



# Thermometric Titration with OMNIS – fast, simple, and reliable

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YOU  
CAN  
TRUST

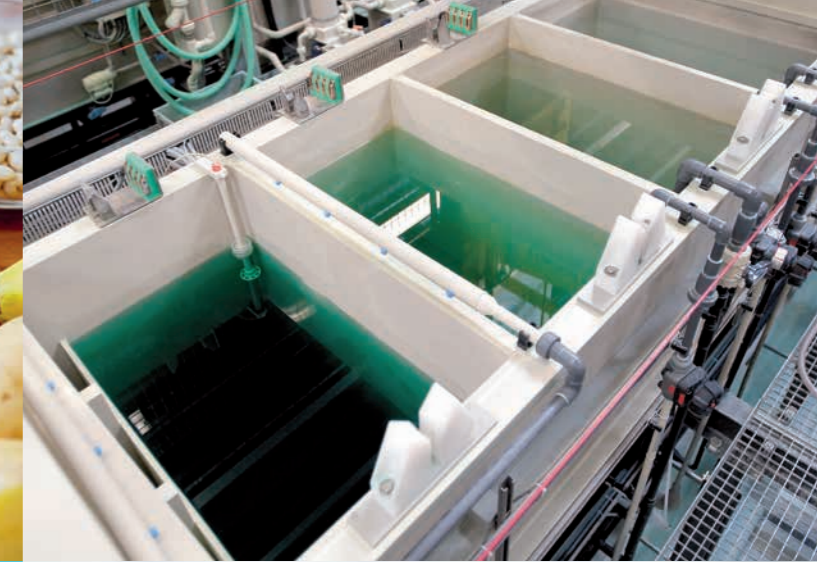
 **Metrohm**

# What is thermometric titration?

Titration is one of the oldest and most common chemical analysis techniques in the world. However, a suitable potentiometric sensor is not always available for every application challenge. Fortunately, observing the changes in the potential of these sensors is not the only way to follow a chemical reaction. Another option is monitoring the reaction enthalpy, i.e. thermometric titration. In fact, every chemical reaction is accompanied by a change in enthalpy ( $\Delta H$ ):

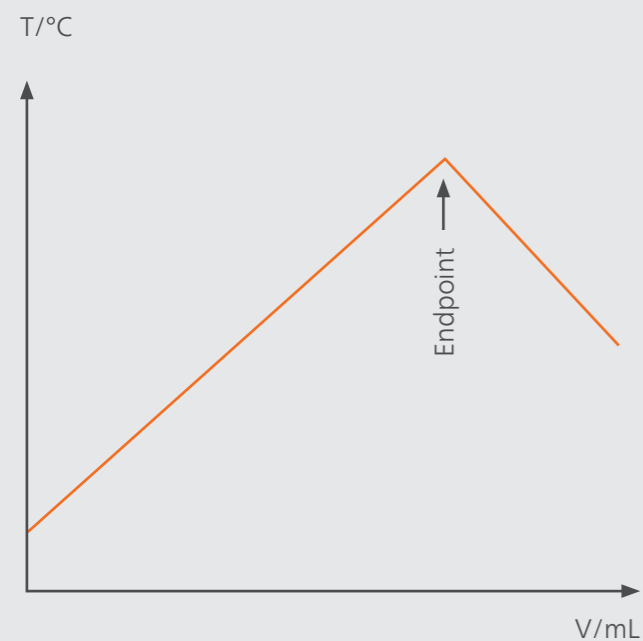
$\Delta H = \Delta G + T\Delta S$ , where  
 $\Delta G$  = change in free reaction energy  
 $T$  = absolute temperature  
 $\Delta S$  = change in reaction entropy

As the chemical reaction takes place, either an increase (exothermic reaction) or decrease (endothermic reaction) can be registered in the sample solution. This increase or decrease of the temperature is related to the converted amount of sample. In summary, this means that in thermometric titration a change in the temperature is observed as long as the added titrant reacts with the analyte in the sample solution.

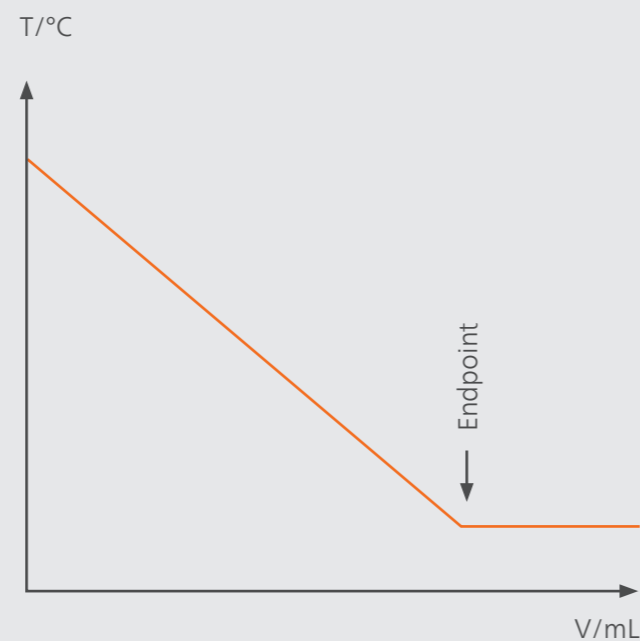


## WHY THERMOMETRIC TITRATION?

- A problem solver for difficult samples that cannot be titrated potentiometrically
- Fast – results within a minute
- No additional hardware needed – thermometric titration is available in OMNIS
- Robust method for high-throughput routine analysis
- Well suited for aggressive media
- One sensor for all applications
- No sensor calibration needed
- Maintenance-free sensor (no diaphragm, no membrane, no electrolyte)



Exothermic titration



Endothermic titration

## Application overview TET

Thermometric titration is a highly versatile technique. In principle any chemical reaction with a sufficiently large temperature change can be monitored.

Analyte	Matrix	Titrant
Total acid number (TAN)	Mineral oils, biodiesel, edible oils...	KOH in isopropanol
Total base number (TBN)	Mineral oils, biodiesel, edible oils...	HClO <sub>4</sub> in acetic acid
Acid mixtures (HF, HNO <sub>3</sub> , H <sub>2</sub> SO <sub>4</sub> ...)	Electroplating baths	NaOH
Phosphate	Liquid/solid NPK fertilizer	Mg(NO <sub>3</sub> ) <sub>2</sub>
Sulfate	Liquid/solid NPK fertilizer	BaCl <sub>2</sub>
Sodium	Salts, foodstuff	Al(NO <sub>3</sub> ) <sub>3</sub> / KNO <sub>3</sub> solutions
Magnesium & Calcium	Milk	Na <sub>4</sub> EDTA

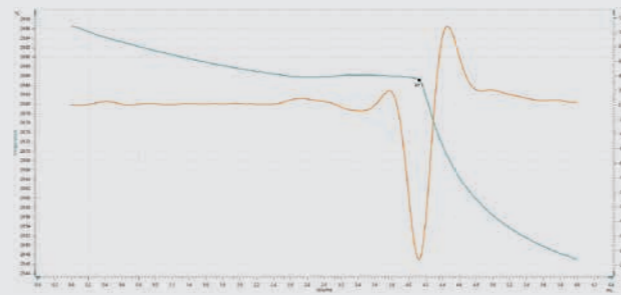


# Application examples

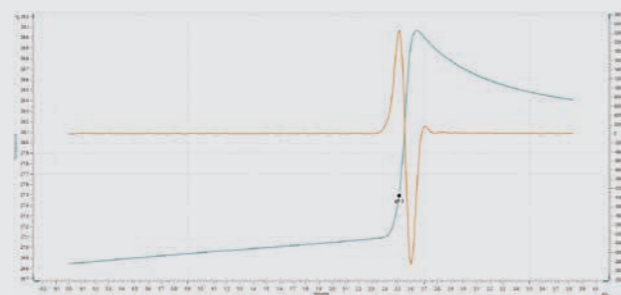
## CATALYTICALLY ENHANCED THERMOMETRIC TITRATION FOR DETERMINATION OF ACID NUMBER (AS PER ASTM D8045)

ASTM D8045 describes the simple, fast, and robust determination of total acid number (TAN) by thermometric titration in petroleum products. The chemical reaction is catalytically enhanced with paraformaldehyde to obtain a pronounced change of the temperature of the sample solution. Catalytic enhancement is needed, if the target analyte is present in the sample in only low concentrations or if the chemical reaction is characterized by a low enthalpy. The same principle can be applied for the determination of total base number (TBN) where isobutyl-vinyl-ether is used as catalyst.

The same method as for TAN can also be used to determine free fatty acids in edible oils, which then allows conclusions to be drawn on the oxidation stability/quality of the oil or fat.



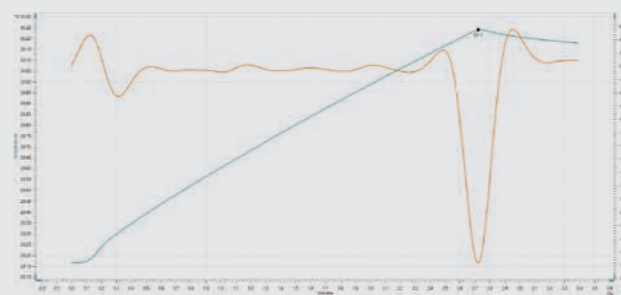
Titration curve of TAN analysis by thermometric titration



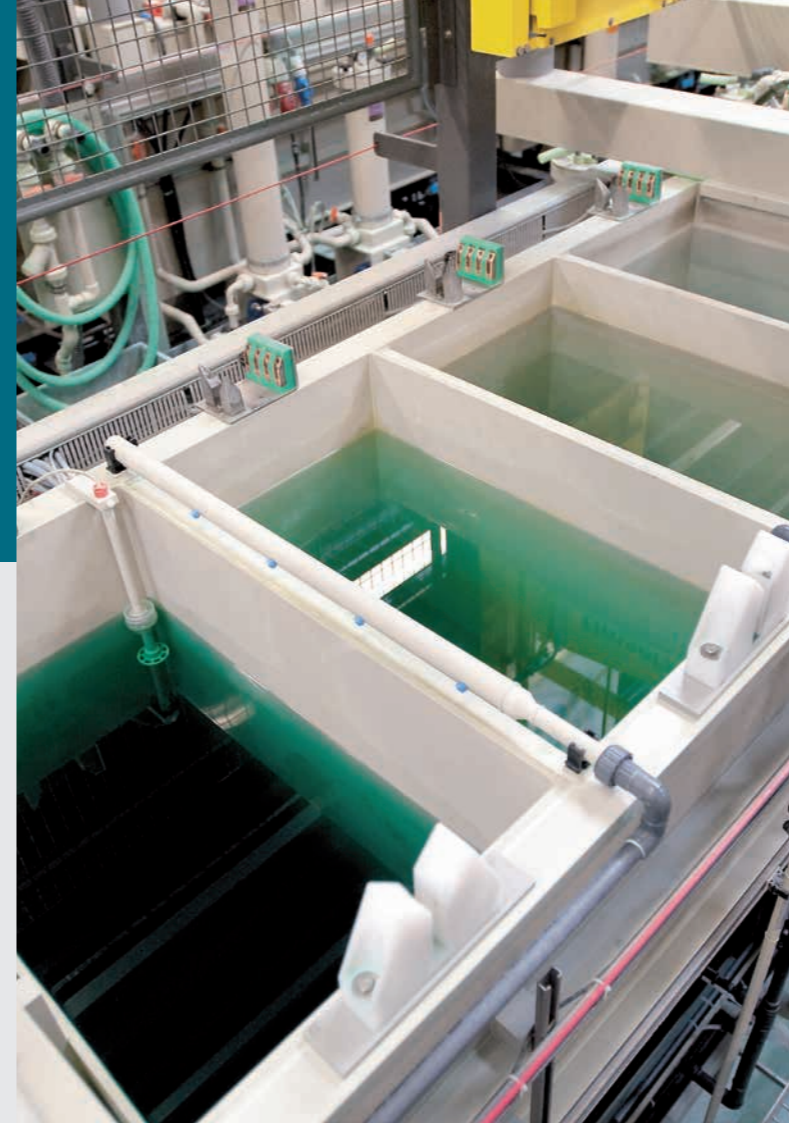
Titration curve of TBN analysis by thermometric titration

## ANALYSIS OF FERTILIZERS

In liquid or solid fertilizers, the phosphate or sulfate content can be analyzed fast by thermometric titration. Traditionally, these parameters have been determined gravimetrically, which is a rather time consuming and complex procedure. Both, phosphate and sulfate, are determined in a precipitation titration with magnesium and barium, respectively.



Titration curve of phosphate analysis by thermometric titration



## ANALYSIS OF ELECTROPLATING BATHS

Electroplating baths are complex matrices and often contain mixtures of several acids. When used in such environments, potentiometric sensors need careful cleaning and maintenance.

As the sensor for thermometric titration is highly robust and maintenance-free, this method is ideal for measuring such matrices. Moreover, with thermometric titration, it is easier to determine the third endpoint of phosphoric acid. In potentiometric titration this is only possible upon addition of sodium chloride, while with thermometric titration the third endpoint is visible without spiking the sample.

## SODIUM DETERMINATION

Sodium is present in many different food-stuffs such as potato chips, (soy) milk, instant noodles, cheese, and many more. Often it is present as sodium chloride, i.e., plain table salt.

Excessive consumption of sodium chloride is known to be detrimental to human health, which is why the world health organization (WHO) recommends a limit of no more than 5 grams table salt per day. With thermometric titration you can determine the sodium content (and therefore also the salt content) in your sample reliably and accurately in less than three minutes.





# Thermometric titration and the OMNIS Titrator

## THE OMNIS THERMOMETRIC TITRATOR

With the «Functional license Thermometric Titrator», the OMNIS Titrator becomes a dedicated instrument for thermometric titration. It also includes pH and temperature measurement to support further routine laboratory measurements. For maximum stirring efficiency and precise titrations, a rod stirrer is recommended.

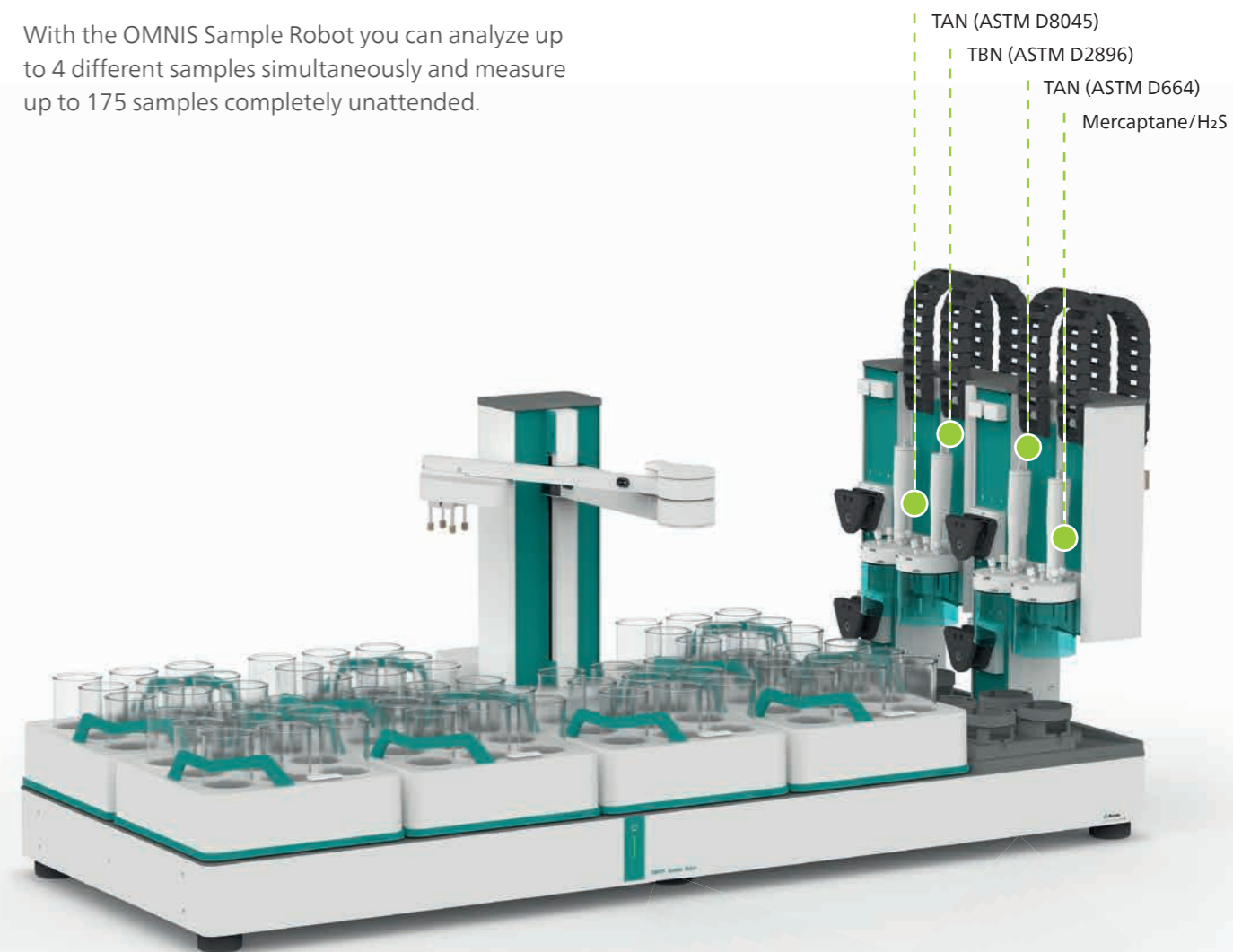
## MODULARITY AND SCALEABILITY

Expand your stand-alone OMNIS Titrator with up to four additional OMNIS Dosing Modules or OMNIS Titration Modules and you can perform up to five applications in parallel.

You can consolidate all your potentiometric and thermometric standard titration applications, e.g., for petrochemical analysis, on one fully automated OMNIS titration system.

## HIGHER SAMPLE THROUGHPUT NEEDED?

With the OMNIS Sample Robot you can analyze up to 4 different samples simultaneously and measure up to 175 samples completely unattended.



## ROBUST YET HIGHLY SENSITIVE – THE DIGITAL THERMOPROBE

The heart of thermometric titration is clearly the sensor – the digital Thermoprobe. The dThermoprobe includes a highly sensitive thermistor, which measures the enthalpy changes during the titration reactions. The dThermoprobe has a short response time of just 0.1 seconds and a high resolution of  $10^{-4}$  K which makes it highly suited for thermometric titration.

The dThermoprobe is available in two versions: dThermoprobe which is suitable for (non)-aqueous titrations and the dThermoprobe HF, which tolerates aqueous solutions containing HF.



## ORDERING INFORMATION

Instrument	
2.1001.0020	OMNIS Titrator with magnetic stirrer, without function license
2.1002.0010	OMNIS Titration Module without stirrer
2.1002.0110	OMNIS Titration Module with magnetic stirrer
2.1003.0110	OMNIS Dosing Module with magnetic stirrer
2.1006.0020	OMNIS Rod Stirrer Titration
6.02100.010	Measuring module digital
6.06001.130	Function license TET (for upgrading an existing OMNIS Titrator)
6.06001.930	Function license Thermometric Titrator (dedicated OMNIS Titrator for thermometric titration)
6.03001.120	OMNIS 2 mL cylinder unit
6.03001.150	OMNIS 5 mL cylinder unit
6.03001.210	OMNIS 10 mL cylinder unit
6.03001.220	OMNIS 20 mL cylinder unit
6.03001.250	OMNIS 50 mL cylinder unit
6.01117.300	dThermoprobe
6.01118.300	dThermoprobe HF
6.01405.000	5 x SGJ 14 titration vessel lid OMNIS
6.01406.220	20 – 90 mL titration vessel
6.01450.210	10 – 90 mL PFA titration vessel
6.01406.210	10 – 90 mL titration vessel