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The electronic Eppendorf Xplorer® pipette – Versatile adjustment

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Abstract

Piston-stroke pipettes with an air cushion are subject to the effects of temperature, air pressure and air humidity. Such effects are kept to a minimum by constructive measures which are designed to ensure that dispensing accuracy is not significantly affected. Liquids whose physical properties differ significantly from those of water, or temperature differences between the pipette, the pipette tip and the dispensed liquid may also lead to incorrect dispensing volumes. These factors make it necessary to be able to readjust the devices for different physical conditions. Thanks to its numerous adjustment possibilities the new electronic pipette Xplorer from Eppendorf allows for easy compensation of such physical effects.

Introduction

Since piston-stroke pipettes are mainly used for pipetting of aqueous solutions, they are adjusted with distilled water as a test medium. Depending on the density of the particular liquid the air volume over the liquid expands in different ways. Consequently, other liquid volumes may, under certain circumstances, be aspirated into the tip when dispensing non-aqueous solutions. Liquids with a high vapor pressure, such as organic solvents, can also not be dispensed with the level of accuracy specified for distilled water. The air pressure, which is dependent on the height of the location above sea level, is a further factor to be considered during dispensing operations with air cushion pipettes.

Adjustment

Solutions whose physical data is very different from water with regard to their density, viscosity, surface tension and/or vapor pressure may lead to incorrect dispensing volumes. This makes it necessary to readjust piston-stroke pipettes with an air cushion to account for this. If the density of an aqueous solution changes by approximately 10 %, for example, because of the salt concentration, the volume will change by approximately 0.2 %. This statement does only apply if other relevant properties of the liquid do not change at the same time.

Another reason for changing the factory settings can be, for example, the altitude of the location at which the pipette is used. If the pipette is used at an extremely high altitude, it must be adjusted to the ambient air pressure. At 1000 meters above sea level, the volume error of a 100 µL pipette is about -0.3 %. In addition, when using pipette tips that significantly differ from standard tips in their geometry, changing the adjustment can also improve dispensing accuracy.

In contrast to performing calibration which involves determining the measured random (precision) and systematic (accuracy) errors from the nominal value and which does not require any alterations that will permanently change the dispensing system, performing an adjustment will change the device for all subsequent dispensing operations.

Changes made to the adjustment do not affect dispensing precision. Precision can only be improved by exchanging parts. Precision is also considerably affected by handling errors.
The actual volume of a pipette can be checked by weighing as follows:

$$\text{ACTUAL volume} = \frac{\text{Mean value of the weighings}}{\text{Density of liquids at weighing temperature}}$$

If the set volume corresponds to the actual volume, no correction is necessary.
If there is a difference between the actual volume and the set volume, make sure to check the following factors before readjusting a pipette:

- Is there any liquid dripping from the tip?
- Is the pipette tip fitted leak-proof?
- Is the tip cone undamaged?
- Are the piston and the cylinder leak-proof?
- Does the temperature of the pipetted liquid correspond to the temperature of the device and the ambient air?
- Is the weighing location free from drafts?
- Does the work method and pipetting speed permit complete aspiration and dispensing of the liquid?
- Has the correct value for “Density liquids at weighing temperature” been used for the calculation of the actual volume?
- Is the pipette volume setting correct?
- Is the balance sufficiently sensitive (balance resolution 0.001 mg) for very small volumes (< 10 µL)?
- Were original epT.I.P.S. pipette tips used with the correct volume (see technical data) as test tips?

The factory setting of the Eppendorf Xplorer may only be changed after all of the above listed points have been thoroughly checked and the pipette volume setting is still different from the measured volume.

The Eppendorf Xplorer offers several individual adjustment options which can be used as an alternative to adjusting the pipette, depending on the application.
The following adjustment options are available for selection:

Adjustment

Liquid type ethanol 75 % or glycerol 50 %
When this adjustment option is selected, the factory setting is changed by an internal factor which considers the density of the ethanol or the glycerol. This means that the substance can be dispensed with greater accuracy (smaller systematic error) with the Xplorer pipette.

epT.I.P.S. long
This enables the pipette to be adjusted to the different lengths of a pipette tip, such as, epT.I.P.S. 1200 µL elongated or epT.I.P.S. 10 mL L. When this adjustment option is selected, the tip geometry of the longer tip is considered in the internal volume calculation. This means that the technical data of the original tip (test tip) is reached. This function can also be used when the Xplorer pipette is not used with its test tip, e.g., when using the 300 µL epT.I.P.S. for the pipette size 5–100 µL. When using the following tips dispensing accuracy can be increased with this function:

- Eppendorf Xplorer 10 µL (medium gray):
  epT.I.P.S. long 20 µL L (light gray tray)
- Eppendorf Xplorer 100 µL (yellow):
  epT.I.P.S. 300 µL (orange tray)
- Eppendorf Xplorer 1000 µl (blue):
  epT.I.P.S. long 1250 µl L (dark green tray)
- Eppendorf Xplorer 1200 µL (green, 8-channels):
  epT.I.P.S. long 1250 µL L (dark green tray)
- Eppendorf Xplorer 10 mL (turquoise):
  epT.I.P.S. long 10 mL L

Geographic altitude
The mean air pressure of a location depends on its height above sea level. When testing a piston-stroke pipette it is thus important to take fluctuations in pressure into account. At higher altitudes with a drop in air pressure the aspiration volume of a piston-stroke pipette is reduced. The Xplorer pipette's stroke is corrected taking into account the air pressure at the respective altitude. This can be easily accomplished using the "Geographic altitude" adjustment function that allows the altitude to be adjusted in increments of 250 m (820 ft). The maximum altitude that can be selected is 5000 m.

The adjustment options **Liquid Type, epT.I.P.S. long** and **Geographic Altitude** can be combined with each other.

Individual adjustment

Another possibility of readjusting the Xplorer is to use the “Individual adjustment” function. With this option, the gradient or axis intercept is changed taking into account the exact density of the solution to be dispensed. 1-point, 2-point or 3-point adjustment are available for selection. To create the weighing results, the use of a fine balance with a high resolution is required. Dispensing volumes below 10 µL require a balance with a resolution of 0.001 mg. The arithmetic operations required for performing the correction are automatically performed by the Xplorer pipette during the 1-3-point adjustment, so that the user does not have to carry out any complicated calculations.

1-point adjustment

After you input the density, the selected volume and the corresponding weighing result, the Xplorer determines a correction factor. The factor is only valid for the selected volume and the selected work technique (speed, prewetting, wall dispensing method, etc.).

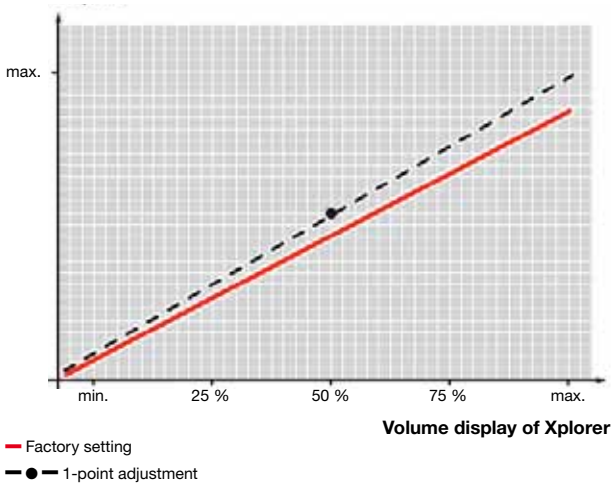

Fig. 1: Example for the piston-stroke correction of a 1-point adjustment

In this example the factory piston-stroke setting is increased by a factor (Fig.1). Strictly speaking, the correction only applies to the testing volume, but it is used for the entire volume range. The correction is different to that for a mechanical pipette.
A correction with a factor results in a smaller stroke correction for a small volume than for a large volume.

In the case of a mechanical pipette the stroke can only be changed by a fixed volume (Fig. 2). This volume change applies to the entire measurement range of the mechanical pipette. The existing adjustment is changed in parallel by a fixed amount.

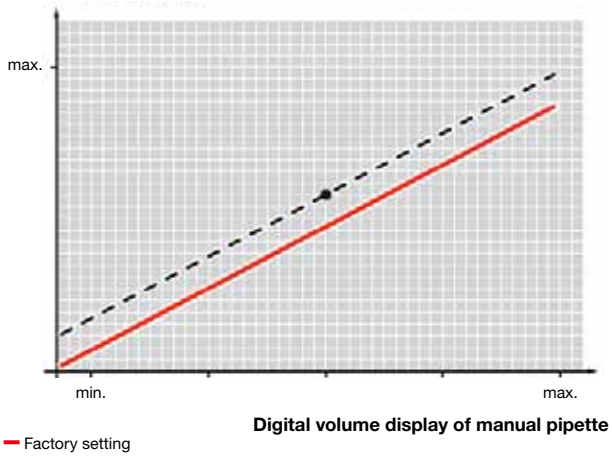

Fig. 2: Example for the change of the piston stroke of a mechanical pipette

2-point adjustment

After you input the density, two different volumes and the corresponding weighing results, the Xplorer determines a correction factor. The factor applies to the volume range between the tested volumes and only for the selected work technique. However, the factor is also used here for the entire volume range, that is, also below and above the two measuring points (Fig. 3).

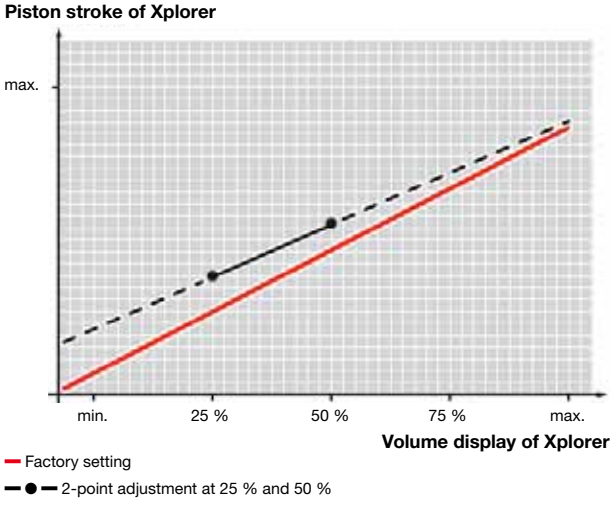

Fig. 3: Example for a 2-point adjustment

Individual adjustment

3-point adjustment
After you input the density, three different volumes and the corresponding weighing results, the Xplorer determines two correction factors. The factors are correct from measuring point to measuring point in the selected volume regions and only for the selected work technique. However, the respective factor is also used below and above the first or third measuring point (Fig.4).

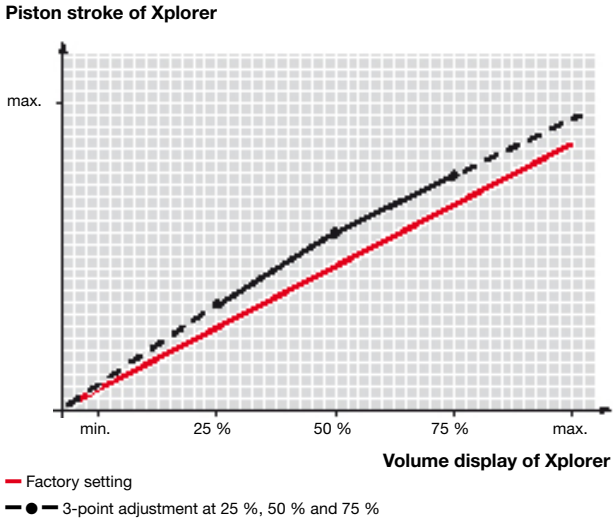

Fig. 4: Example for a 3-point adjustment

In contrast to 1-point and 2-point adjustment, 3-point adjustment is more accurate. If three significantly different volumes are used for calculating the two correction factors, the corrected volume range is considerably larger and thus also more precise. However, 3-point adjustment is more time-consuming.

It is necessary to carry out a gravimetric test for each Xplorer pipette whose factory setting has been changed by one of the above-mentioned adjustment options.
This is the only way of ensuring that the selected adjustment meets the required measurement errors.
To ensure that other users are informed of the changed adjustment, each Xplorer pipette that has been changed by the adjustment must be additionally marked by a clearly visible label indicating the type of change made.

The precise work technique relating to the individual adjustment options is described in the adjustment instructions of the Eppendorf Xplorer (see Xplorer Adjustment Instructions).

Factory settings
A pipette that has been readjusted can be reset to the original settings using the “Reset to Factory Settings” adjustment option at any time.

Outlook

Today, it is expected that pipettes should not only offer ease of use and precision. Other features, such as simple volume adjustment, have become standard requirements for such devices. The electronic pipette Eppendorf Xplorer meets such requirements in every respect, making it ideally suited as an instrument for daily use in the lab.

Eppendorf Xplorer® Technical Specifications and Ordering Information

Single-channel Eppendorf Xplorer®, (incl. charger)

Volume range	Volume	Systematic deviation		Random deviation		Order no.
Medium gray multi-function rocker for 20 µl epT.I.P.S.® pipette tips						
0.5–10 µL	1 µL	±2.5 %	±0.025 µL	±1.8 %	±0.018 µL	4861 000.015
	5 µL	±1.5 %	±0.075 µL	±0.8 %	±0.04 µL	
	10 µL	±1.0 %	±0.1 µL	±0.4 %	±0.04 µL	
Yellow multi-function rocker for 200 µl epT.I.P.S.® pipette tips						
5–100 µL	10 µL	±2.0 %	±0.2 µL	±1.0 %	±0.1 µL	4861 000.023
	50 µL	±1.0 %	±0.5 µL	±0.3 %	±0.15 µL	
	100 µL	±0.8 %	±0.8 µL	±0.2 %	±0.2 µL	
Orange multi-function rocker for 300 µl epT.I.P.S.® pipette tips						
15–300 µL	30 µL	±2.5 %	±0.75 µL	±0.7 %	±0.21 µL	4861 000.031
	150 µL	±1.0 %	±1.5 µL	±0.3 %	±0.45 µL	
	300 µL	±0.6 %	±1.8 µL	±0.2 %	±0.6 µL	
Blue multi-function rocker for 1,000 µl epT.I.P.S.® pipette tips						
50–1,000 µL	100 µL	±3.0 %	±3 µL	±0.6 %	±0.6 µL	4861 000.040
	500 µL	±1.0 %	±5 µL	±0.2 %	±1 µL	
	1,000 µL	±0.6 %	±6 µL	±0.2 %	±2 µL	
Violet multi-function rocker for 5 ml epT.I.P.S.® pipette tips						
0.25–5 mL	500 µL	±3.0 %	±15 µL	±0.6 %	±3 µL	4861 000.058
	2,500 µL	±1.2 %	±30 µL	±0.3 %	±6.25 µL	
	5,000 µL	±0.6 %	±30 µL	±0.15 %	±7.5 µL	
Turquoise multi-function rocker for 10 ml epT.I.P.S.® pipette tips						
0.5–10 mL	1,000 µL	±3.0 %	±30 µL	±0.6 %	±6 µL	4861 000.066
	5,000 µL	±0.8 %	±40 µL	±0.2 %	±10 µL	
	10,000 µL	±0.6 %	±60 µL	±0.15 %	±15 µL	

Multi-channel Eppendorf Xplorer®, (incl. charger)

Volume range	Volume	Systematic deviation		Random deviation		Order no. 8-channel	Order no. 12-channel
Medium gray multi-function rocker for 20 µl epT.I.P.S.® pipette tips							
0.5–10 µL	1 µL	±5.0 %	±0.05 µL	±3.0 %	±0.03 µL	4861 000.104	4861 000.112
	5 µL	±3.0 %	±0.15 µL	±1.5 %	±0.075 µL		
	10 µL	±2.0 %	±0.2 µL	±0.8 %	±0.08 µL		
Yellow multi-function rocker for 200 µl epT.I.P.S.® pipette tips							
5–100 µL	10 µL	±2.0 %	±0.2 µL	±2.0 %	±0.2 µL	4861 000.120	4861 000.139
	50 µL	±1.0 %	±0.5 µL	±0.8 %	±0.4 µL		
	100 µL	±0.8 %	±0.8 µL	±0.25 %	±0.25 µL		
Orange multi-function rocker for 300 µl epT.I.P.S.® pipette tips							
15–300 µL	30 µL	±2.5 %	±0.75 µL	±1.0 %	±0.3 µL	4861 000.147	4861 000.155
	150 µL	±1.0 %	±1.5 µL	±0.5 %	±0.75 µL		
	300 µL	±0.6 %	±1.8 µL	±0.25 %	±0.75 µL		
Green multi-function rocker for 300 µl epT.I.P.S.® pipette tips							
50–1,200 µL	120 µL	±6.0 %	±7.2 µL	±0.9 %	±1.08 µL	4861 000.163	—
	600 µL	±2.7 %	±16.2 µL	±0.4 %	±2.4 µL		
	1,200 µL	±1.2 %	±14.4 µL	±0.3 %	±3.6 µL		

The data for systematic and random deviations only applies when using Eppendorf epT.I.P.S. pipette tips.

Charging stand	Order no.		Order no.
for 1 pipette	4880 000.000	for 4 pipettes (incl. charging adapter)	4880 000.026

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