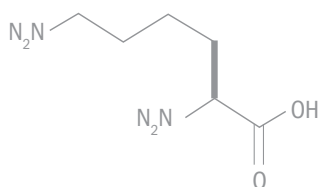
Key Technologies



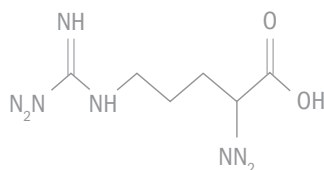
Protein Binding with iTag[®]

All proteins contain amino acids. The basic amino acids that are found in foods are Arginine, Histidine and Lysine. Our proprietary iTag solution binds to protein at these three amino acid sites using an acid group. The aromatic portion of the iTag molecule absorbs light and is easily detected with a colorimeter.

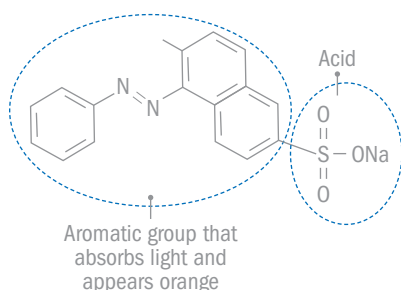
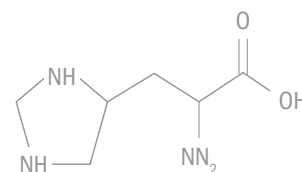
Lysine



Arginine



Histidine



Our Process, More Accurate than Kjeldahl

A pre-determined amount of iTag solution is added to a sample, then homogenized to release the proteins. The iTag molecules bind to the proteins, and are removed from solution. The remaining iTag is drawn up through a disposable filter into the built-in colorimeter. The amount of iTag bound to the protein is determined and the results displayed. The entire process takes only 2 – 3 minutes for most samples, and yields results that are more accurate than Kjeldahl or combustion techniques.

Sprint Publications

- Park, C.W.; Parker M.; Drake M.A., *J. Dairy Sci.* 99, 4303-4308 **2016**
- Paiva, I.M. et al., *Rev. Inst. Laticínios Cândido Tostes*, Juiz de Fora, 70, 192-199 **2015**
- Campbell, R.E.; Boogers I.A.L.A., Drake M.A., *J. Dairy Sci.* 97, 1313-1318 **2014**
- Park, C.W.; Bastian E.; Farkas, B., Drake M.A., *J. Food Sci.* 79, C19-C24 **2014**
- Desai, N.T.; Shepard L.; Drake M.A., *J. Dairy Sci.* 96, 7454-7466 **2013**
- Listiyani, M.A.D. et al., *J. Dairy Sci.* 94, 4347-4359 **2011**
- Campbell R.E.; Miracle R.E.; Drake M.A., *J. Dairy Sci.* 94, 1185-1193 **2011**
- J.K. Amamcharla, L.E. Metzger, *J. Dairy Sci.* 93, 3846-3857 **2010**
- Zhao D.; Jai V.; Farkye N.Y. T88 *J. Anim. Sci.* 88, E-Suppl. 2 **2010**.



We Simplify Science

cem.com



Over 50,000
systems sold
worldwide



CEM has been an
ISO-certified facility
since 1994



All systems serviced &
supported by experts
with an average of 15
years of experience



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R&D, the result...
11 R&D 100 awards



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