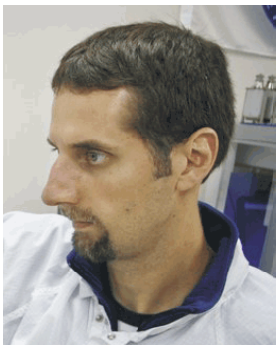

Travis Schafer
Quality Control and Field Applications Scientist, Artel, Inc.

Many labs around the world struggle using handheld pipettors for dispensing small samples. User variation in things like how the tip is touched off to the receiving vessel, tip pre-wetting or rinsing in the receiving liquid after dispensing often compromise consistency and lead to accuracy and precision problems.

But even careful operators who know this are driven by the fact that the available pipettors simply cannot provide both the fine resolution needed to accurately aspirate a small sample and the high flow power needed to cleanly deliver it (a dilemma bedeviling automated pipetting as well).

Most scientists in these labs understand that pipetting is accomplished by the sound principle of mechanical displacement. The pipettors push and pull a precision diameter shaft/piston through a seal to suck a sample in or push it out. When an air gap is allowed between the end of the piston and the sample to prevent contamination it is “air displacement”, and when the protective air barrier is sacrificed so the piston can come directly in contact with the sample to improve precision and accuracy it is “positive displacement”. But demanding both fine resolution and high flow from one piston is asking the impossible. Now, however, the creation of the Differential PipettorTM does just that -- it lets the rock solid principle of mechanical displacement operate to give both ultrafine resolution and abundant high flow power to aspirate small samples accurately and deliver them accurately and cleanly without touching off.

The Differential Pipettor uses the mechanical displacement principle differently from all other pipettors. It runs on two husky pistons of slightly different diameters that are lined up with each other, each passing through its rugged seal, and able to move separately or together relative to their common chamber. There is no small piston or small seal anywhere so sealing is smooth and stable. You can see this technology work here http://www.differentialpipetting.com/how-it-works.html. When the 2 pistons move together their small cross section area difference displacement is the same as a very thin single piston would give - which is Differential DisplacementTM. This creates the differential volume for precise aspiration. When one piston moves alone it gives a strong clean air impact to blow the sample cleanly off. The ability of the two pistons to move either together or separately gives two dramatically different resolutions, hence Dual Resolution. In addition to this solution for getting both precise aspiration and large dispensing flow, the piston arrangement also lets the Differential Pipettor operate with only a downward movement, with no direction changes and about half the movement of regular pipettors.

The ability of any pipettor to be able to dispense a sample is directly related to how much velocity it can impart to the sample at the tip. Most liquids need to leave a tip at a velocity of at least 1.5 meters/sec to fully clear the tip. Many manufacturers try to make do with changing pipettor tip taper or tips with very tiny orifices so that the small flow rate available can get the sample through the tiny tip at a faster velocity. These compensations often don't give enough tip velocity and can also damage certain solutions during both the aspirating and dispensing steps. The Differential Pipettor's Single piston mode is capable of providing as much tip

escape velocity as needed to insure complete and clean touch-free dispenses through sensible tip geometry and orifices that cannot damage things. See how this works here http://www.differentialpipetting.com/files/107837190.pdf.

I used several Differential Pipettors, both adjustable and fixed volume type, to compare precision and accuracy with our best state-of-the-art reference pipettors. I did this from 0.75µL through 10µL. New tips were used in all cases. Delivery into the Artel Pipette Calibration System (PCS) vial with the reference pipettors was done in the standard tip touch-and-drag manner. With the Differential Pipettors, delivery was done contact-free by aiming generally at the center of the vial and depressing the plunger to blow the sample out into the vial liquid without the tip touching anything. The Differential Pipettor tips were free from any visible red dye after the contact-free blowoffs. The PCS results showed that accuracy and precision of the Differential Pipettors were fully comparable to that of our reference pipettors, and perhaps then some, but a larger series would be needed to look for any statistically significant differences. See the published study here http://www.differentialpipetting.com/files/114196605.pdf.

I subsequently had access to one of the very first ultra ultra fine resolution Differential Pipettor models which let me pipette even lower throughout the 200 nanoliter to 900 nanoliter range. This model has dual piston diameters that differ by only 0.001 inches, which gives the differential mode the same resolution that a 10µL syringe would have but with its same stout pistons and rugged seals. The aspiration stroke and excursion felt smooth and stable throughout, including several mm of good stroke for even the smallest size. Because the Differential Pipettor can dispense by either standard touchoff or by contact-free blowoff, I did both kinds of delivery, which I have never had the opportunity to do before. The PCS results quantitatively captured the fact that touchoff delivery lets additional volume wick-off from the outside of the tip, and suggested some volume retention inside. See the published study here http://www.differentialpipetting.com/files/111932685.pdf Everything in the data and my handling indicates that the contact-free delivery gives the most accurate and consistent results and eliminates many errors related to operator technique variability that are intrinsic to touchoff delivery.

I could instantly tell how well this piece of equipment functions. The Differential Pipettor has no small seal or piston anywhere and the strong clean flow impact dispenses the samples cleanly. Being able to actually see the pistons and the rugged seals directly during operation gives additional insight into its robust build quality. It seems to excel in aspirating and dispensing precision and ruggedness and would be faster and easier for large repetitive pipetting tasks. This might be the best single-channel hand held pipettor, operating all the way down into the nanoliter ranges, in the market.

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