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# PDV6000 *plus*

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PORTABLE TRACE METALS ANALYSER



Operation Manual  
Issue 2

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## CHAPTER 1

# 1 Introduction

This chapter introduces you to your PDV6000 *plus* voltammetric analyser.

The following sections provide an overview of the PDV6000 *plus*, its capabilities, method of working together with an overview of performing on site analysis. Contact details are provided should you require any assistance with your instrument.

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## 1.1 Scope

This manual applies to the PDV6000 *plus* internal software V2.3 or later. Further upgrades to the software and manual may be available from the website.

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## 1.2 Overview of the PDV6000 *plus*

The PDV6000 *plus* is an easy to use portable instrument designed to identify and measure the concentration of heavy metal ions in a wide range of sample types, both in the laboratory and out on site. Typical quantification limits are 5 parts per billion in the sample solution.

The PDV6000 *plus* comprises a small analytical cell assembly and controller used together to provide a very convenient and portable tool for field screening for most heavy metals.

The controller can be programmed with up to 10 analytical methods to detect 10 different metals. The results of the analysis are displayed on the controller screen. The PDV6000 *plus* is capable of better than 10% precision and accuracy used as a standalone instrument. When used in conjunction with VAS, a Windows software application provided with the kit, the PDV6000 *plus* is capable of highly accurate and reproducible metal ion analysis in the laboratory, with precision and accuracy better than 5%.



Figure 1: PDV6000 *plus* carry case, controller, analytical cell assembly and accessories.



The VAS software also allows the user to reprogram the PDV6000 *plus* instrument with custom menus and applications.

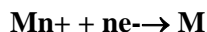
VAS can be installed on any computer that meets the minimum recommended hardware as specified by the Windows 98, ME, NT, 2000 or XP operating system it is running. An additional 10 Mb of free hard disk space is required for the VAS software itself.

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## 1.4 How It Works – An Overview Of Voltammetry

The principle of analysis used by the PDV6000 *plus* is Anodic Stripping Voltammetry (ASV). This technique was first discovered in the 1920s and won the Nobel Prize in chemistry for its inventor Jaroslav Heyrovsky in 1959.

Anodic Stripping Voltammetry is a simple procedure. A reducing potential is applied to the working electrode. When the electrode potential exceeds the ionisation potential of the analyte metal ion in solution ( $Mn^+$ ), it is reduced to the metal which plates onto the working electrode surface as follows:



The longer the potential is applied, the more metal is reduced and plated onto the surface of the electrode (also known as the “deposition” or “accumulation” step). This concentrates the metal on the electrode surface.

When sufficient metal has been plated onto the working electrode the metal is stripped (oxidised) off the electrode by increasing, at a constant rate, the potential applied to the working electrode. For a given electrolyte solution and electrode, each metal has a specific potential at which the following oxidation reaction will occur:



The electrons released by this process form a current. This is measured and may be plotted as a function of applied potential to give a “voltammogram”. The current at the oxidation or stripping potential for the analyte metal is seen as a peak. An example voltammogram showing the peak for Sn is shown in Figure 2.

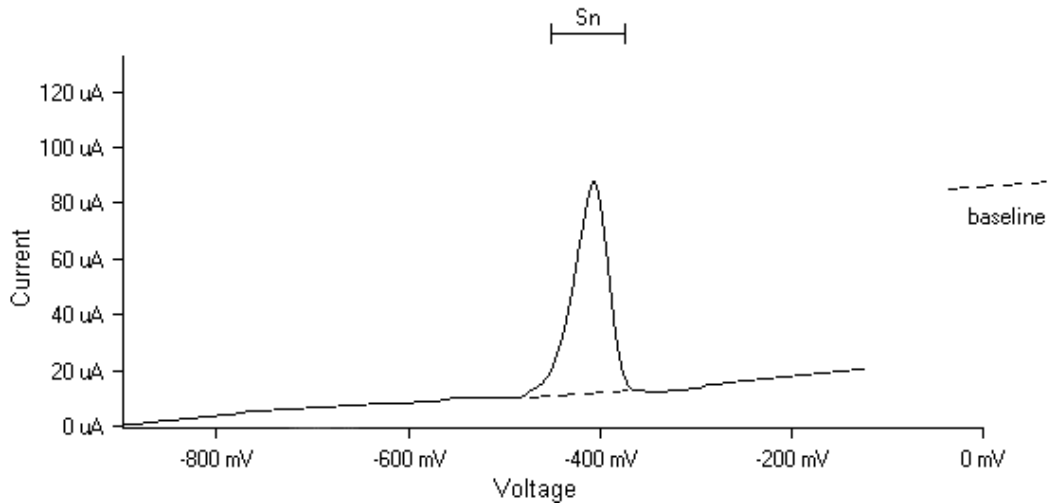


Figure 2: Example voltammogram showing peak for Sn.

To calculate the sample concentration, the peak height or area is measured and compared to that of a known standard solution under the same conditions.

As a metal is identified by the potential at which oxidation occurs, a number of metals may often be determined simultaneously, due to their differing oxidation potentials. An example is shown in Figure 3, in which Cd, Pb and Cu are analysed simultaneously.

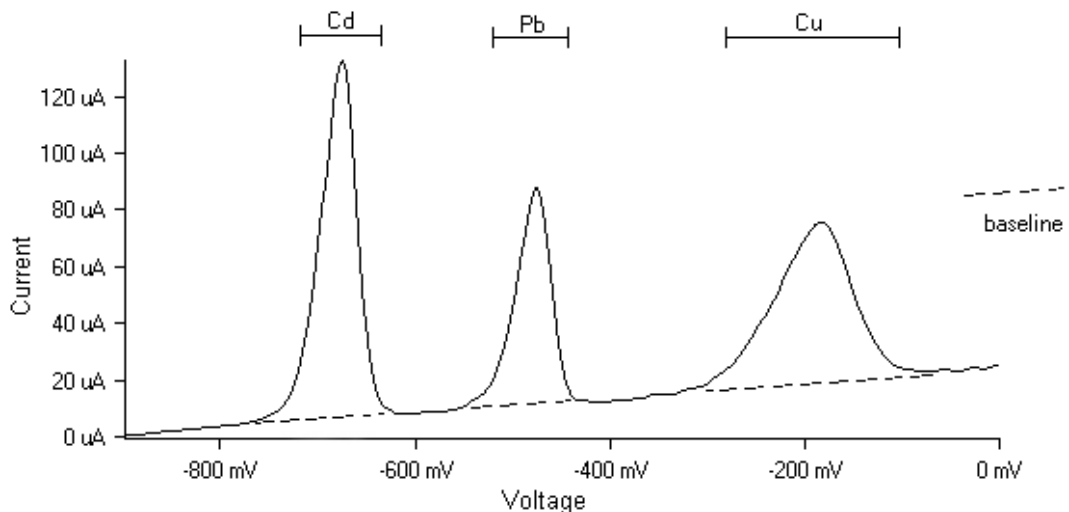


Figure 3: Example voltammogram showing peaks for Cd, Pb and Cu.

The plating step makes it possible to detect very low concentrations of metal in the sample. The length of this step can be varied to suit the analyte concentration of the sample. For example, analysis of a 5 ppb solution of Pb may require a 180 to 300 second accumulation step, while a solution in the ppm range would require less than 30 seconds.

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## 1.5 On Site Analysis

The main purpose of most routine analysis is to achieve two items of information about the sample. The first item is to identify if the sample contains the target analyte above or below a previously agreed concentration. The second item is to find out by how much the target analyte is above or below the set concentration. This information is then used to make a decision about what should be done. The faster the information is obtained, the sooner the decision can be made and a fast decision often saves significant amounts of money. On-site analysis can provide this level of information very quickly, provided the on site method can achieve the data quality objectives suitable for the task.

The data quality objective may be simple or complex, depending on the purpose of the analysis. For example, an electronic component fabricator may have a discharge consent limit for Pb and Cu in the effluent of 0.5 mg/l. The data quality objective could be:

1. Analysis must detect Pb and Cu in the effluent down to 0.25 mg/l with an acceptable error of +/- 20%.
2. Analysis must be able to quantify the concentration of Cu and Pb within the range 0.25 – 2 mg/l with an accuracy of 10% and reproducibility of +/- 10%
3. Data reporting requires only concentration values of the metals detected in the sample and the time the sample was taken.

This is a simple data quality objective where only 2 target pollutants are of interest and the reporting requirements minimal. The data quality objective can be met by laboratory analysis, which is able to provide considerably better detection limits, precision, accuracy and QC data to support the result. The PDV6000 *plus* can also meet the set data quality objective but would be able to give the result within minutes of taking the sample. A rapid result would allow the effluent to be held in a reservoir tank and not discharged. The time taken to get the laboratory result, even if the lab could analyse the sample in 24 hours would allow many thousands of litres of contaminated water to be discharged.

For the majority of samples, simple data quality objectives are all that are needed, both practically and legally to be able to confidently manage an operation that is dependant on analytical results.

The PDV6000 *plus* was designed for on site analysis and has sufficient sensitivity, precision and accuracy to satisfy the data quality objectives for most situations. When used in the field as a standalone instrument, the PDV6000 *plus* should only be used as a screening tool to indicate the approximate concentration range of the metal of interest. When used with a computer and the supplied VAS software, the PDV6000 *plus* can provide more accurate and reproducible data.

Conditions that may affect accuracy and precision with on site analysis include:

- Sample homogeneity.
- Sample handling errors.

- Pipetting errors.
- Unpredictable matrix effects.
- Sample and analytical cup contamination.
- Extraction efficiency of soil or solid matrices.

It is realistic to expect the PDV6000 *plus* to obtain data in the field that is within 20% of the actual value. For this reason when used on site it is best to use the PDV6000 *plus* to classify samples as “above a threshold concentration” or “below a threshold concentration”. For example, using Pb, with a limit of 20 ppb in drinking water. The PDV6000 *plus* should be calibrated with a 20 ppb Pb standard and any result that is above 20 ppb less 20%, i.e. 16 ppb, should be considered as potentially being above the 20 ppb limit.

For soil samples, the sample collection, degree of sample homogeneity, extraction efficiency and reproducibility of the extraction can cause a significant variation between the result obtained compared to the actual soil concentration. This is also true of a result generated by a laboratory.

For classifying areas of land as contaminated or not, more frequent sampling and analysis in the area will provide a greater confidence in the final interpretation than a single sample result from the best analysis system available.

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## 1.6 Contacting Cogent Environmental

Your local agent will be familiar with setting up and using this instrument. If you require assistance please first contact your local agent.

Cogent Environmental also provides customer support and service via the internet. For the latest details of all support and upgrades, FAQs, etc. please visit our website at **[www.cogentenvironmental.co.uk](http://www.cogentenvironmental.co.uk)**.

We are sure your PDV6000 *plus* will give you accurate and reliable service and expect that you will find it very useful in your voltammetry work.

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NEED TO REGISTER IN THE TECHNICAL  
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