Pipetting Performance Starts with Motor Design: Why It Matters for Lab Performance

Laboratories across the world rely on pipettes to dispense precise liquid volumes during research and testing. Their ability to deliver high-quality, reproducible results is often a factor in purchasing decisions, but many laboratory managers also focus on user safety and comfort as well as cost and maintenance implications. At the core of many of these performance factors is motor design within electronic pipettes.

Electronic air displacement pipettes are frequently chosen for handling non-viscous or aqueous liquids due to their high levels of accuracy and precision in these contexts. They became particularly visible during the response to COVID-19, where vaccine development required high-volume, reliable sample handling. The unprecedented demand for both volume and consistency expedited the uptake of electronic pipettes, and today they are the primary option for many laboratories seeking increased user comfort and reduced user error.

Manual vs electronic pipettes

In an air-displacement pipette, a manually or electronically activated piston drives changes in the air column to aspirate and dispense liquid. Manual pipettes create pressure changes via an operator compressing and releasing a spring-loaded mechanism, which can result in different application of force between users and even between instances of one operator. One study found that over ten attempts, the mean rate of imprecision in a single user for pipetting 10 µL of distilled water was 5.7%.

There have been numerous studies relating to the impact on operators of pipetting, even at relatively moderate volumes. One study found that in biomedical laboratory work, intensive pipette use represented the most dominant ergonomic problem with another suggesting that some form of automation ought to be taken into

consideration when operators are expected to handle high volumes of pipetting work.

These ergonomic concerns are one reason why some laboratories are exploring electronic solutions. While some laboratories find that the higher upfront cost of an electronic pipette represents a more significant barrier, others may feel the initial cost is justified by improved user comfort. The impact on efficiency is also a factor, whether that is linked to reduced user discomfort or simply the removal of an opportunity for human error. This makes the underlying motor system a critical determinant of pipetting performance and consistency.

Selecting the right motor for your electronic pipette

For laboratories transitioning to electronic pipette use, multiple factors may influence the choice. In these systems, motor design directly determines how accurately and consistently liquid is aspirated and dispensed. As the first step in many laboratory workflows, pipetting performance has a direct impact on downstream results, reproducibility, and operational efficiency. This makes motor design a key factor in maintaining reliable performance over the working life of the device.

For specialist laboratories like those working in regulated industries or high-throughput environments, the answer will be linked to the context, so any decision should start by identifying the key requirements. Engaging suppliers in the early stage of the design process can help deliver optimal designs, so managers should look for suppliers that take the time to discuss individual requirements.

Motor selection plays a vital role in the precision and accuracy of electronic pipettes by defining the force, speed, smoothness, and positional fidelity of the piston's movement. These will vary in importance depending on the objectives of each laboratory, and to an extent, each task.

These considerations become clearer when comparing common motor technologies used in electronic pipettes.

Brushed DC motors

Brushed DC motor technology is an ideal choice for applications that benefit most from low friction, low starting voltages, absence of iron losses, high efficiency, good thermal dissipation or linear torque-speed function.

They are a high-performance option that translates direct current (DC) power into rotational motion without complex electronics. Their smooth operation and straightforward control make them attractive for handheld devices like pipettes. However, as pipetting requires linear movement, DC motors require additional components to convert the plane of movement. DC motors also have maintenance implications as their moving parts suffer wear over time. Some helpful questions to ask users might include the following:

- How long is the motor on each axis running?
    - Shorter timescales make DC motors a more attractive option.
- What is the timing requirement for the pipetting cycle?
    - The longer a motor is required to move on its standard plane of movement, the more modification is needed. DC motors would require this sort of modification.
- What sizing constraints need consideration?
    - DC motors tend to be significantly smaller than stepper actuators, so may represent a more efficient solution where space is limited.

Where speed and power are more important, or where motion is limited in timescale, DC motors may represent the most efficient option.

Stepper actuators

An alternative approach is stepper linear actuation, which addresses several limitations of traditional motor designs. Stepper linear actuators offer an integrated solution that is popular in the context of electronic pipettes due to their direct linear motion and high positional resolution.

With no need for additional components to operate on the standard pipetting axis, they can deliver substantial improvements in accuracy over manual operation while remaining lightweight enough to support ergonomic, hand-held designs.

- What level of positional accuracy is required for consistent pipetting?
- Stepper actuators move in discrete, repeatable steps, making them well suited to applications where fine positional control directly affects dispense accuracy.
- Is consistent, repeatable motion more critical than speed?
- Where the priority is predictable, reproducible motion rather than raw speed, stepper actuators tend to be the more reliable option over the working life of the device.
- How important is repeatability across high-throughput workflows?
- Their longer lifespan and consistent performance can be particularly valuable in high-throughput environments, where reducing the force required to stabilize a hand-held pipette can also help minimize staff fatigue and the risk of repetitive strain.

Where accuracy, repeatability, and long-term consistency take priority over speed, stepper actuators often represent the most effective option.

Questions to ask when choosing an electronic pipette

Both brushed DC motors and stepper linear actuators can meet the precision demands of electronic pipettes, with the most appropriate choice ultimately depending on intended usage. Design considerations should reflect the specific application, making it important to engage suppliers who can deliver tailored solutions rather than standardized products.

While DC motors can offer high levels of precision, they are prone to wear over time and can represent higher initial outlay. Stepper motors may offer a longer lifespan but can be less optimal when the key requirement is a fast motor.

There is no “one size fits all” design when it comes to pipetting motors, but there are some important questions that will help; these can also form the basis of collaborative partnerships with a supplier.

- How will this motor improve pipetting reproducibility across users and cycles?
- How will this solution minimize user discomfort?
- What maintenance burden will this solution introduce?
- How will this design maintain pipetting accuracy and calibration over time?
- How critical is motor speed for this application?
- How does motor runtime on each axis affect performance?

Across disciplines, laboratories must balance the need for repeatable, consistent output with the equally critical priority of minimizing operator strain, particularly in pipette-driven workflows where small inconsistencies can scale into significant variability. As a result, thoughtful motion system design has become increasingly important. For many laboratory decision makers, this means working with suppliers who understand how motor design choices translate into real-world pipetting performance and operational outcomes.

Image captions:

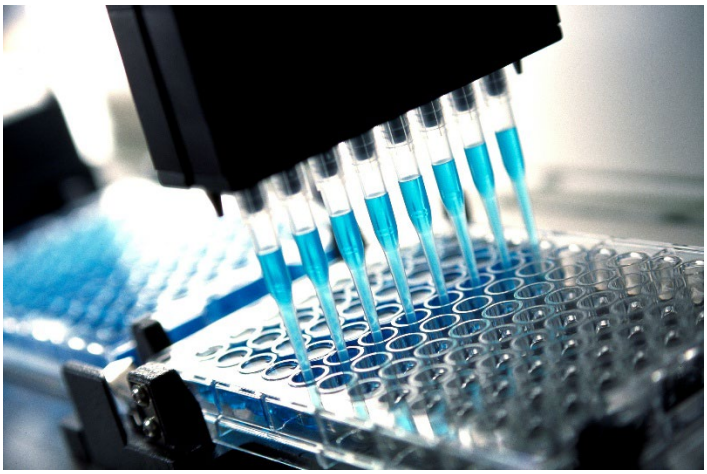


Image 1: Laboratories across the world rely on pipettes to dispense precise liquid volumes during research and testing.



Image 2: Dave Beckstoffer is a Senior Industry Manager on the medical team at Portescap, a Regal Rexnord brand, with over 35 years of experience in the motion control industry.

The image(s) distributed with this press release are for Editorial use only and are subject to copyright. The image(s) may only be used to accompany the press release mentioned here, no other use is permitted.

About Portescap

Portescap, a proud member of Regal Rexnord, excels in addressing critical motion challenges with premium miniature electronic motors and components. For over 70 years, our extensive product range – including coreless brush DC, brushless DC, stepper, gearhead, encoder, and controller technologies – has powered applications across the aerospace and defense, automation, industrial power tools, medical, robotics, and surgical hand tool industries. Expert engineers collaborate with you from prototype to production, ensuring exceptional performance tailored to your specific needs.

As part of Regal Rexnord, customers benefit from seamless access to a vast brand portfolio and a robust global manufacturing and sourcing network. Dedication to innovation and sustainability drives us to design products that significantly impact daily life. Leveraging Regal Rexnord's broader expertise and resources, we aim to deliver sustainable solutions that power, transmit, and control motion, helping to create a better tomorrow.

For more information, visit www.portescap.com

Press contact:
Portescap
Katie Guiler
Senior Digital Marketing Specialist
Tel.: 678-612-8592
Portescap.sales.europe@regalrexnord.com

PR Agency:
Marketing + Technologies Group
Anne-Marie Howe
Progress House, Great Western Avenue, Worcester, WR5 1AQ, UK
Tel.: +44 (0) 1905 917477
a-m.howe@markettechgroup.com
news.dmaeuropa.com