METALYSER FIELD-PRO

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Contents

1. INTRODUCTION

The Metalyser Field Pro HM3000 Instrument is ideal for testing of very low heavy metal concentrations in natural water courses, for example lakes and rivers. The HM3000 is a rugged field kit that tests for a range of 16 heavy metals and can be used both as a collection and measurement device for atsite analysis. The HM3000 is very portable as it uses a battery as its power source and the rugged tablet PC that runs Trace2o's advanced Windows based Metaware software gives the user laboratory capabilities on site.

The Metalyser HM3000 utilises a voltammetric analysis technique to detect heavy metal ions in solution. The instrument takes a complex idea but makes it easy to understand and is therefore useable for a competent person not trained in voltammetry. No complex chemical techniques need to be employed during the course of the analysis.

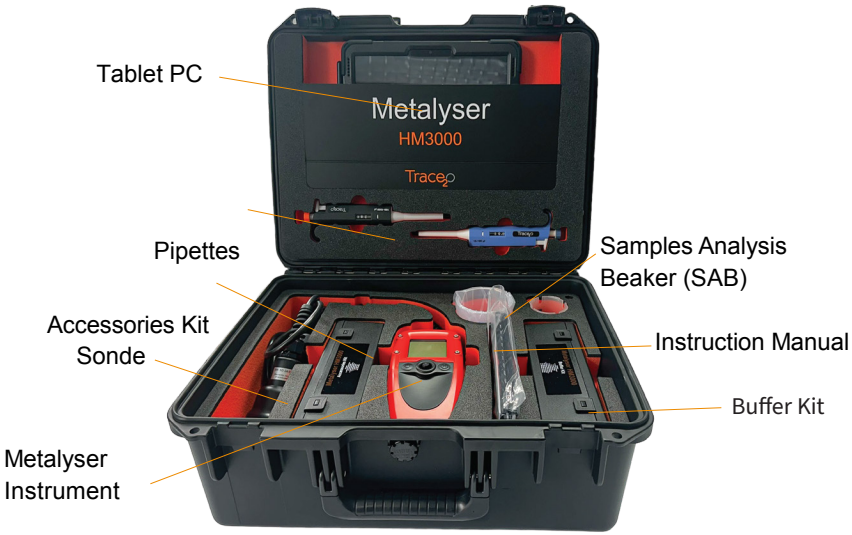
The Metalyser HM3000 is very robust and the unit is sealed against water ingress and the electrodes are designed for as little user interaction as possible.

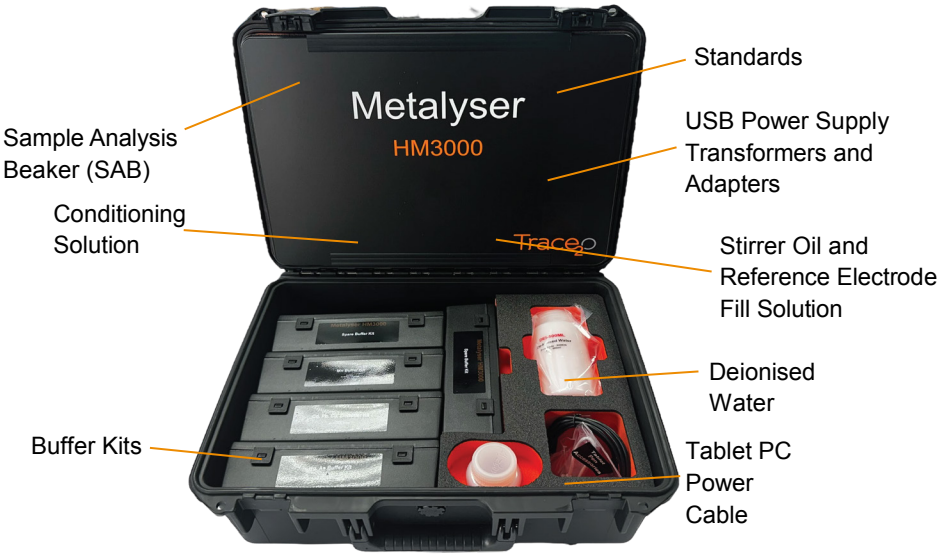
The Metalyser HM3000 is ready out-of-the-box and can be factory configured and can be used after charging the built-in battery. The software loads automatically on start-up and the instrument is ready to go.

The Metalyser HM3000 has two modes of operation and can be run in either of these. The primary mode of operation is via the tablet PC and built-in Metaware software which gives the user advanced control of the instrument to provide greater accuracy and sensitivity. This method gives the user linear regression capabilities and more sensitive test methods. The secondary mode of operation is as a standalone instrument, running from the instrument's builtin intuitive joystick-driven menu system and graphic display interface. The second mode of operation is ideal for quick screening work.

The Metalyser HM3000 communicates with the tablet PC via a Bluetooth connection which eliminates the need for trailing cables during use. It is possible to connect the PC via the USB cable to the instrument, but this is not advised as the instrument will drain power from the tablet PC. If this is necessary contact Trace2o as a special cable can be supplied.

2. KIT CONTENT



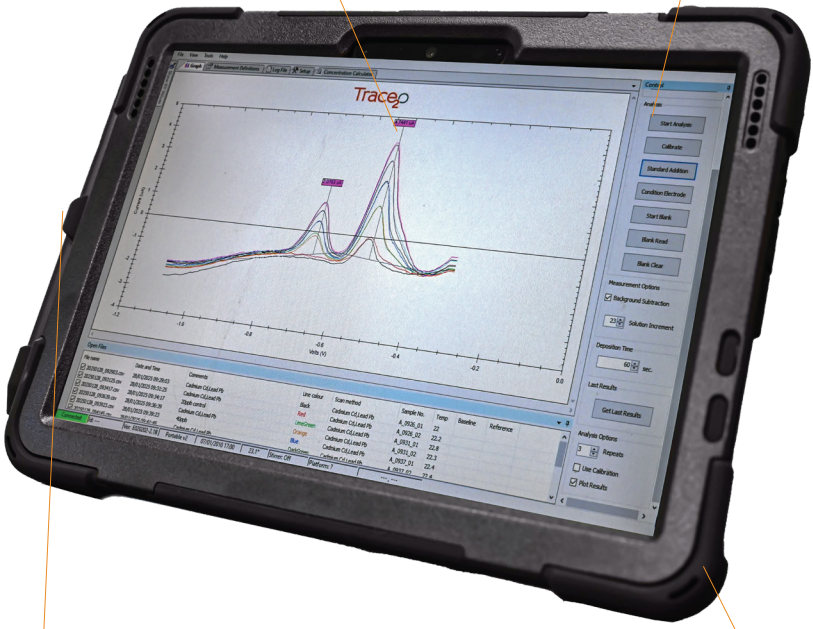


3. GETTING TO KNOW YOUR METALYSER

3.1 Tablet PC

Trace2o Metaware Software

10.5” Touchscreen Display



Cut-outs for Charge Port, Camera, and Speakers

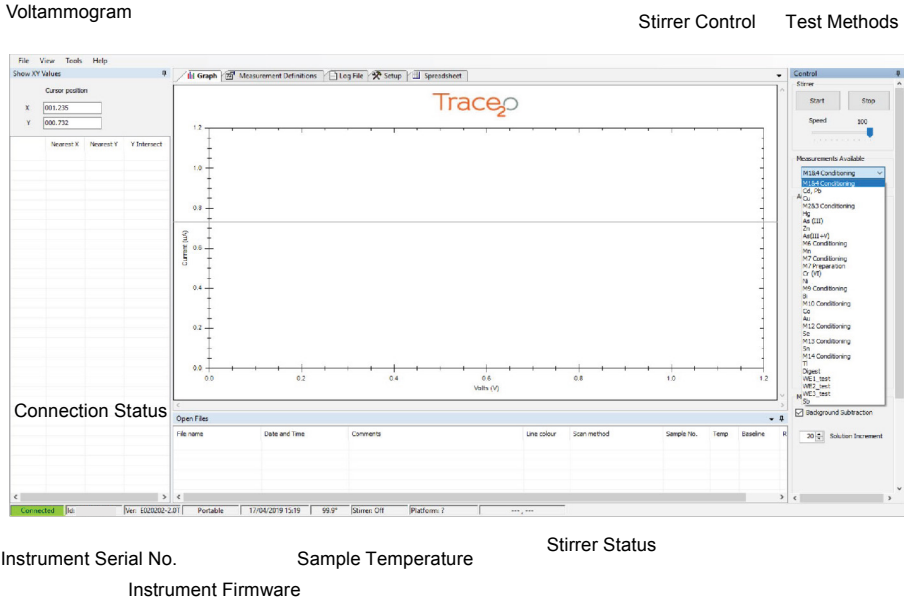
Impact Absorbent Rugged Case with 9H Tempered Glass Screen

3.2 Tablet PC and Metaware software

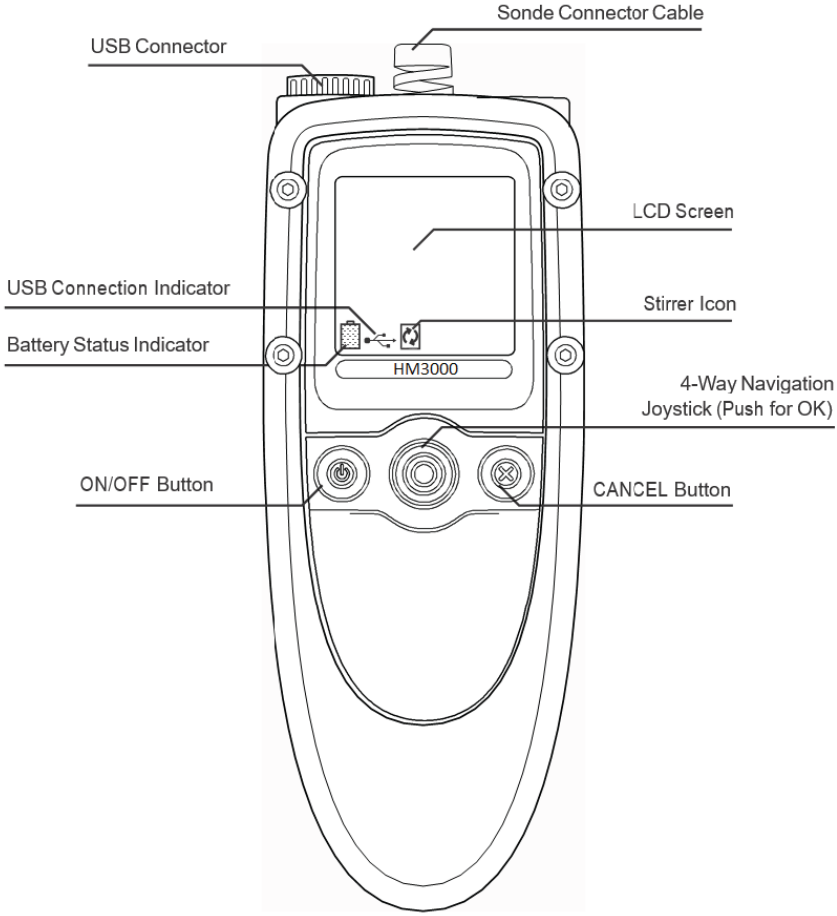
The Windows Surface Go 4 is equipped with an Intel® N200 Processor capable of supporting any field-work needs and running the Trace2o Metaware Software. With a 10.5” touchscreen and weighing just 521g (without rugged case) the tablet included in the HM3000 kit provides a truly portable solution to heavy metal analysis in the field.

The PC is pre-loaded with the Trace2o Metaware software. This is essentially a Windows-based control panel which controls the instrument and provides a graphical representation of the data (voltammogram) allowing the user to accurately analyse the data. The built in linear regression function provides the user with a comprehensive way to record results and calculate the unknown sample concentrations.

The Metaware main window appears as shown:



3.3 Instrument



USB Connector

The USB connector can be used to charge the battery using the supplied car or mains charger, and also for download/upload and charging via a PC or laptop.

LCD Screen

The LCD screen tells you what is happening as you use the instrument when not connected to the tablet PC. It will display the current date and time as well as other useful indicators such as battery and connection station. The screen is also backlit, enabling use of the instrument under poor lighting conditions.

ON/OFF Button

The ON/OFF button is used to turn the instrument on and off. There is also an optional 10 minute auto switch off feature should you leave the instrument unattended.

Navigation Joystick

The joystick allows you to quickly and easily navigate your way through the menus and features of the Metalyser when the instrument is not connected to the tablet PC. The joystick provides five controls: Up, down, Left, Right and OK. To navigate up, down, left or right, simply push the joystick in the required direction. To select an option or 'OK' a choice, press the joystick in the centre.

Cancel Button

Pressing the cancel button will return you to the previous menu or screen.

3.4 On Screen Indicators

At the bottom of the screen these symbols will appear periodically to provide information about the instrument's status.

Battery fast charge indicator

Battery trickle charge indicator

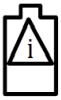
Battery fault/overheat indicator

Battery full

Battery ¾ full

Battery ½ full

Battery ¼ full



Battery empty

USB connection to PC established

Stirrer on indicator

3.5 Instrument Menu System

If used as a standalone instrument, the Metalyser is controlled via a system of on-screen menus. The structure of these menus is illustrated below to assist you in navigating them.

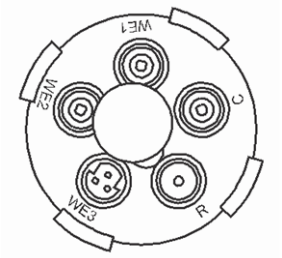
Main Menu

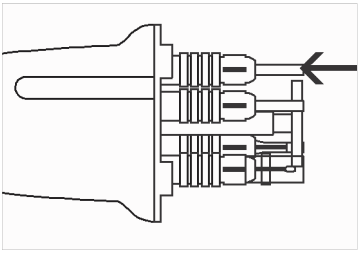
Test Methods	→	Condition Electrode	Used to condition the working electrode with a Conditioning solution. When used as part of a test it is used to prime the electrode to increase sensitivity
	→	Analyse Sample	Used with Cal ibrate function. Calibration must be undertaken before analyse sample can be used
	→	Standard Addition	Used to analyse samples an d calculate the unknown concentration by the addition of a known standard
	→	Calibrate	Used with analyse sample. Calibration must be performed before analyse sample is used
	→	Blank subtraction	Used to set or replace a baseline if contaminants are suspected in the buffer.
Data Log	→	View Log	Data Log viewing options
	→	Last Result	Displays latest result and graph
System	→	Backlight	Backlight control options
	→	Set date/time	Used to set the instrument date and time
	→	Language	Used to select the display language
	→	Charge	Battery charging options
	→	Auto switch off	Auto off select
	→	Program P/STAT	Program internal hardware (Not used in normal operation)

4. COMPONENTS AND CARE OF COMPONENTS

4.1 The Sonde

The sonde head contains the electrodes, stirrer and temperature probe to carry out analysis. It comes pre-assembled with the 4 electrodes and a Sample Analysis Beaker (SAB). The electrodes are the WE1 (Working Electrode 1), WE2 (Working Electrode 2), R (Reference Electrode) and C (Counter Electrode). The sonde has the electrode letter references embossed onto it to ensure they are connected in the correct positions.





To fit an electrode, simply align the arrow on the electrode with the arrow on the sonde head and push the electrode onto its socket. A quiet double click should be heard. Gently pull on the top of the black holder of the electrode to ensure it is fully connected.

To remove the electrodes pull back the connector shroud with the arrow on and the connector will pull off.

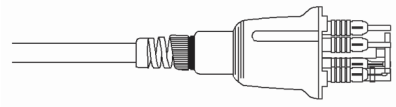
When attaching or removing electrodes be careful to avoid touching the stirrer.

The different Working Electrodes can be identified by the number of connecting pins and are not interchangeable.

Electrode WE1 (6 pins) is to be fitted in position WE1.
Electrode WE2 (3 pins) is to be fitted in position WE2.

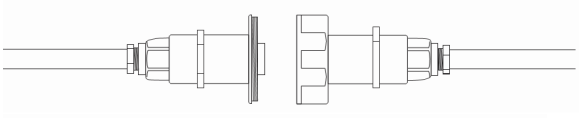
Do not mix up the electrodes as this can cause damage to the instrument.

The sonde can be assembled in one of two ways. Firstly, the short cable attached to the Sonde can be connected directly to the instrument. It can then be attached to the clamp and stand included in the kit and fitted inside the box. The second option is to fit the extension cable between the Sonde and the instrument. This allows the instrument to be used to collect samples as well as analyse them.



The sonde (electrodes x 4)

SAB (Sample Analysis Beaker)



In-line waterproof cable connector

Warning: Sonde head is designed for submersion up to 1 metre in water. Lowering the head deeper than this may result in water ingress which will require sonde head replacement.

Note: A clamp and stand are provided. The stand slots into the hole in the right hand rear corner of the box. This can be used to clamp the Sonde as shown above, which improves stability during the analysis.

4.2 Electrodes

Counter electrode – this electrode needs the least maintenance of all. A quick visual inspection to ensure the electrode has no physical damage.

Reference Electrode – this electrode contains a liquid filled tube, the liquid can be replenished by using the Reference Electrode Fill Solution provided in the kit. Perform a visual inspection to ensure it has no physical damage and ensure there is enough liquid in the outer tube and that there are no bubbles in the inner tube. For best performance, the Reference Electrode tip should be kept wet. Please remove cap before use, and replace after use. Always place a few drops of
deionised water in the cap before replacing it on
the electrode.

Working Electrode – the electrode surface should be examined for cracks and imperfections that will affect analysis. The electrode should be regularly polished to remove contaminants and ensure a smooth mirror-like surface using the supplied glass platen, polishing cloth and polishing slurry (see below). Ensure that the protective rubber cap is replaced during storage of the electrode to prevent damage to the electrode surface. After polishing, conditioning steps need to be undertaken before analysis. The different Working Electrodes can be identified by the number of connecting pins and are not interchangeable.

Electrode WE1 (6 pins) is to be fitted in position WE1.

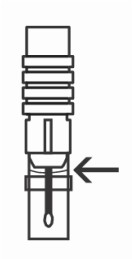
Electrode WE2 (3 pins) is to be fitted in position WE2.

Do not mix up the electrodes.

Refilling Reference Electrode

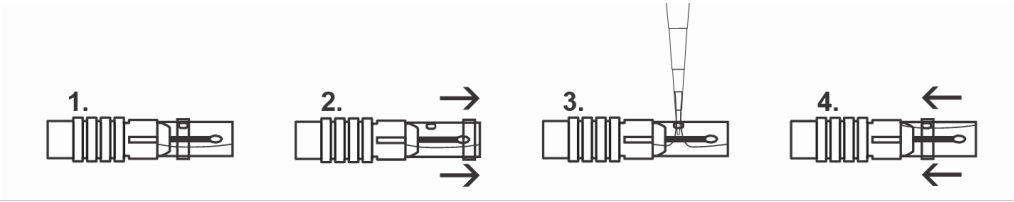
The Reference Electrode cap needs to be removed prior to analysis and replaced when the electrode is going to be stored. It is best practice not to let the tip of the Reference Electrode dry out. To ensure this, always add a few drops of deionised water into the cap before replacing on the electrode.

The Reference Electrode must contain Reference Electrode Fill Solution to operate. Ensure the Reference Electrode is held vertically with the connector upwards and determine that there is enough solution in the Reference Electrode.



Fill Solution at max

Fill solution level too low

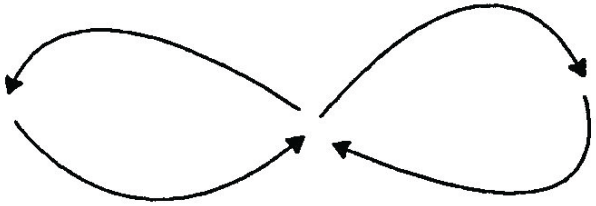


The outer tube needs to be at least 1/3rd full. To top up the Reference Electrode Fill Solution:
Place the reference electrode horizontal with the hole facing up
Slide the band down from the hole
Use the pipette to drop enough solution into the Reference Electrode to fill it up.
Once topped up, replace the band to prevent the electrode fill solution escaping.

Note: Only use the supplied Reference Electrode Fill Solution.

Polishing technique for Working Electrode

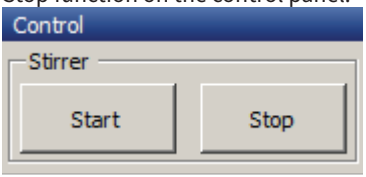
To carry out analysis, the Working Electrode must first be polished to give a smooth surface to allow for plating. To polish the electrode, firstly make sure the glass platen and holder are clean and free of dust or dirt which may cause scratching. Place a clean cloth on the platen and dampen the cloth with the polishing solution provided. Hold the electrode perpendicular to the platen and use a smooth figure of eight motion as indicated.



Polish until the surface has a mirror finish and no scratches or imperfections are seen.

The instrument also consists of:

Stirrer – the stirrer is crucial to the operation of the instrument so it needs to be checked to ensure it is working properly. It has been designed to minimise turbulence thus ensuring increased repeatability. The stirrer is crucial to the operation of the instrument and needs to be checked to ensure it is working properly. To test for the operation of the stirrer, use Start/ Stop function on the control panel.



If the stirrer fails to rotate, turn the sonde head upside down, add a few drops of the Stirrer Oil (do not use any other oil) down the stirrer shaft at the base near the sonde head (near where it enters the sonde) and rotate gently to ensure the lubricant coats the bottom of the shaft.

Sample Analysis Beaker (SAB) – the SAB has a fixed volume, so that when full and removed from the water course, excess sample water will empty out of the holes, levelling off at a constant volume.

Tablet PC – The rugged tablet PC is IP65-rated which means it can withstand low pressure spray from all directions but not immersion in water. It is also protected against dust which may harm the device. Periodic cleaning using nonabrasive cleaners is all that is necessary. The tablet PC is pre-loaded with AVG Free anti-virus software which should be updated regularly. If required this can be uninstalled and a version of your preference installed. Windows updates should also be carried out on a regular basis.

Instrument – the instrument is waterproof and robust. A periodic visual inspection to ensure that it is not damaged and that the screen is readable will suffice.

Buffers – the buffers should be stored in a dark, cool, dry environment. If stored correctly, the powder buffers have a shelf life of 3 years, liquid buffers have a shelf life of one year. Refer to individual buffers for expiry dates.

Standards – The standards should be stored in a dark, cool place and have a shelf life of 12 months. Refer to standards for expiry dates. Should any contaminant come into contact with the standards, they should be discarded.

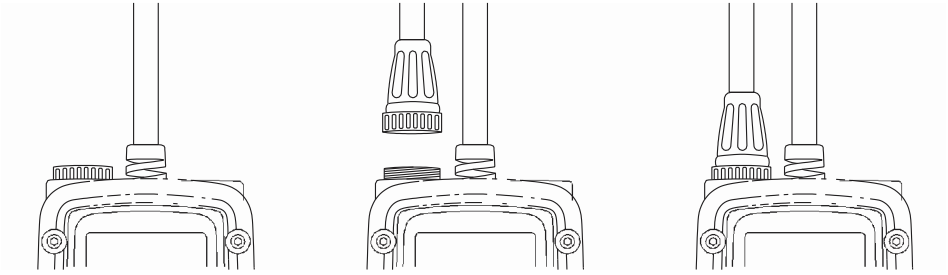
Plating Solutions – The plating solutions should be stored in a dark, cool place and have a shelf life of one year. Refer to solutions for expiry dates. Should the efficacy of the plating solution deteriorate before this during use, they should be discarded and replaced.

5. GETTING STARTED

5.1 Charging the batteries

When you first receive your Metalyser kit, it is advised to fully charge the batteries. There are two batteries requiring charge: the tablet PC battery and the Instrument battery.
To charge the tablet PC, open the rubber cover on the top left hand side of the tablet and insert the power cord into the round DC socket, then fit the plug to a mains outlet. A full charge of the tablet PC should give 6 hours of run-time. A vehicle charging kit is available as an optional extra for the tablet PC.

The handheld instrument can be charged using the supplied USB cable and the chargers provided in the kit. Connect to the device as shown below, then connect to the chosen charging system (mains/12V). If a computer is used, the software drivers may need to be installed to perform a fast charge. Refer to section below on driver installation.



Unscrew the blue cap | Insert mini USB lead | Tighten the screw cap

The Metalyser is capable of charging at a fast rate, taking approximately 7 hours to fully charge the battery, or a trickle charge rate, which should be used for overnight top up charge if the instrument is only used once or twice a day.

From the system menu select Charge and you will be given three options:

100mA	Trickle charge rate
500mA	Fast charge rate
AUTO	The instrument will automatically select the best charge rate

To select the charge rate follow these steps:

From the main menu select System
From the system menu select Charge
Highlight required charge rate and press <OK>
Press <cancel> to return to main menu

Note: The fast charge option is only available when the instrument is switched on. The instrument will also charge at a trickle rate if the instrument is connected for charging but not switched on.

Driver Installation
Your Metalyser is compatible with most computers with a USB socket, but first the USB drivers may need to be installed. The drivers are located on the Software USB stick provided for all versions of Windows post Windows 95.

Insert the USB memory stick into an available USB port on your PC
Connect the USB cable supplied to the Metalyser instrument as described for battery charging. Connect the other end to an available USB port on your PC
Windows will run the 'install new hardware wizard'
When asked if Windows can connect to Windows update to search for software.
Select 'No, not this time'
Select 'Install from a list or specific location', navigate to USB memory drive
Windows should install the drivers
Once complete, the wizard will run again. Use the same settings as before
Once Windows has installed the drivers, reboot the computer and your Metalyser should be installed
To verify correct installation select fast charge on the instrument and check that the fast charge icon (see page 7) is displayed on the Metalyser's screen

5.2 Powering up the system

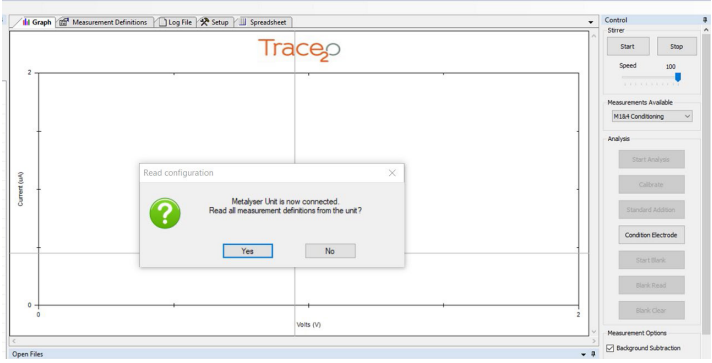
Turn on the Metalyser® instrument by pressing the power button. The display will come on.
Next press and hold the power button on the tablet PC for 5 seconds before releasing. The lights should now come on and the instrument will start up.
Windows will load and request a log-on. Please enter:

Username: HM3000
Password : <None>

It is recommended the password is changed to one of your personal choosing.

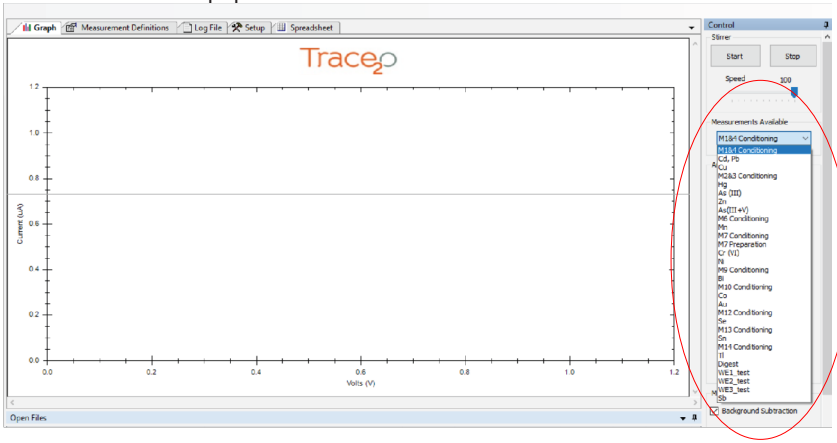
Windows will continue loading and then the Metaware software will load up.

The box at the bottom left of the window pane should display ‘Connecting’ followed by ‘Connected’ and turn green. If this does not happen immediately, go into the ‘Tools’ Menu and scroll down to ‘Connections’. Select your Metalyser (serial number on the reverse of the handheld instrument) from the list of Bluetooth connections available.



A ‘Read configuration’ box should pop up and ask if you wish to ‘Read all definitions from the unit’. It is recommended to select <Yes>. If the instrument has been recently connected and a connection is being reestablished after a short period of inactivity, for example travelling between sites, <No> can be selected.

When the test methods have been read, the ‘Measurements available’ drop down box should be populated as below:



5.3 Language Selection

Metaware

The Metaware software comes with pre-installed language packs. To select the language pack select ‘tools’ and then ‘language’ and select the language of choice.

Instrument

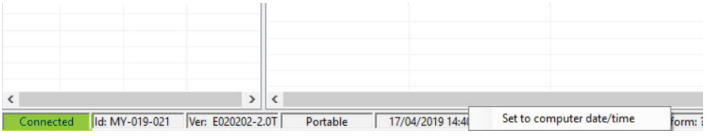
The Instrument language can also be changed. To Change the language follow the steps below:

From the main menu, select System
From the system menu, select Language
Highlight required language and press <OK>
Press <cancel> to return to main menu

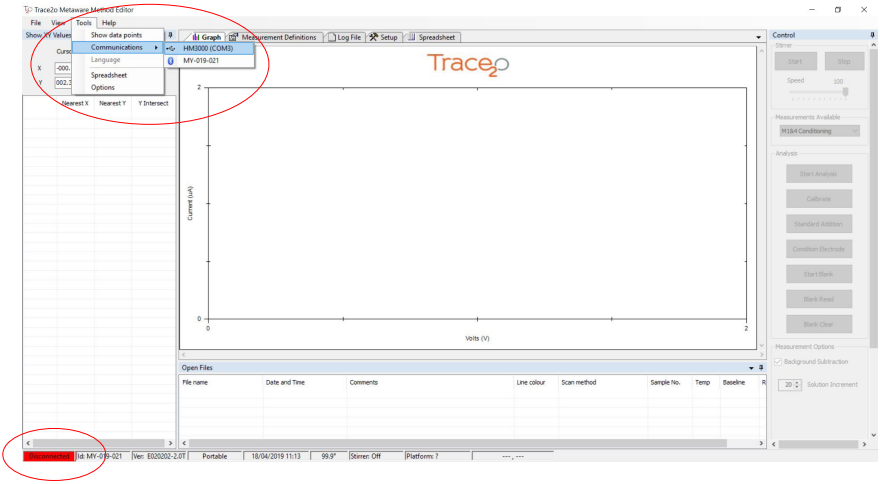
5.4 Setting the Date and Time

The instrument has an internal calendar and clock which is used to date stamp the results log. The clock may be set to UTC when you receive the instrument so may need re-setting. It will also need re-setting if the battery is disconnected. The clock can be set either through the Metaware or directly on the instrument.

To set via Metaware, right click on the time pane at the bottom of the Metaware window and click ‘set to computer date/time’.



To set the clock on the instrument, the instrument must first be disconnected from the Metaware as the instrument controls are isolated when the Metaware is running and the status is showing connected. To disconnect, navigate to ‘Metalyser’ via the tools/communications menu and click the Bluetooth logo. The pain at the bottom left should show disconnected.



Following this, use the instrument joystick to navigate as follows:

From the main menu, select System
From the System menu, select Set date/time and press <OK>
Use the navigation key to alter the date and time
Press <OK> when finished to save settings

5.5 Backlight (Instrument method only)

Your Metalyser handheld instrument is equipped with a backlight to aid viewing in poor lighting conditions.

To change the backlight settings follow the steps below.

From the main menu, select System
From the system menu, select Backlight. The following menu will be displayed

ON	The backlight will be on at all times
OFF	The backlight will be off at all times
AUTO	The backlight will switch on when a key is pressed or the screen refreshes. It will turn of after five seconds of inactivity.

The battery life will be shortened in this mode.

Highlight the required setting and press <OK>
Press <cancel> to return to main menu

5.6 Auto switch off (Instrument method only)

The Metalyser instrument can be set to automatically switch off after ten minutes of inactivity. This is recommended to extend battery life. To adjust the Auto Switch Off:

From the main menu, select System
From the system menu, select Auto Switch Off
Highlight the required setting and press <OK>
Press <cancel> to return to main menu

6. OPERATING PROCEDURE

6.1 Methods

The Metalyser operating procedure consists of three main steps – Plating (Conditioning), Analysis and Results. The plating step forms a plate on the surface of the working electrode which can be seen as either a grey or yellow/gold layer on the tip of the Working Electrode. The quality of this plate is essential to achieving reliable results.

The following table illustrates which electrode to use for each element:

Elements Analysed	Working Electrode Used	Colour of Working Electrode After Plating
Cd, Pb	WE1	Grey
Hg	WE2	Yellow/Gold
As	WE2	Yellow/Gold
Cu	WE1	Grey
Zn	WE1	Grey
Sb *	WE1	Grey
Mn *	WE1	Grey
Bi *	WE1	Grey
Cr (VI) *	Chromium Electrode	Yellow/Gold
Co *	WE1	Grey
Au *	WE3	Black (no plating required)
Ni *	WE3	Black (no plating required)
Se *	WE1	Grey
Tl *	WE1	Grey
Sn *	WE1	Grey

*Not available as standard

If WE1 is to be used in the analysis, then WE2 is not part of the circuit and has no role in the analysis. Likewise for WE1 during analyses using WE2. When switching between different analyses, the unused electrode needs to be removed, otherwise results may be affected.

Procedures for each parameter are detailed in the relevant application notes.

6.2 Plating

This is a process used to form a very thin plate on the surface of the Working Electrode and only takes a few minutes to complete. The plating step is necessary prior to the analysis of each element, however it is possible to analyse elements consecutively if they share a common plating solution (e.g. Cd, Pb, Zn all use HG500 Hg Plating Solution).

Before carrying out the plating step, the Working Electrode surface must be polished to remove any scratches and imperfections (see page 14).

There are two preliminary steps needed for analysis with the Metalyser®. The plating step uses the HG500 Hg Plating Solution, HG1000 Thick Hg Plating Solution or AU500 Au Plating solution, added to the SAB, to form a plate on the Working Electrode. After plating, the mirror-finish black tip is covered with a plate that is either grey (Hg plating solutions) or yellow/gold (Au plating solution) in colour.

The element being test determines the plating solution required:
HG500 Hg Plating Solution – Cd, Pb, Cu, Zn, Sb, Bi, Co, Tl
AU500 Au Plating Solution – Hg and As
HG1000 Thick Hg Plating Solution – Mn, Se, Sn
AU1000 Thick Au Plating Solution – Cr (VI)

WE1 is used for Cd, Pb, Cu, Zn, Sb, Bi, Co, Tl, Mn, Se and Sn analysis
WE2 is used for Hg and As analysis
WE3 is used for Au and Ni analysis
Chromium Electrode is used for Cr (VI) analysis only

It is necessary to perform the plating and conditioning steps before an analysis session, or if the sensitivity of the analysis decrease. This is because, over time, the plate will reduce in thickness and eventually come off. Typically this will be after 20+ consecutive samples or a period of 2-3 hours. It is therefore suggested to regularly re-plate the electrode; if analysing a lot of samples, it is recommended to plate in the morning and again at the beginning of the afternoon session.

If in doubt, remove the old plate by wiping the surface, polishing the tip of the Working Electrode to a mirror-finish (with the polishing kit provided), the rinse with the wash bottle and perform a new plating.

When analysing for elements requiring a plate different to the one currently being used, the electrode not in use will need to be removed from the sonde to prevent interference. It is advised to group together analyses using the same plate to save switching between them.

When using the Metaware on the tablet PC, the conditioning of the electrode occurs when the M group of interest is selected from the Measurements Available drop down menu. If using the instrument directly, select the method of interest from the Test Methods menu, then choose the conditioning step which will be at the top of the list. The conditioning step should be carried out in samples water and undertakes a run which sensitises the Working Electrode.

6.3 Analysis

Before using the Metalyser to perform a test, ensure that the working electrode has first been successfully plated and conditioned for the metal of interest. The complete instructions for each Metal are included in the application notes.

There are two ways to analyse a sample in the field: Single point or Multi-point Standard Addition procedure. A third procedure using *calibration curve technique can be carried out, but only in exceptional circumstance - please contact info@trace2o.com for assistance.

Standard Addition (Single Point): This is the recommended method of analysis when using the Metalyser instrument on its own, where the user adds a known amount of standard to the solution, giving a known peak height. The Metalyser will first run a scan on the sample, to determine if the metals are present and measure the response. A prompt will be given to add a standard to the sample; this is done using the pipette provided. A fixed volume of standard is added to the SAB which will produce the increase in peak height from which the initial sample concentration can be calculated.
Multi-point Standard Addition: This is the recommended method when using the tablet PC and gives more advanced analysis. By selecting the Analyse Sample option, an analysis will be run and the results plotted. A standard addition is made to the sample and the Analyse Sample option is run again; this step can be repeated to produce multiple voltammograms corresponding to different standard additions. The peak heights can be measured manually (as described in advanced graph functions, page 30) and the results tabulated using the spreadsheet function. Once the data has been entered the calculate function can be used to generate a linear regression curve and determine the result for the original sample concentration.

*Calibration: This is not the recommended method of use for analysis. See above note.

After each analysis, the sonde head and the electrodes are to be washed thoroughly. This is in order to minimise carry-over and to clean off all traces of the previous analysis. This can be achieved by using the deionised water or by washing the sonde head (without the SAB) in the sample water. This is particularly important following an arsenic analysis.

6.4 Adding a standard addition

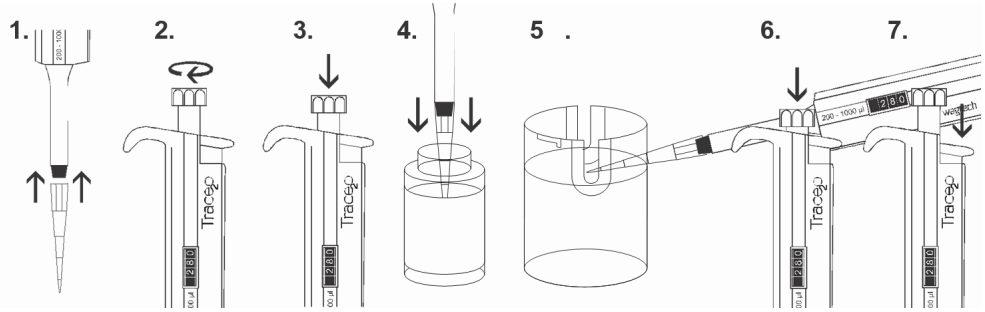
When prompted, a 20ppb Standard Addition needs to be added to the SAB. This is achieved by using the pipette (which is set to 280µl). The 20ppb default setting can be changed prior to commencing analysis by using the up/down selector in the Metaware, or during analysis by pushing the joystick left and right when using the handheld instrument. Each 140µl increase on the pipette is equivalent to 10ppb.

If the user wants to measure higher levels, then a higher value closer to the concentration level will be required. The accuracy will increase the closer the Standard Addition is to the actually concentration. For example, if an unknown sample is expected to be around 15 ppb, then a 20 ppb standard in this case is sufficient. If the user expects the analysis to be 100 ppb then, for example, a 120 ppb standard would be suitable.

How to use a pipette

Place a clean pipette tip on the pipette.
Select the volume required by twisting the dial at the top of the pipette.
Hold the pipette vertically with the hand wrapped around it and the thumb on the plunger and press the button down gently to the first stop.
Place the pipette tip in the standard bottle just underneath the top of the liquid and slowly release the plunger.
Move the pipette to the SAB and locate the pipette tip through the hole in the SAB.
Push the plunger all the way down to the second stop and hold, then slowly withdraw the pipette tip from the SAB.
To release the pipette tip after use, push the white button at the side of the pipette.

Before carrying out testing, become familiar using the pipette and the two different stops on the plunger to ensure the correct volume of standard is added.



6.5 Altering Deposition Times

The default deposition time of 60 seconds is suitable for all analysis down to 5 ppb for most elements, 10 ppb for arsenic. To increase the accuracy for the lower levels, an increased deposition time is recommended. If the user expects the analysis to be higher, then a shorter deposition time should be used.

When using the instrument directly, this can be adjusted by choosing a deposition time, when prompted at the beginning of the test methods. 30, 60 or 120 seconds can be selected by moving the joystick to the right or left on the screen and pressing the centre of the joystick to 'OK' it. The table below shows the suggested ranges for choosing deposition times.

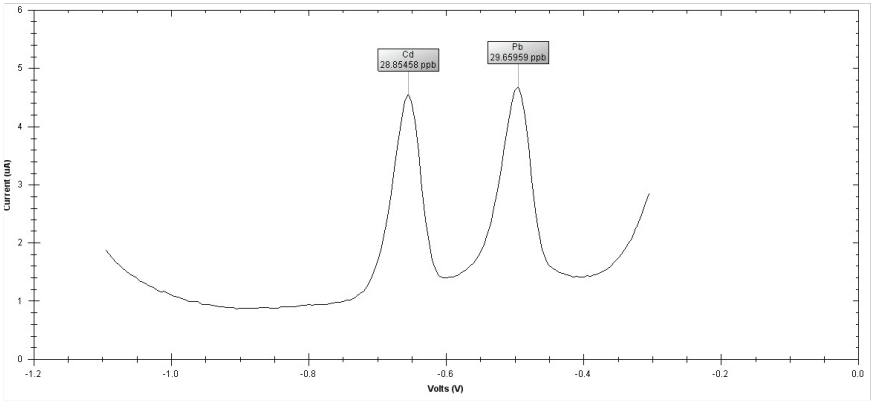
Deposition Time	Concentration Range
30 seconds	50 500 ppb
60 seconds	10 50 ppb
120 seconds	<10 ppb

The instrument has been designed to have a maximum reading of 500 ppb. Should the user wish to measure higher than this, they will need to dilute the sample. For example, if the used wishes to measure 600 ppb, dilute the sample by half and then multiply the result by 2. Always dilute with water that will not contribute to the heavy metals being tested; deionised water is ideal.

6.6 Results

Following the analysis, a graph known as a voltammogram will be displayed. This is a plot of output current vs applied potential. If the metals of interest are present in the sample, peaks will be seen in the data. The peaks will automatically be labelled with the metal name and the concentration value calculated and displayed.

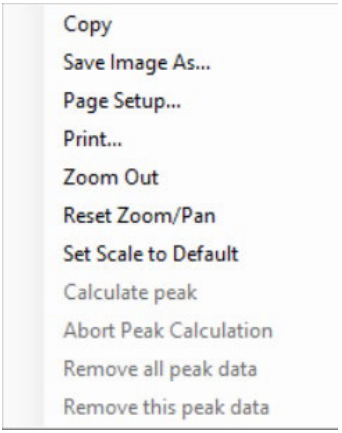
The voltammogram below shows a typical result for an M1 analysis. The two peaks displayed are for cadmium and lead.



Basic graph functions:

Right clicking the mouse whilst hovering over the graph will show the following options:

Copy: Copies the graph to the Windows clip board.
Save Image As: Saves the image as a graphics file.
Page Setup: Setup the printing options.
Print: Prints the graph to a selected printer.
Zoom Out: Zooms back out one zoom step.
Reset Zoom: Restores the viewing window to the default setting.
Set Scale to Default: Restores the axis to the default values.



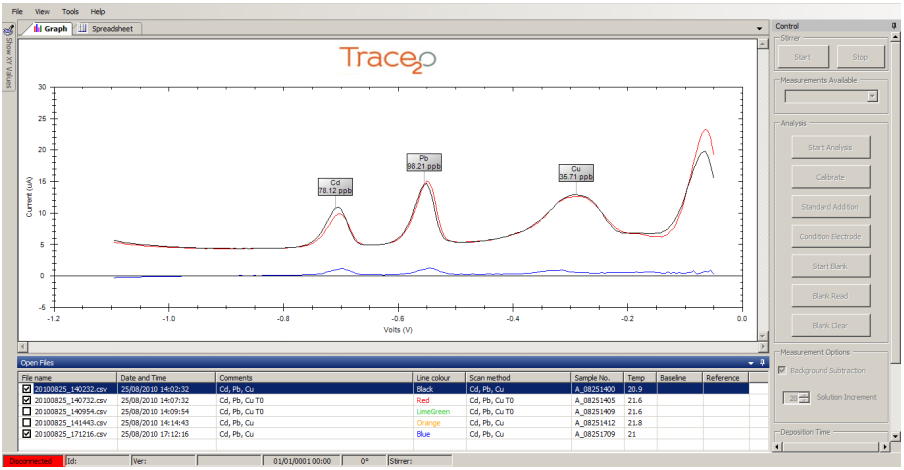
Advanced graph functions

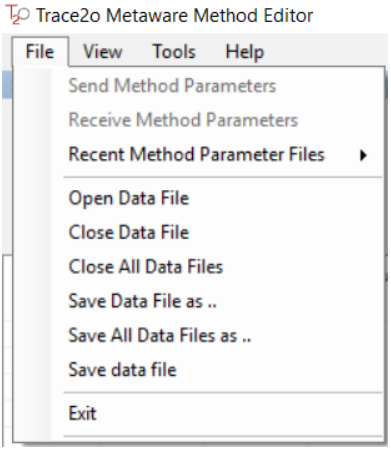
It is possible to measure the peak heights manually to provide raw current data which can facilitate more accurate data analysis by providing data for use in the linear regression table.

Calculate Peak: To calculate a peak, first position the cursor over the data-point you wish to use at the base of one side of the peak, then right click the mouse and select 'calculate peak' (if a valid point is not found, this function will be greyed out). Move the mouse to the other side of the peak and left click the mouse. The baseline will be drawn in and the peak height shown, reported as a current (μA).
Abort Peak Calculation: If an error is made during the selection of data points the calculation can be aborted.
Remove all peak data: Removes all of the peak data from the graph.
Remove this peak data: Used to remove result readings from voltammogram. Move the cursor over the peak result box and then select this option which will remove the peak data.

Show Data Points:

For more detailed information the data points can be displayed on the graph. Click the Tools option from the top menu and select the 'Show Data Points' option to toggle them off and on.





File Menu while using the Graph tab

The table of analyses (open files) at the bottom of the screen displays all of the data currently loaded. The graphs can be toggled on and off using the tick box on the left for each individual graph.

Files can be saved using “Save Data File As” from the File menu and later opened or closed using several standard Windows options (as shown left).

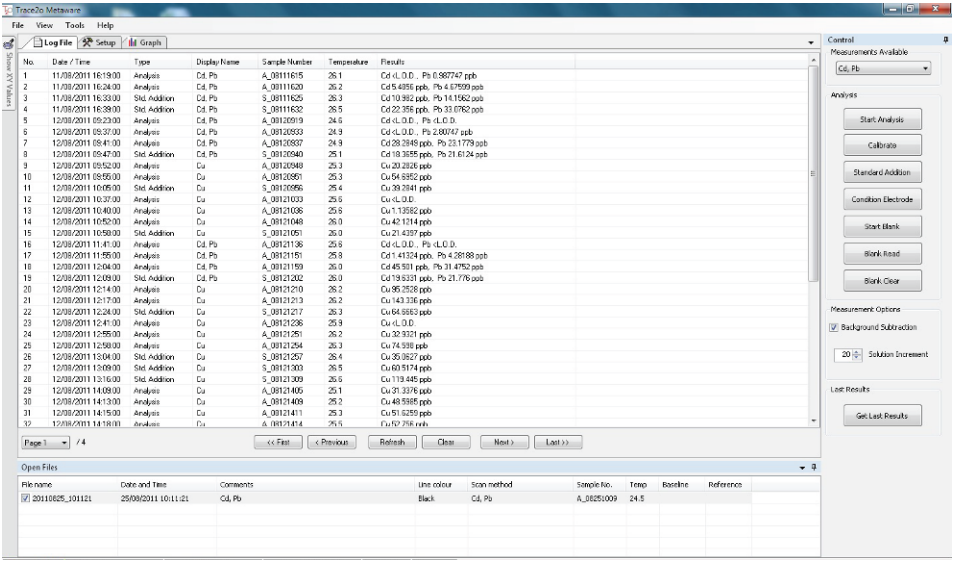
If a file is saved with a different name, the updated filename will not be displayed until the file is re-loaded.

Note: The contents of the “File” menu will change according to which tab is currently in use.

6.7 Results log

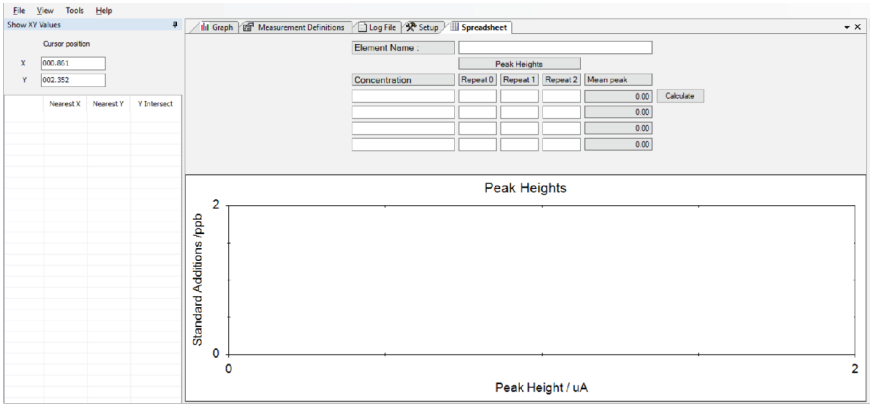
The results summary for each analysis will be stored in the instrument's memory. Select the log file tab and then refresh to display the log file. These results only contain numerical information but each analysis run by Metaware can be saved complete with the graphical data.

The log file can be saved in .CSV format which can be then loaded into a spreadsheet for record keeping.

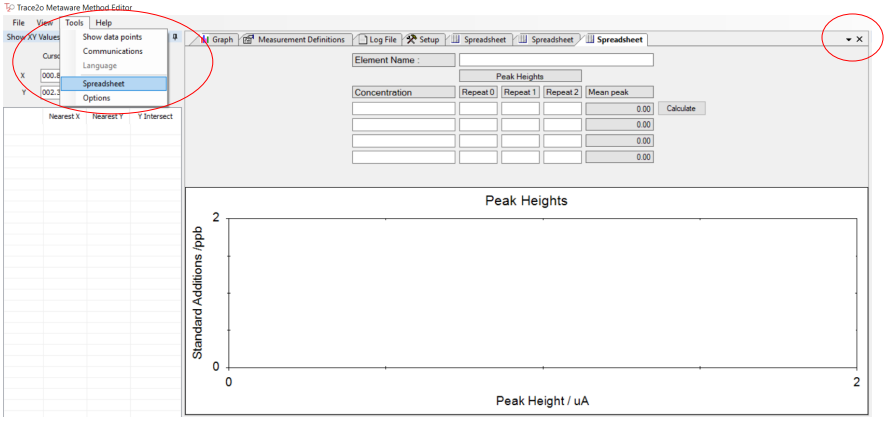


7. LINEAR REGRESSION

The Metalyser HM3000 has a built-in spreadsheet function enabling the user to perform linear regression on the analysis data.

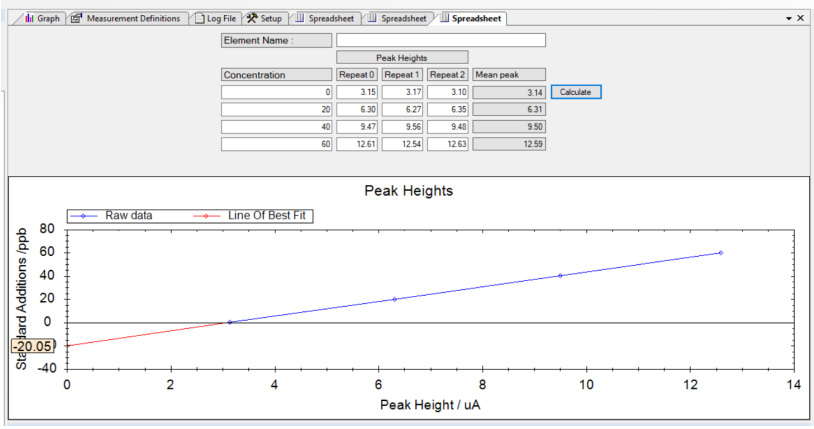


To create a spreadsheet, input an element name in the box to the right of Element Name. Multiple spreadsheets can be created by selecting Spreadsheet from the Tools drop down menu. To delete a spreadsheet, press the X in the top right corner of the spreadsheet inner window.



The table has four possible entries for concentration. The first entry would normally be zero as this related to the unknown concentration in the sample trying to be established. The second, third and fourth entries would be the total concentration of standard added after each standard addition. In the below example, three standard additions are performed, each of 20ppb. The calculated peak heights from the graph tab need to be calculated and entered into the table. To achieve greater accuracy, repeat analysis can be run after each addition to give an average over three readings, although this is not necessary to fill the table. When all the data is entered, click Calculate. The main peak heights will

be calculated and a graph of concentration vs. peak height is plotted. A line of best fit will be drawn through the data points and the y-intercept shown which corresponds to the unknown sample concentration for the metal of interest. The value shown is a negative because this indicates the amount which needs to be added to each of the data points to ensure the line of best fit goes through the origin. From the data entered into the example below, the unknown sample concentration is 20.05ppb.



8. ADVANCED OPERATIONS

8.1 Background Subtraction

The Background Subtraction method is used to create a new baseline for the analysis. Some of the buffers used may contain small amounts of metals and the blank subtraction can be used to measure this and offset it against the results. Performing this will replace the previous blank. The blank offsets can also be cleared if required.

After each analysis the Sonde head and the electrodes should be washed thoroughly. This is in order to minimise carry-over and to clean off all traces of the previous analysis. The Sonde head can be washed in the sample water and then given a final rinse with the rinse solution in the kit.

8.2 Variable volume standard additions.

The standard addition added to the sample must be a concentration of the metal that matches what is programmed into the instrument. The default set-up is to use 280µl addition of a 5ppm standard which equates to 20ppb in the SAB where the SAB holds 70ml of sample.

To calculate the final concentration of standard in the SAB in ppb, use the equation

$$\frac{\text{Addition volume (µl)}}{\text{SAB volume (ml)}} \times \text{Standard Concentration (ppm)}$$

To achieve higher accuracy, the standard addition should be matched closely to the expected sample concentration. For higher concentrations the volume of the addition could be excessive, leading to errors due to the increase in volume of the SAB especially with multiple additions. To reduce the volume smaller additions can be made using higher concentration of the standards. If the standard addition is changed the final concentration in the SAB needs to be calculated and entered into the Solution increment box under Measurement options in the control panel.

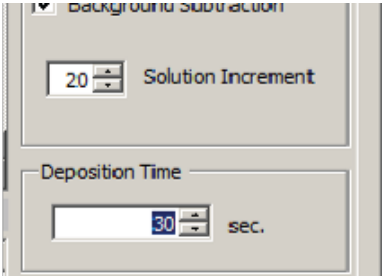
The following table gives some guidance as to what values to use:

Final concentration in SAB	Metals standard	Standard Addition volume
1 ppb	5ppm	14ul
5 ppb	5ppm	70ul
20ppb	5ppm	280ul
100ppb	50ppm*	140ul
500ppb	50ppm*	700ul

*Standards supplied as accessories.

8.3 Variable Deposition time

The sensitivity of the analysis is controlled by the deposition time which is the time for which metals are deposited onto the electrode during the analysis. The relationship between deposition time and sensitivity is linear so doubling the deposition time will double the amount of metal deposited.



To adjust the deposition time, alter the value in the measurement options box. If using the standard addition function or calibration the results given in ppb will be automatically corrected and no calculation is required, although if the calibration is performed the deposition time must be the same as that for the consequent analyses.

If using the spreadsheet function it is important to ensure that the deposition time is kept the same for all analyses.

9. TROUBLESHOOTING

While your Metalyser is designed to be very reliable, problems may occur throughout its working life. The following tables are intended to help you diagnose and resolve these problems simply and quickly. Should you not be able to resolve the problem, please contact your supplier and they will be able to assist you.

When troubleshooting the instrument, the following steps should be undertaken in this order:
Reference Electrode – does the Reference Electrode contain the right level of electrode fill solution? Is it damaged at all? Are there air bubbles in the inner tube?
Stirrer – does the stirrer rotate? Does it mix the powder reagents when operating? To check this, run the stirrer according to the instructions on page 15.
Working Electrode – is the Working Electrode plated correctly? Is WE1 grey in colour or is WE2 yellow in colour? Has the grey WE1 Hg plate been wiped off before the WE2 plating?
Solutions – have the solutions been contaminated? Have the correct buffers been added in the correct order? Has the right amount of standard been added?

The Metalyser will try and help you with determining the problems. See below:

Displayed Error	Probable Cause
> L.O.D	The metal concentration is above the maximum limit of 500 ppb Dilution should be used
< L.O.D	The metal concentration is below the minimum limit of detection for the method being used
Addition error	The increase in metal response was not sufficient enough to determine the addition
Calibration error	The addition was not added or the metals have not been detected

Problem	Possible Cause	Solution
	Plating step not completed	Wipe end of Working Electrode, polish and re-plate as per procedure
Peak not visible	Plate damaged	Re plating required
	No heavy metals in solution	Test with known amount of standard solution
	Stirrer not rotating	Ensure stirrer is rotating by watching powder buffers swirl around SAB If the stirrer is stuck, see section about rotating the stirrer (page 15)
Results lower than expected		
	Physical mask over the electrode	Ensure no debris – for example, leaves – are physically masking the electrode surface from preventing the analysis from occurring
Results increasing with each run	Organics present	Instrument is not designed to deal with strong organics System is for natural rivers/water courses
Samples >L.O.D	Over range on instrument	The Metalyser has been designed for low level ppb analysis in natural water The Metalyser will measure high limits by: a) choosing a shorter deposition time, i.e. change default from 60 to 30 seconds (as explained on page 28) b) diluting the sample a known amount and multiplying the result by the dilution factor
Metalyser not responding to key press	Internal fault	First turn off the Metalyser, wait for a few seconds and then turn it back on If this does not fix the problem, disconnect the battery and reconnect If the fault persists, contact the supplier to organise a return
	Connected via Metaware	Disconnect the Metalyser from Metaware Turn off Metalyser and then turn back on after a few seconds This should give control back to the Metalyser

Note: Periodically it is good practice to check the response of the instrument and hence the quality of the plate during the course of the day by looking at the graph of the last result looking for peaks. The information on this graph is very informative and tells the operator what is happening with the results.

10. INTERFERENCE EFFECTS

The Metalyser has been designed to test very low levels of metals in water and as such is very sensitive. Due to the interaction of other metals and organics in the water source, interferences can occur as with any system of this type.

The Metalyser is designed to function in water sources that might be suitable for drinking. The buffers chosen mean that in many instances interferences are unlikely to occur.

11. SPECIFICATIONS

11.1 Tablet PC

Touchscreen: 10.5” PixelSense™ Display

Resolution: 1920 × 1280 (220 PPI)

Length: 245 mm (9.65 inch)

Width: 175 mm (6.9 inch)

Height: 8.3 mm (0.33 inch)

USB-CFootnote 3.1 (data, DisplayPort and charging)

MicroSDXC card reader

3.5mm headphone jack

Surface Type Cover port

Surface Connect port

11.2 Instrument

Environment	Water Ingress: IP67 Operating temp: -20°C to +70°C Storage temp: -20 °C to + 70 °C
Battery	3.3V Li-ion 2200mAh rechargeable.
Connections	1 x waterproof Mini USB port, 1 x 12 Way Multipole Connector.
Display	128 x 128 pixel monochrome backlit LCD.
Power supply	4.5 – 5V DC, 700mA.

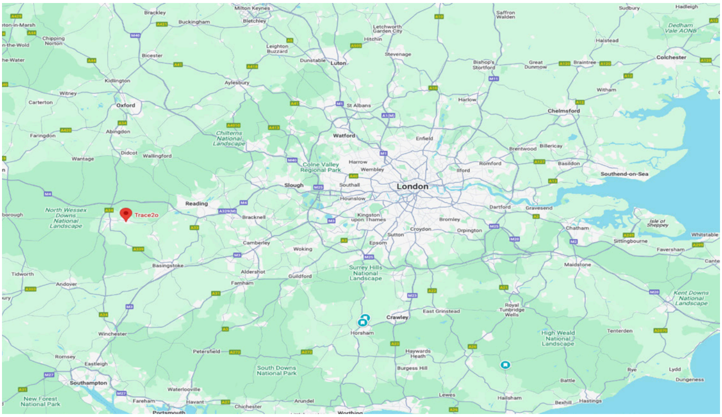
NOTES

NOTES

12. CONTACT INFORMATION

Trace2o, Station Road, Thatcham, Berkshire, United Kingdom, RG19 4HZ

T +44 (0)1635 866 772 | info@trace2o.com | www.trace2o.com



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ISO 9001
REGISTERED FIRM