Initial recognition

With the standard S-shaped titration curve, the first criterion the titrator automatically searches for is an inflection point in the curve. This is indicated by a peak (either maximum or minimum) in a plot of the 1st derivative (slope) versus the volume of titrant added. To prevent erroneous recognition of a single spike as a peak, the titrator searches for peaks consisting of at least five data points, a maximum or minimum with at least two lower points before and two lower points after the peak (see fig. 1).

For the reason given above, the earliest the titrator can recognize an EQP is at the 4th measured point but only after two increments beyond the peak.

This fact is important in titrations with very low titrant consumption such as blank determinations. In such instances it is often better to perform the blank titration as an absolute end point rather than an equivalence point. It is
also important to note that any measured values during a predispense are not taken into account.

Even with the "5 points" rule, it is sometimes possible that this sequence of data points occur even when no equivalence point really exists. This can be due to an unstable measured signal, control parameters that are not optimal, poor stirring or local disturbances in chemical equilibrium in the sample. To prevent recognition of false EQPs there are four possibilities: Threshold, Range, Tendency and Steepest jump only.

**The Threshold**
The threshold value is essentially a minimum size that any peak in the 1st derivative should be in order to be recognized.

The best way to select an appropriate threshold value is to perform a titration to a selected maximum volume and print out the table of measured values or 1st derivative curve. Checking the 1st derivative column of the table of measured values, the actual size of the peak can be determined.

As a general rule, select a threshold of approximately 50% of the maximum (or minimum) for steep titration curves or 70-80% for flatter curves.

When setting the threshold value one should bear in mind that the purpose of the parameter is to prevent recognition of other minor peaks, so that in fact the threshold need only be greater than the next largest peak.

**The Range**
A second possibility in ensuring recognition of the correct equivalence point is to select a range within which the equivalence point should occur. This range is given in the unit of measure of the electrode used for the titration.

**The Tendency**
The third possibility is to specify the tendency or direction the titration curve should be following. This is specified as either positive or negative. Again, this applies to the plot of measured value versus titrant consumption.

By using these three criteria alone or in combination one is 99.9% assured of the titrator recognizing the correct equivalence point.

**The Steepest Jump**
In the odd case where it is almost impossible to get the correct EQP there is the choice of using only the steepest jump in signal as the EQP. In this case it is necessary to titrate to a predefined maximum volume.

Using these four recognition criteria 100% confidence that the correct equivalence point has been found is as much as guaranteed.

In the next issue of USERCOM the remaining parameters known as Evaluation and Termination criteria will be covered. Watch this space!
Eight Good Reasons for Using a PC Titration Software Program

You do not need a PC software program to use a METTLER TOLEDO titrator. Even complicated problems can be solved directly using the instrument. However, if extensive data analysis is needed, special documentation required or just simply results to be stored in a database, then a PC software program can make your work much easier. This article shows eight applications which can be solved using a PC software like METTLER TOLEDO DLWin Plus.

1. **Control all titrators with just one PC**
   PC software allows you to control multiple titrators from a personal computer. E.g. DL Win Plus can be used to control 7 different titrators and one balance. The titrators do not even have to be in the same laboratory as the PC. Using multitasking, samples can be analyzed simultaneously wherever they are. Each titrator is shown in its own window on the PC screen. This enables graphs, results and measured values to be monitored “live” on the screen.

2. **Save all your methods and settings**
   Have you ever spent ages developing a new method? Do you want to be sure that all titrators are using this same method? With a PC software program, you can save the method as well as other settings (titrants, sensors etc.) and transfer it to multiple titrators as needed. With DLWin Plus, it’s even possible to store all user data of a titrator in the computer in one step. This gives you the possibility to easily backup all your settings.

3. **Get a Better Overview of your results**
   Although the display of METTLER TOLEDO titrators is both large and clear, the overview on the PC screen is superior. A software such as DLWin Plus shows you everything at a glance: your results (saved in a database), titration curves, readings and statistics. Samples can be collated and processed using filter and sorting tools.

4. **Reevaluate critical measurement data**
   PC Software offers an easy way to determine results for measurements which were for some reason not found by the titrator. In DLWin Plus, you just display the titration curve of the measurement in question and apply one of the graphical evaluation methods on it. DLWin Plus offers five different methods: The Tubbs method (see Fig.), tangential and segmented evaluations, extrapolation (for Karl Fischer) as well manual determination of the result (useful together with the first derivative curve or for what-if evaluations). Of course, the reevaluation functions are also well suited for the verification of existing results.
Applications

5 Add curves, results and statistics to your reports

For most documentation needs, a direct printout from the titrator is enough. But if you need to include titration data into reports and documentation, PC software is very helpful. With DLWin Plus allows automatic or manual export of measurement data to Microsoft Excel or Word or any other wordprocessing, spreadsheet or database package. Even titration curves can be transferred by simply using the Copy/Paste function.

6 Transfer a method to multiple instruments

As mentioned before, DLWin Plus can save methods from the titrator into a PC-file. Method files can be put on a file server or any other storage medium to form a method database. Whenever needed, these methods can be transferred to any suitable titrator. It’s even possible to email a method to your factory on the other side of the globe!

7 Use Microsoft Excel for special calculations

Special evaluations, custom formatted curves or advanced statistical calculations can be easily carried out using Microsoft Excel. If you push the corresponding button in DLWin Plus, Microsoft Excel is automatically opened and the measurement is displayed as a nicely formatted table. Of course, you must have Microsoft Excel already installed on your PC.

8 Recalculate your Results

With the help of PC software, the recalculation of measurements you did even a long time ago are easily accomplished. With DLWin Plus, you can either use the formulas defined in the titrator or you build your own formulas using the formula editor.
The advantages of a high-speed homogenizer are listed below:
1. Procedure and stirring times can be significantly reduced.
2. Hazardous solvents such as formamide and chloroform can be eliminated.
3. Manual procedures are reduced by automation.
4. Increased accuracy of analysis as the samples are no longer exposed to ambient humidity.

The use of a high-speed homogenizer is ideal for the determination of water content in highly viscous samples. It allows direct and very efficient extraction of the water from substances like chocolate, mustard, butter, marmelade etc. in the titration vessel.

Table 1 shows the advantages of an homogenizer compared to traditional methods like e.g. external extraction, for several applications.

<table>
<thead>
<tr>
<th>Application</th>
<th>Type of sample</th>
<th>Traditional method</th>
<th>Advantage of the homogenizer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grains, starchy products</td>
<td>50 °C Dissolving in methanol/formamide 2:3</td>
<td>Analysis at room temperature Hazardous formamide eliminated</td>
</tr>
<tr>
<td></td>
<td>Chocolate</td>
<td>Long stirring time Dissolving in methanol/chloroform 2:1</td>
<td>Saves time, hazardous chloroform eliminated</td>
</tr>
<tr>
<td></td>
<td>Sweets</td>
<td>Grinding in a mortar, 50 °C Dissolving in methanol/formamide 2:3</td>
<td>Reduces manual procedures, increases accuracy, hazardous formamide can be eliminated</td>
</tr>
<tr>
<td></td>
<td>Powdered milk</td>
<td>External extraction in formamide</td>
<td>Reduces manual procedures, formamide is eliminated</td>
</tr>
<tr>
<td></td>
<td>Emulsions</td>
<td>Long stirring time Dissolving in methanol/chloroform 2:1</td>
<td>Saves time, hazardous chloroform is eliminated</td>
</tr>
<tr>
<td></td>
<td>Toothpaste</td>
<td>Externally extracting in methanol</td>
<td>Reduces manual procedures, saves time</td>
</tr>
<tr>
<td></td>
<td>Tablets</td>
<td>Grinding in a mortar</td>
<td>Reduces manual procedures, increases accuracy, saves time</td>
</tr>
</tbody>
</table>

Table 1
Two special adapter kits are available for using the homogenizer, so that two different models can be used. This depends on the application and availability within the particular country. Table 3 shows their applications and their suitability.

Table 2 explains the applicative suitability of both homogenizers. In general, it can be said that the model from Kinematica is more compact and can therefore be used without an additional lab stand. The IKA model is bigger and needs a lab stand, but it is a better solution for hard and coarse samples like tablets. METTLER TOLEDO offers a special adapter set for both homogenizers (Table 3).

### Which homogenizer for which application?

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Powdered milk</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Instant coffee</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Toothpaste</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Body lotion</td>
<td>•</td>
<td>•</td>
<td>•</td>
</tr>
<tr>
<td>Tablets</td>
<td>•</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2

### Homogenizers and adapter sets

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Drive unit</th>
<th>Generator</th>
<th>METTLER TOLEDO parts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kinematica</td>
<td>Polytron PT1200 CL</td>
<td>PT-DA1212/EC</td>
<td>Adapter set 12 Order number ME-51107534</td>
</tr>
<tr>
<td>IKA</td>
<td>Ultra-Turrax T25 Basic S 25 KV-18G S 25 KV-18G</td>
<td>18 Order number ME-51107409</td>
<td></td>
</tr>
</tbody>
</table>

Table 3
What Do You Do if you have a Sticky Sample?

People working with highly viscous samples like e.g. toothpaste know how difficult it can be to weigh the sample and bring it into the titration cell without losing some material. The usual tools like syringes or spatulas do not work nicely, because the sample sticks to them. This is not only inconvenient, but also leads to unprecise results.

METTLER TOLEDO, together with a Swiss customer has developed a special spatula; the Visco Spoon™. This is a spoon with a ground glass joint that exactly fits the opening of the titration vessel. Before analysis, the spoon is first tared, the sample (Fig: 1 and 2) then weighed (Fig: 3) and the Visco Spoon™ inserted (Fig: 4) into the opening of the titrator where it remains during the entire titration. A variation of this enables several samples to be easily and quickly analyzed by simply using three Visco Spoons one after the other.

A Protective Cover for METTLER TOLEDO Titrators

Protective keypad covers are now available for the following instruments: DL38, DL31, DL36, DL50 Graphix, DL53, DL55 and DL58. These covers are made of highly transparent and chemically resistant plastic and come in three to a packet. They protect the keypad and housing fronts of the titrators from corrosive chemicals or dirty substances. The DL5x protective cover can also be used to protect density meters and refractometers.
Titrating Edible Oils and Fats

Today, it is usual in the food industry to test oils and fats for their quality and acceptability. Routine procedures such as the determination of fatty acids, saponification number, iodine number, peroxide index and moisture content are all important aspects of the quality assurance laboratory.

In the new Application Brochure No. 24, all common tests in the food industry are described and explained in detail. The example presented here is the determination of the saponification number.

**Saponification number; Simple Quick and Accurate Using Automated Systems**

The saponification number is determined by mixing the oil or fat with KOH 0.5 mol/L in ethanol and heating it with 30 mL ethanol for half an hour. The degree of saponification is found by a back titration using HCL 0.5 mol/L.

With a METTLER TOLEDO DL58 titrator, this procedure can be fully automated by an ST20 sample changer, a Tbox DR42 and a heating insert. A contact thermometer measures the temperature and the Tbox DR42 regulates the output of the heating insert. The precision of this automated system is significantly increased as can be seen in the following table.

<table>
<thead>
<tr>
<th>Edible oils/fats</th>
<th>Saponification number</th>
<th>srel*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thistle oil</td>
<td>188.39 mg KOH/g oil</td>
<td>0.209%</td>
</tr>
<tr>
<td>Nut oil</td>
<td>189.14 mg KOH/g oil</td>
<td>0.264%</td>
</tr>
<tr>
<td>Olive oil</td>
<td>190.61 mg KOH/g oil</td>
<td>0.285%</td>
</tr>
<tr>
<td>Coconut fat</td>
<td>253.07 mg KOH/g fat</td>
<td>0.183%</td>
</tr>
</tbody>
</table>

Table 1 * = relative standard deviation

Advantages compared to manual determination:

- Titration not reliant on the operator: differing colors or poor detection of the end point no longer critical.
- Automation of the titration with the DL58 titrator ensures quick and reliable measurement.
- Higher acquisition costs soon recovered in the time saved; results can be achieved much quicker.

Reference:
Standard Incremental Additions with Ion-Selective Electrodes

Slowly but surely, ion analysis with ion-selective electrodes is becoming established as a cost-effective and reliable measurement technique. A wide measuring range (ppm - %), simple handling and low acquisition costs enable it to be used in the most varied of applications. Along with the well-known direct measurement method (potential correlated with concentration using a calibration factor), addition techniques are becoming ever more important. These reduce or eliminate the effects of matrix and calibrations while allowing measurement to be carried out right up to the limits of determination. This article discusses and brings together two common addition techniques.

Simple Standard Addition.
Using simple standard addition, the difference in potential of a sample is measured before and after addition. The original concentration of the sample can be calculated by rearranging the Nernst and the mixing equations. Because only the much more stable electrode slope is required for the calculation and the zero point does not change, this can extend calibration intervals considerably.

The following gives a short account of the mathematical relationships:

Variables:

- $E_1$: potential before addition
- $E_2$: potential after addition
- $\Delta E$: difference in potential [mV]
- $C_x$: concentration of the sample solution [mol/L]
- $\Delta C$: difference in concentration [mol/L]
- $C_s$: concentration of the standard solution [mol/L]
- $s$: electrode slope [mV/decade]
- $C_2$: concentration after standard addition [mol/L]
- $V_x$: volume of sample [mL]
- $V_s$: volume of standard solution [mL]

The Nernst equation for the two states before and after addition can be written as follows. Subtracting one equation from the other results in Equation 3.

1.) $E_1 = E^° \pm s \log(C_x)$
2.) $E_2 = E^° \pm s \log(C_2)$
3.) $\Delta E = \pm s \log\left(\frac{C_2}{C_x}\right)$

$C_2$ can be expressed using the combined equation.

4.) $C_2 = \frac{V_xC_x + V_sC_s}{V_x + V_s}$

Using the combination of 3.) and 4.) as well as rearranging mathematically, we finally have:

5.) $C_x = \frac{V_sC_s}{10^{\frac{\Delta E}{s}} - V_x}$

Note that activities are always measured with ISEs, and not concentrations. To keep the ion concentration constant, a solution of ions - so-called ionic buffer - is added. With standard addition, the ionic strength of the solution should not change significantly; this is achieved by using highly concentrated solutions or standards with ionic buffer solutions.

Standard Addition and Dilution.
For standard addition with subsequent dilution, the potential of the sample is measured before and after standard addition and then the entire sample is diluted with water to double its volume. Figure 1 shows a graph of how the potential and concentration change as a function of this addition and dilution.

![Fig. 1: Potential](image)
The three states can be described using the Nernst equation as follows:

1.) \( E_1 = E^° + s \log C_x \)
2.) \( E_2 = E^° + s \log \frac{V_x C_x + V_s C_s}{(V_x + V_s)} \)
3.) \( E_3 = E^° + s \log \frac{V_x C_x + V_s C_s}{(V_x + V_s) \cdot 2} \)

By rearranging for \( \Delta E \) addition and \( \Delta E \) dilution, this results in the following equations:

4.) \( \Delta E_a = s \log \frac{V_x C_x + V_s C_s}{(V_x + V_s) \cdot C_x} \)
5.) \( \Delta E_v = s \log \frac{1}{2} \)

Balancing both equations and solving for \( C_x \) gives:

6.) \( C_x = \frac{V_s C_s}{10^{\frac{\Delta E_A}{20 \text{ mV/d} \text{dil}}} \cdot (V_x + V_s) - V_x} \)

The attractive aspect about this technique is that calibration of the electrode is no longer required and measurement can be made in the non-linear limit areas of the electrode.

Both methods can be easily be programmed into the METTLER TOLEDO titrators DL58, DL70ES and DL77 so that the ionic concentration can be measured fully automatically. Using the wide range of electrodes available, up to 20 different ions can be measured reliably and at low cost.

Reader's survey

In the last UserCom, we asked for your comments. We were quite impressed by the amount of feedback. The first analysis shows us, that the UserCom is very well received.

We would like to thank all the readers who participated. Out of all the answers, we drew 5 winners of a SWATCH watch. They are:

- Julien Joelle, 27106 Val de Reuil Cedex, France
- H. Deschwanden, 4625 Oberbuchsiten, Switzerland
- Karl-Hans Reischert, 68305 Mannheim, Germany
- Das Laborteam, 94253 Bischofsmais, Germany
- Eveline Reichhardt, 73431 Aalen, Germany
Density Measurement & Refractometry
Part 1 Apparent Density / True Density

In this issue of USERCOM, we will start with a new series of articles called “Density Measurement and Refractometry”. In this and following articles we will present the most important methods for determining density and refractive index and explain the problems which may occur when performing such determinations. We hope that this new series of articles will help you to identify and avoid errors when measuring density and refractive index and will increase the quality of the measurement result.

In the first article, we present the two most important methods for determining the density of liquids: The classic pycnometer method (for measuring the apparent density) and the modern oscillation-type method (for measuring the true density) as found in the digital density meters from METTLER TOLEDO. We explain the problems that can arise when the results obtained from these two different methods are compared with each other.

Pycnometer Method / Oscillation-Type Method

For a long time, the pycnometer was the only way to provide accurate density measurements. Many established standards thus still use this as a reference.

Pycnometers are always used with balances to determine the mass of an accurately defined volumetric sample. The density of a sample is simply its mass divided by its volume.

\[
\text{Density}_{\text{sample}} = \frac{\text{Mass}_{\text{sample}}}{\text{Volume}_{\text{sample}}}
\]

Digital density meters are increasingly used for determining the density of liquids rather than pycnometers, because they offer the following main advantages:

- Results are independent of the user (fewer sources of error!)
- Less time per measurement
- Automatic thermostating of the sample without a water bath (thermostating by an electronic Peltier thermostat)
- Printout of results according to ISO and GLP

Digital density meters measure the oscillation of a U-shaped tube filled with the sample. The period of oscillation as measured by the instrument is directly displayed as the density (d).

\[
d_{\text{sample}} = d_{\text{air}} - F \cdot [\text{period}^{2}_{\text{air}} - \text{period}^{2}_{\text{sample}}]
\]

If the pycnometer is weighed in air, an intrinsic error occurs when determining density. The reason: The apparent loss in mass due to the surrounding air (air buoyancy) is ignored. Accurate density determinations with a pycnometer should always be carried out in a vacuum (difficult in practice!).

Determining the apparent density of water gives the following values:

Apparent density of air at 20 °C: ApD air = 0.00000 g/cm³
Apparent density of water at 20 °C: ApD water = 0.99715 g/cm³
True Density (Digital Density Meters)
The true density (TD) is the density of a sample measured in a vacuum using a balance. The true density of a sample determined by the pycnometer method is only obtained if it is carried out in a vacuum.

Digital density meters (METTLER TOLEDO DE40/50/51) always measure the true density.

The U-shaped tube is filled with the sample and the oscillation frequency is measured. The frequency is a function of the sample density: the higher the density, the lower the frequency.

Before sample determinations, the density meter is first adjusted with air and water. This adjustment is carried out in two steps:

**Step 1:** The U-shaped tube is filled with dry air. The density meter then automatically waits until the air reaches a temperature of 20 °C. The oscillation frequency of the U tube is now measured and the value assigned to the true density of air at 20 °C (values for the true density of air in the temperature range 0 °C to 90 °C are stored in the instrument).

**Step 2:** The U tube is filled with double-distilled water. The density meter then automatically waits until the water has reached a temperature of 20 °C. The oscillation frequency of the U tube is now measured and the value and the value assigned to the true density of water at 20 °C (values for the true density in the temperature range 0 °C to 90 °C are stored in the instrument). Determining the true density of air and water results in the following values:

- True density of air at 20 °C: TD air = 0.00120 g/cm³
- True density of water at 20 °C: TD water = 0.99821 g/cm³

**All conversion formulas at a glance**

**Formulas for converting apparent density to true density at 20 °C:**

- True density = Apparent density x 0.99986 + 0.00120 g/cm³
- Apparent density = (True density – 0.00120 g/cm³) • 1.00014

**Formulas for converting specific gravity to density at 20 °C:**

- True density = True specific gravity • 0.99821
- True specific gravity = True density / 0.99821
- Apparent density = Apparent specific gravity • 0.99821
- Apparent specific gravity = Apparent density / 0.99821
Converting apparent density into true density (and vice versa)

As we have just seen, different results are obtained when determining true and apparent densities:

### Specific Gravity / Density

For simplicity, the results obtained with the pycnometer method have been stated as specific gravity (SG). Specific gravity is the density of the sample divided by the density of water at the same temperature.

\[
SG = \frac{\text{Density}_{\text{sample}}}{\text{Density}_{\text{water}}}
\]

The density and specific gravity are usually determined at 20 °C.

### Examples

| True density of water | $0.99715 \times 0.99986 + 0.00120 = 0.99821 \text{ g/cm}^3$ |
| True density of air   | $0.00000 \times 0.99986 + 0.00120 = 0.00120 \text{ g/cm}^3$ |
| Apparent density of water | $(0.99821 - 0.00120) \times 1.00014 = 0.99715 \text{ g/cm}^3$ |
| Apparent density of air   | $(0.00120 - 0.00120) \times 1.00014 = 0.00000 \text{ g/cm}^3$ |

### Formula for converting apparent density to true density at 20 °C:

\[
\text{True density} = \text{Apparent density} \times 0.99986 + 0.00120 \text{ g/cm}^3
\]

\[
\text{Apparent density} = (\text{True density} - 0.00120 \text{ g/cm}^3) \times 1.00014
\]

### Formula for converting specific gravity to density at 20 °C:

\[
\text{Density} = \text{Specific gravity} \times 0.99821
\]

\[
\text{Specific gravity} = \frac{\text{Density}}{0.99821}
\]
The Effects of Carbon Dioxide on Alkaline Titrants

The effects of carbon dioxide are a great source of error in titrating with alkaline titrants. CO₂ reacts with strong bases such as NaOH, KOH, TBAH, NH₄OH and combines with it to form carbonates according to the following equations:

\[
\begin{align*}
H_2O + CO_2 & \rightarrow H_2CO_3 \\
H_2CO_3 + 2NaOH & \rightarrow 2Na_2CO_3 + 2H_2O
\end{align*}
\]

The titrant thus contains both carbonate and hydroxide ions. If this is used to titrate strong acids, then there is a typical “carbonate titration curve” with two jumps in it [Figure 1].

As titrating strong bases is usually done with weak acids (potassium hydrogenphthalate, benzoic acid), the concentration of the titrant used for the analysis of strong acids is not correct and will produce false results.

Thus, alkaline titrants should be made up and protected to minimize the effects of CO₂.

Making up CO₂-free Solutions

NaOH or KOH pellets are suitable for making CO₂-free solutions only if they are washed three or four times with deionised water. This is to wash away any carbonate that might be on the surface of the pellets. However, it is much better to use titrant as a concentrate in the form of ampoules (Titrisol, Fixanal).

The water used should be deionised and CO₂-free. Degasing by heating or gassing through with nitrogen in an ultrasonic bath are well-established procedures.

Storing Titrants

If the titrant is not to be used for a long period of time, then it should be sealed away from air. Any air remaining in spaces can be purged through with nitrogen.

Any titration flasks that have been standing should have a “drying tube” filled with an inert substrate containing sodium hydroxide. This absorbs any CO₂ before it can contaminate the titrant. [Figure 2].

Applications, in practice, have shown that residence times of even a day are sufficient to contaminate a sodium hydroxide solution so that accurate results can no longer be obtained.

A detailed description of measurements are found in Application Brochure No. 16: “Validation of Titration Methods”

Good analytical results can be achieved by using suitable methods and instruments and also by carrying out traditional good laboratory practice. This also naturally includes all procedures connected with handling reagents.

Ch. Walter

Fig 1: Titrating strong acid with a titrant containing carbonate ions

Fig 2: Titrant flask protected from the effects of CO₂ with an absorbing agent.
Helpful Tips on Maintaining a METTLER TOLEDO Titrator

If you are working with METTLER TOLEDO titrators, then you will certainly have learnt to appreciate their reliability and accuracy. Some things, however, are easily forgotten: Despite its rugged design for use in all areas of application, a titrator is a precision instrument that needs to be looked after. The following article offers a few tips to avoid unpleasant and expensive downtimes and to show how you can get the best out of your METTLER TOLEDO titrator.

Tip 1  Titrators are built and approved for the temperature range stated in the specification sheet and in the operating manual. If a titrator is sitting by a window or in a strong light source, then radiation can easily heat it up to temperatures of 60 °C. Although this will not harm the titrator in any way, it should be borne in mind that the heat will change the concentration of the titrant and thus change the results!

Tip 2  Also as important as temperature is relative humidity. Permissible values are also found in the operating manual of the titrator (in general, this is 40-80%). Lower values can affect the measuring signal of the electrode caused by electrostatic charges. Higher values affect the discharge potential of the electrode.

Tip 3  The housing and keypad of our titrators are made of a chemically-resistant plastic. However, if residue of a highly concentrated titrant remains on the housing for any period of time, then it may get into the titrator. By carefully removing this residue, you can prevent costly damage to the unit.

Tip 4  An important component of the analysis chain is the electrode. It thrives on “tender loving care”! Always close the electrode cover when storing to prevent electrolyte running out. Never let the electrode dry out. METTLER TOLEDO titrators always have an electrode holder. Fill this with the electrode reference electrolyte (indicated on electrode) to protect the electrode after use. Also keep an eye on the level of the electrolyte in the electrode and top up when required.

Tip 5  Input resistors of measurement amplifiers for titrators are 10^9 – 10^12 Ohm. The input signal will be affected if the input jacks are dirty. Liquids which have dripped or dried out should be cleaned up immediately.

Tip 6  Titrators are very low current consumers. If you require extremely accurate results, then always leave them switched on!

These few pieces of advice should help you get even better results from your METTLER TOLEDO titrator. In return, it will show its appreciation by giving you even greater reliability and longer operating life!

However, if one day a fault should occur with your titrator, then there is always a service organization in your area to ensure that the titrator and its peripherals are fully functional in the quickest possible time.
The application chemists of the AnaChem market support group have prepared several publications and a series of application brochures to support customers in their routine work in the laboratory. Each brochure is dedicated either to a particular sector of industry (such as paper and pulp, petroleum and beverages), a particular titrator or a specific analysis technique. The following list shows all publications, together with their order numbers. They are available from your local METTLER TOLEDO marketing organization.

### Publications, reprints and applications

<table>
<thead>
<tr>
<th>German</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>51724658</td>
<td>51724659</td>
</tr>
<tr>
<td>51725007</td>
<td>51725008</td>
</tr>
<tr>
<td>704152</td>
<td>704153</td>
</tr>
<tr>
<td>724491</td>
<td>724492</td>
</tr>
<tr>
<td>724556</td>
<td>724557</td>
</tr>
<tr>
<td>724558</td>
<td>724559</td>
</tr>
<tr>
<td>724650</td>
<td>724651</td>
</tr>
<tr>
<td>724653</td>
<td>724654</td>
</tr>
<tr>
<td>724654</td>
<td>724655</td>
</tr>
<tr>
<td>724651</td>
<td>724652</td>
</tr>
<tr>
<td>724676</td>
<td>724677</td>
</tr>
<tr>
<td>724674</td>
<td>724675</td>
</tr>
<tr>
<td>724768</td>
<td>724769</td>
</tr>
<tr>
<td>724907</td>
<td>724908</td>
</tr>
<tr>
<td>724909</td>
<td>724910</td>
</tr>
<tr>
<td>724911</td>
<td>724912</td>
</tr>
<tr>
<td>724916</td>
<td>724917</td>
</tr>
<tr>
<td>725012</td>
<td>725013</td>
</tr>
<tr>
<td>725020</td>
<td>725021</td>
</tr>
<tr>
<td>725014</td>
<td>725015</td>
</tr>
<tr>
<td>725016</td>
<td>725017</td>
</tr>
<tr>
<td>725018</td>
<td>725019</td>
</tr>
<tr>
<td>725021</td>
<td>725022</td>
</tr>
<tr>
<td>724353</td>
<td>724354</td>
</tr>
<tr>
<td>724477</td>
<td>724478</td>
</tr>
<tr>
<td>724325</td>
<td>724326</td>
</tr>
<tr>
<td>724589</td>
<td>724590</td>
</tr>
<tr>
<td>724521</td>
<td>724522</td>
</tr>
<tr>
<td>724105</td>
<td>724106</td>
</tr>
<tr>
<td>51724624</td>
<td>51724625</td>
</tr>
<tr>
<td>51724626</td>
<td>51724627</td>
</tr>
<tr>
<td>51724628</td>
<td>51724629</td>
</tr>
</tbody>
</table>

* Also available in French (51709856), Spanish (51709857) and Italian (51709858)