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How to Select a Mechanical Pipette

Application Note

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Factors to be considered when selecting a mechanical pipette.

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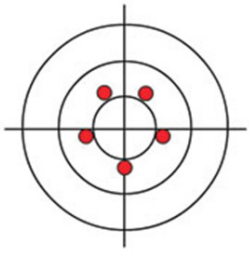
Introduction
Widely used in laboratories of all kinds, mechanical pipettes are long-lasting tools. Because they are used for several hours a day, ergonomics and personal preferences - such as handling comfort – are important selection criteria. Other factors such as the application, laboratory workflow, required volume ranges, physical properties of the sample, and requirements for accuracy and precision also need to be considered when searching for the right pipette for the job.

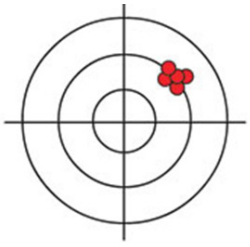
Accuracy and Precision
Accuracy and precision are two of the most critical aspects when choosing a pipette. Accuracy means that the delivered volume equals the set volume. Precision expresses the proximity of multiple pipetting results. Here are some examples:

The result is accurate, but not precise: The mean volume matches the set volume, but the individual pipetting results deviate from each other.



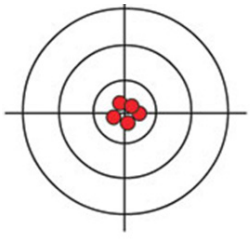
Accurate, but not precise

Result is precise, but not accurate: There is only minor variation between pipetting results; however, the mean volume differs from the set volume.



Precise, but not accurate

Result is accurate and precise: The mean volume equals the set volume; there is only minor variation between pipetting results.



Precise and accurate

The terms accuracy and precision are expressed in the technical specifications of the pipette as systematic error % (inaccuracy %) and random error % (imprecision %). It is worth noting that the specifications are typically valid only when using the manufacturer's own pipette tips. The best accuracy can be obtained by using a high quality, professionally maintained and calibrated pipette with appropriate high quality tips. Precision, on the other hand, is largely affected by pipetting experience and good laboratory practices, such as correct pipetting angles, optimal pipetting speed, and a consistent pipetting rhythm.

To achieve the highest level of accuracy, you should choose the smallest volume pipette capable of handling the volume in question. This is important because pipetting accuracy decreases when the dispensed volume approaches the pipette's minimum capacity. For example, when dispensing 10 µl of liquid, using a 1 ml pipette would result in rather poor accuracy, a 300 µl pipette would be better, and a 10 µl pipette ideal. Moreover, to achieve good pipetting results, it is important to select a pipette with low pipetting, tip-loading, and tip-ejection forces. High forces exhaust the arm and hand muscles more quickly, resulting in poorer results, especially in long pipetting series.

We recommend that you also look for the following features, all of which affect the reliability of pipetting results:
- Easy calibration for various types of liquids. It is also advantageous if settings can be saved for later use.
- Volume adjustment locking – this feature helps to prevent accidental volume changes during pipetting. Pay special attention to the reliability, ergonomics, and intuitiveness of the mechanism.
- Color coding of the pipette or pipette caps – this helps you select the correct tip for the pipette.

Ergonomics
Pipetting is one of the most common tasks performed in a laboratory on a daily basis. Studies show that more than 40% of lab professionals suffer from pipetting-caused disorders.* In addition to causing discomfort, hand or arm injuries limit working performance and may therefore impact accuracy, precision, and the reliability of results.

For the best possible ergonomics, it is important to pay attention to the following qualities when choosing a pipette:

- Required pipetting force: High pipetting force increases the risk of RSI. Moreover, it lowers accuracy and precision in long pipetting series. The typical force required to move the plunger to the first stop is between 3 and 15 N. The force required to press the plunger to the second stop can be as high as 40 N. You can carry out a simple test to compare the pipetting forces of two pipettes by pressing the plungers against each other. The plunger with the lower pipetting force will move first.
- Tip ejection forces: Tip ejection typically requires more force than pipetting. The high tip ejection forces of mechanical pipettes present an injury risk, especially in conjunction with repetitious pipetting. Typical tip ejection forces range from 15 to 30 N.

- Tip loading: Next to tip ejection, tip loading requires the most force during pipetting. The tip loading force is the force required to attach the tip firmly to the pipette. Poorly fitting tips require tapping, rocking, or even tightening by hand to ensure proper sealing. The force can be reduced by using properly fitting tips.
- Grip design and balance: The pipette should fit comfortably in the hand, and the finger support should make holding the pipette effortless. Moreover, a well-balanced pipette with the mass center in the middle provides stability that considerably reduces hand muscle strain and wrist torque.
- Weight and length: The lighter and shorter the pipette, the more ergonomic it is.
- Volume adjustment: Adjusting the pipetting volume should be convenient and ergonomic. To avoid unnecessary strain on the thumb, it should be possible to adjust the volume with two hands – one holding the pipette while the other rotates the adjustment wheel.
- Volume display: To avoid having to hold the pipette in an awkward position, the volume should be easily readable during normal pipetting.
- Suitability for right and left-handed users: The pipette should be comfortable to use for both right and left-handed users. All operations should be equally functional from both directions. Moreover, the display should be easy to read regardless of direction.

Preventing Contamination
To avoid aerosols or drops of a sample from being spread around when ejecting the tip, be sure to select a pipette with gentle tip ejection. When the tip is gently ejected, the remaining liquid droplets or aerosols are much less likely to disperse over a wide area.

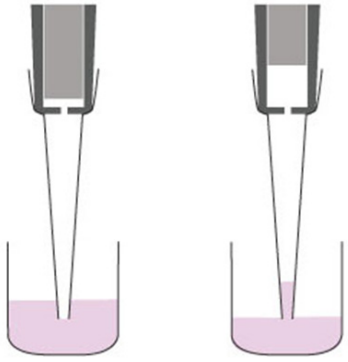
For fast and convenient decontamination procedures, choose a mechanical pipette that is fully autoclavable without disassembly. This also applies to multichannel models.

You should choose a pipette that offers the possibility to use a filter on the tip cone. Tip-cone filters prevent aerosols and fluids from contaminating the internal components of the pipette. They are also an economical and effective way to prevent sample contamination. Alternatively, filtered pipette tips can be used.

Single or Multichannel Pipette?
Single-channel pipettes are the workhorses of liquid handling. They are available in adjustable and fixed-volume models. Adjustable-volume pipettes allow the dispensed volume to be changed as needed, whereas fixed-volume pipettes always dispense the same quantity of liquid. Fixed-volume pipettes prevent dispensing errors caused by incorrect volume selection. They are suitable for applications with a constant liquid transfer volume as well as being ideal for beginners and non-certified technicians.

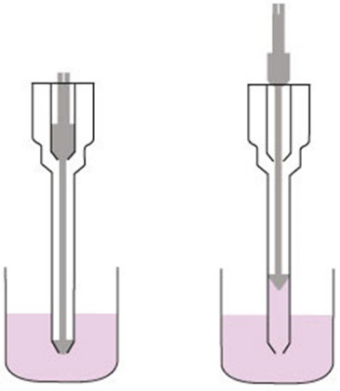
Here are the most important points to consider when selecting a multichannel pipette:
- Check that the position of the lower part of the pipette can be adjusted 360 degrees to ensure that pipetting can be performed ergonomically.
- Make sure that the pipette provides fast, secure, and simultaneous tip-loading for all tips. It should be possible to mount the tips evenly without excessive force.
- Check that the tips can be easily ejected.

Air or Positive Displacement Pipette?
There are two types of mechanical, piston-operated pipettes: air displacement and positive displacement pipettes. Air displacement pipettes, which are intended for general laboratory work and aqueous samples, have an air column between the piston and the liquid. Most pipetting work in laboratories is performed using this type of pipette.



How an air displacement pipette works

Positive displacement pipettes are intended for demanding samples such as highly viscous, volatile, radioactive, or corrosive liquids. In this type of pipette the piston is in direct contact with the liquid, ensuring there is no risk of contamination. Because these pipettes require special tips, positive displacement pipetting is more costly than air displacement pipetting.



How a positive displacement pipette works

Calibration and Maintenance
All pipettes need regular maintenance to ensure reliable results and maximum instrument lifetime. When choosing a pipette, it is important to consider the service aspects. Do you want the user to be able to perform calibration? If yes, ensure that this is possible and that it is easy to do. If the user will clean the pipette, it should be easy to disassemble and have as few removable parts as possible. The easiest pipettes to clean have only three removable parts and can be disassembled without tools.

If you plan to use external calibration and maintenance services, check the location of the closest service center, as well as the quality, cost, and speed of their services.

To learn more about Sartorius pipettes, visit www.sartorius.com/mechanical-pipettes

A disassembled mechanical pipette

Lubricating a mechanical pipette

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