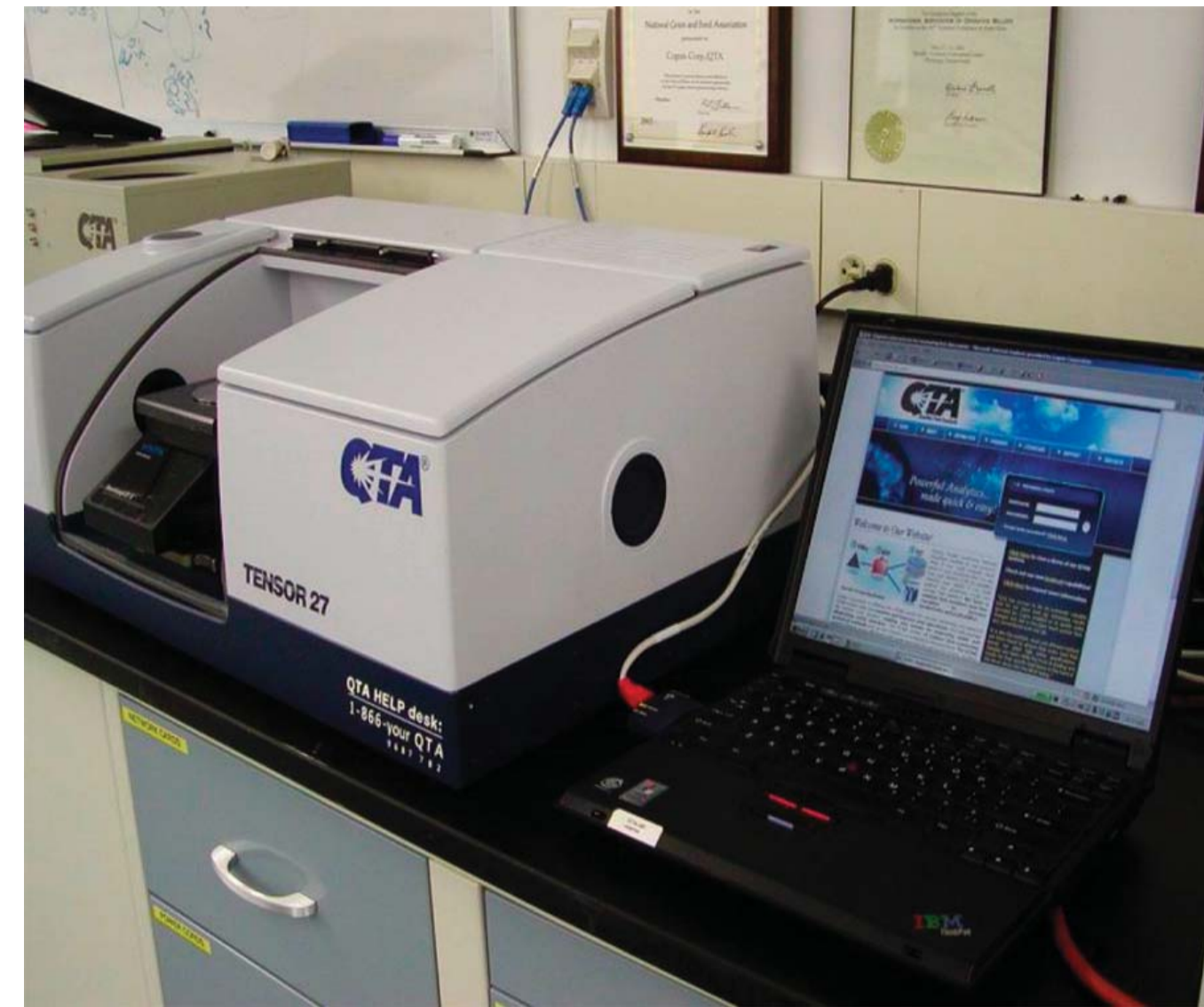


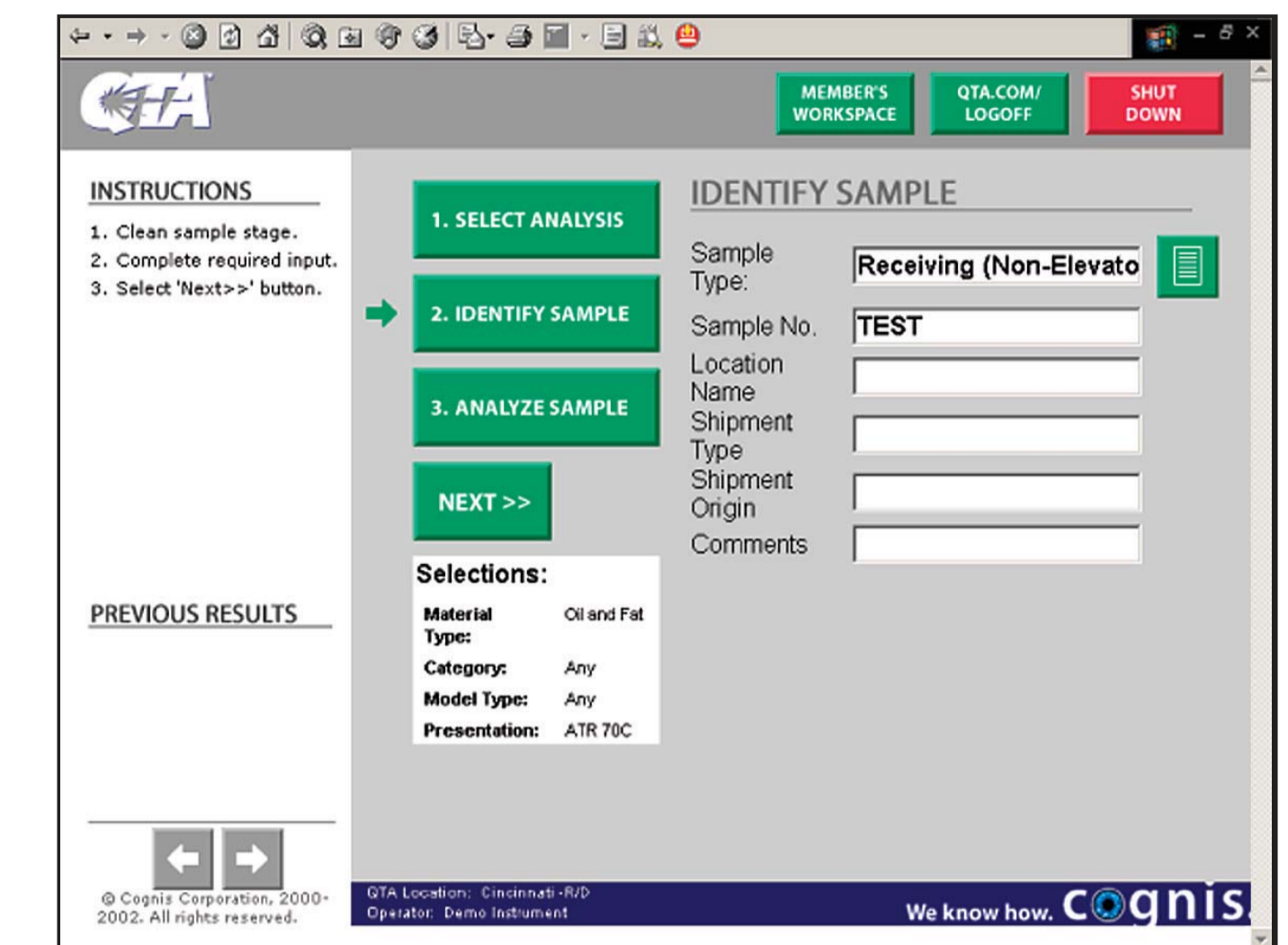
# A networked InfraRed spectroscopy analysis system for biodiesel analysis ensures accuracy & consistency



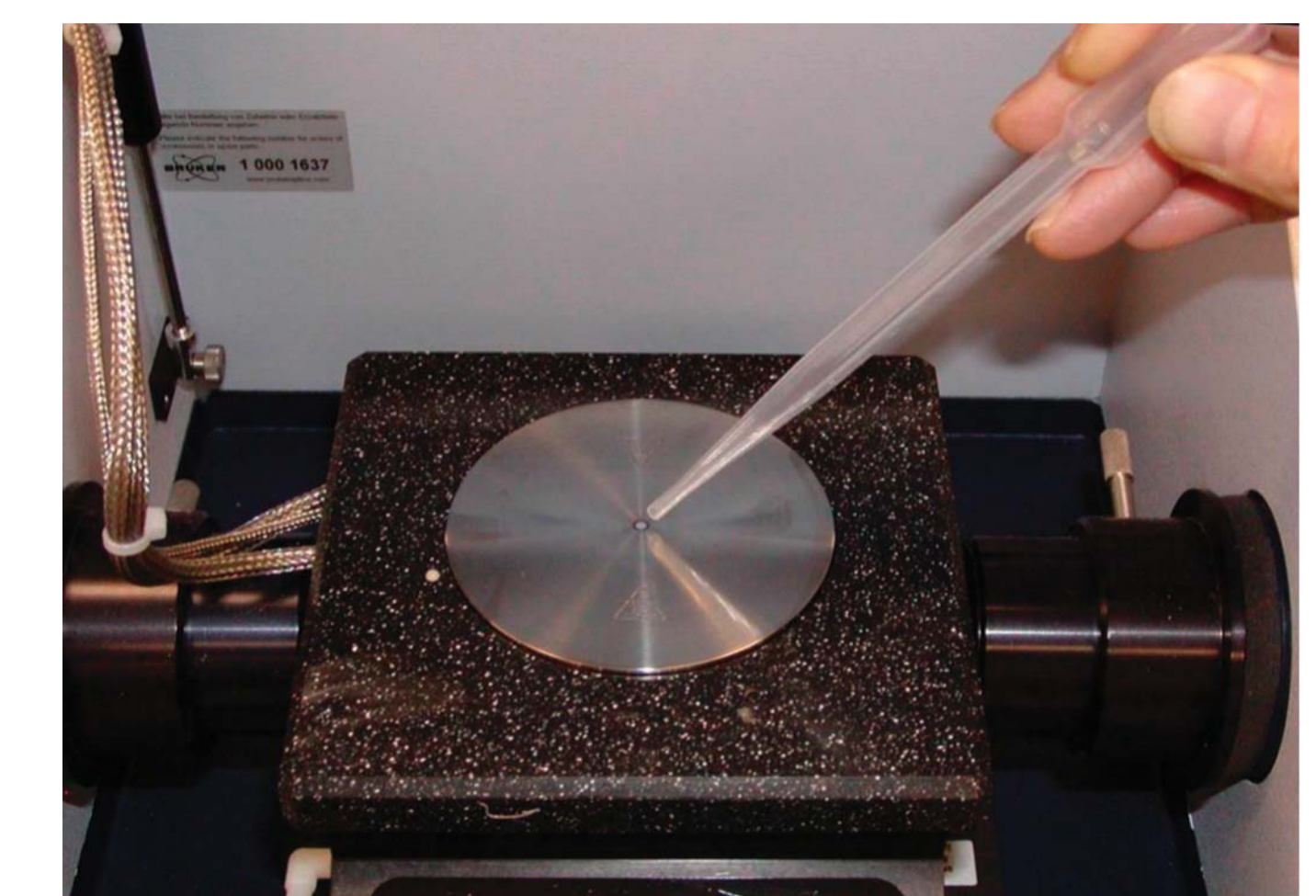
A novel system for biodiesel analysis includes an infrared spectrometer, connected over the internet to a centralized calibration system and database. By centralizing the calibrations, consistency and accuracy are ensured, without variability between biodiesel production facilities. Calibrations have been developed for a wide variety of feedstocks and blends, and primary data was generated using ASTM and EN standard test methods.



A simple user interface is provided, to eliminate the need for skilled analytical personnel at the production facility; rather the system is designed to be used by production operators.



Infrared analysis allows for analyses to be conducted in less than two minutes, with no sample preparation. More frequent analysis is encouraged for both the finished biodiesel product, the in-process samples, as well as the glycerin byproduct and incoming feedstock.



A round robin was conducted to compare nine networked infrared spectrometers. Reference data was provided by up to 4 different wet chemistry labs using ASTM & EN methods. Six biodiesel production facilities provided up to 6 samples each, of varying feedstock and production processes. Same day blind replicates and different day replicates were included.

Biodiesel Tests	Units	Method
Ester content	% m/m	EN14103
Density @ 15°C	Kg/M <sup>3</sup>	EN ISO 3675 OR 12185
Viscosity @ 40°C	mm <sup>2</sup> /s	EN ISO 3104
Water content	mg/kg	EN ISO 12937
Acid value	mg KOH/g	EN 14104
Iodine value		EN 14111
Methanol content	% (m/m)	EN 14110
Monoglyceride content	% (m/m)	EN 14105
Diglyceride content	% (m/m)	EN 14105
Triglyceride content	% (m/m)	EN 14105
Free glycerol	% (m/m)	EN 14105/6
Total glycerol	% (m/m)	EN 14105/6
Oil Tests		
Free fatty acids	% (m/m)	AOCS Ca-5a-40
Moisture	% (m/m)	AOCS Ca-2e-84 (KF)
Glycerin Tests		
Moisture	% (m/m)	AOCS Ea-8-58 (KF)
Methanol	% (m/m)	GC

The central calibrations are maintained and validated over time by skilled chemometricians and spectroscopists.

Calibration Statistics Summary		
	Correlation, R <sup>2</sup> , %	Std error of prediction
Water by KF, %	88	0.006
Acid number, mg KOH/g	88	0.10
Cloud point, deg C	93	1.4
Total glycerin, %	93	0.02
Free glycerin, %	96	0.002
Methanol, %	98	0.028
Mono-glycerides, %	94	0.12
Di-glycerides, %	98	0.05
Tri-glycerides, %	98	0.16
Esters, %	95	0.4
Density, kg/m <sup>3</sup>	97	0.4
Viscosity @ 40 deg C, mm <sup>2</sup> /sec	94	0.075
Iodine Value	99	0.9

Property	Average Standard Deviation	
	Networked Infrared Spectroscopy	Wet Lab
Moisture (KF)	0.008	0.007
Acid Value	0.10	0.07
Cloud Point	0.85	2.30
Total glycerin	0.021	0.022
Free glycerin	0.0023	0.0059

Property	Bias
	Average of wet labs - average of networked infrared spectrometers
Moisture (KF)	-0.02
Acid Value	0.03
Cloud Point	-0.06
Total glycerin	-0.01
Free glycerin	0.001

The data clearly demonstrate that high quality, robust calibrations are in place for biodiesel analysis using a networked infrared spectroscopy system. The variability of these networked FT-IR systems is less than or equal to ASTM and EN methods, when calibrations are properly developed, maintained and validated. The networked FT-IR system is significantly easier to use and promotes biodiesel quality.

Barbara Stefl  
Barbara.stefl@cognis.com  
513-482-3135

Cognis Corporation  
4900 Este Avenue  
Cincinnati, OH 45232

Nan Wang  
nan.wang@cognis.com  
513-482-2828

