MICROMAN® E: Achieve Pipetting Precision of Problem Liquids

GILSON WHITE PAPER

APPLICATION BENEFITS

With a positive displacement pipette, there is no piston in the pipette but in the disposable capillary, directly in contact with the sample. The depression created when the piston comes back up (push button released) enables liquids to be aspirated. Thus, this aspiration force remains constant and unaffected by the characteristics of problem liquids.

SOLUTIONS

Experimental results obtained with positive displacement pipette like MICROMAN® E prove they are the best and fastest way to pipette microliter viscous, dense, surfactant, volatile, cold or hot liquids with high precision and accuracy.

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INTRODUCTION

Commonly used air displacement pipettes are highly accurate for most liquid dispensing applications. However, the viscosity, volatility, surface tension, and temperature of the solution can adversely affect the performance of these air displacement pipettes. Additionally, air displacement pipettes can cause higher risk of cross-contamination with biological samples and the residual carry-over of hazardous and radioactive liquids can endanger the end user. This white paper demonstrates the benefits of replacing air displacement pipettes with positive displacement pipettes like MICROMAN® E for problem liquids.

Figure 1
MICROMAN E positive displacement pipette

WHY TRANSITION TO POSITIVE DISPLACEMENT PIPETTES WHEN PIPETTING PROBLEM LIQUIDS?

With an air displacement system, the air cushion separates the liquid in the plastic tip from the piston inside the pipette (See Figure 1A). Like any gas, the air cushion between the piston and liquids interacts according to the characteristics of liquids (dense, viscous, surfactant, volatile) as well as partly by lab or protocol condition (temperature variation, humidity). Therefore the accuracy (systematic error) and precision (random error) of the air displacement pipette correlate directly to the variation in the volume of the air cushion and the liquid's physical properties.

The following liquid properties and environmental factors can affect the accuracy and safety of air displacement dispensing:

Viscous, dense or surfactant liquids: Liquids such as enzyme solutions, buffers, glycerol, creams, gels, syrups, juices and waste waters can stick to the tip when dispensing causing residual carry-over and contamination. A liquid with high viscosity flows into and out of the tip very slowly. If the tip is withdrawn too soon from the liquid reservoir, an air bubble forms in the tip, reducing the liquid volume. Surfactants reduce the surface tension causing the wetting ability of the liquid to change. A very thin film of liquid remains on the tip walls, flowing down more slowly than most of the liquid mass. The effect is similar to the behavior of viscous liquids, but the remaining liquid film is much thinner.

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Volatile Liquids: Many protocols require the use of solvents such as acetone, hexane and methanol. These liquids evaporate so quickly that they increase the internal pressure of the air displacement tips, leading to leaks of the sample.

Hot and cold liquids: In general, cold liquids tend to be delivered in excess quantity and warm liquids tend to be under-delivered. For example, cold biological liquids containing DNA reduce the temperature of the air cushion once the tip is immersed causing the air to condense. During aspiration, this volume discrepancy is balanced out by suctioning more liquid sample into the tip. When immersing the tip into a warm sample (i.e. blood at 37°C) the captive air inside the tip is exposed to the increased temperature and expands. Therefore, less liquid is aspirated and delivered.

Biological, corrosive, and hazardous solutions: With air displacement pipettes, the pipette shaft is exposed to the air inside the tip allowing aerosols or vapors to contaminate samples and/or potentially the researcher. Filter tips help prevent cross-contamination but they do not provide a complete barrier to gas flow. Corrosive samples like acids may evaporate because of the air cushion inside the tips leading to pipette shaft, seal and piston corrosion after several pipetting cycles. Hazardous liquids (radioactive solutions, body liquids) may contaminate the internal parts of the pipettes as well as the user.

There are alternative solutions to pipetting problem liquids with an air displacement pipette, but these too can introduce additional error.

Reverse pipetting: More liquid is aspirated than required by pushing the pipette piston down to the purge position (the second stop) and dispensing the liquid without purge.

As regular pipetting performance is achieved with the complete A. pipetting cycle including the purge, this method results in decreased accuracy and precision. There is always a risk to aspirate more liquid than possible with the tips or to have the liquid touch the filter tips. Expensive samples and reagents left in the tips may lead to excess waste.

Pre-wetting tips: Performing several pipetting cycles before aspirating the liquid helps saturate the air cushion in the tips and avoids solvent leaks, but this method does not ensure pipetting accuracy.

Use of wide-orifice tips or cutting the ends of the tips: This lab trick" eases the liquid aspiration and dispensing for the regular pipette, thereby allowing the liquid to move more quickly through the tip end. Although, this method may save time, it does not prevent liquid from sticking to the tip walls while dispensing.

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Positive displacement pipettes feature a piston which is integrated in the tip and therefore has direct contact with the sample (Figure 1B). The piston ensures positive displacement of the liquid to be dispensed without any air cushion. In this way, the physical properties of the liquid may not influence the volume of the liquid to be aspirated or dispensed.

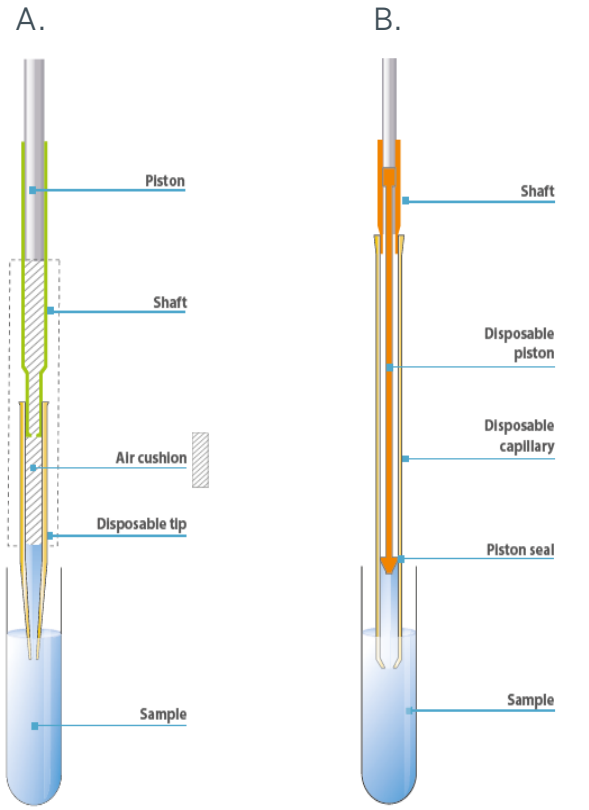

Figure 2
Air displacement (A) versus positive displacement (B) principles

WHAT IS THE MICROMAN® E AND CAPILLARY PISTON (CP) PIPETTING SOLUTION?

The MICROMAN® E was designed by Gilson's skillful team of engineers with over 30 years of experience developing positive displacement pipettes (Figure 2). The MICROMAN® E was created specifically to answer the needs of regular pipette users who work with viscous, dense, surfactant, volatile, corrosive, hot or cold liquids. As a positive displacement pipette, the MICROMAN® E uses disposable capillaries and pistons. These are the only parts to be in contact with the aspirated liquids.

Capillary Pistons (CPs) are disposable plastic consumables:

- Capillaries are made of non-wetting polypropylene with no risk of breakage
- Slim CPs fit into even the narrowest and deepest test tubes
- Pre-assembled, racked and ready-to-use like tips with regular pipette
- Free of dyes
- Available in standard or sterilized versions certified free of detectable DNA, RNA, DNAse, RNAse, ATP, pyrogens and trace metals (certificate upon request)

Gilson CPs are designed, developed and manufactured to fit Gilson MICROMAN® E perfectly. They ensure optimal performance of MICROMAN® E pipettes across the full volume range. The MICROMAN® E and its CPs cover a volume range from 1 µL to 1000 µL with six models of pipettes.

DOES THE MICROMAN® E REALLY DELIVER BETTER RESULTS WITH PROBLEM LIQUIDS THAN REGULAR PIPETTES?

Accurately dispense viscous, dense, and hot solutions with positive displacement pipettes

With a positive displacement pipette, there is no air cushion and no variation of the volume aspirated in response to the physical properties of samples. The piston glides along the internal sides of the capillary for easy and rapid pipetting of viscous, dense, and surfactant liquids (Figure 3). The direct contact of the piston against the capillary wall ensures accurate dispensing. Likewise, volatile liquids (Figure 4) and hot or cold solutions (Figure 5) are aliquoted and dispensed accurately without leaks because there is not an air cushion.

Pipetting accuracy with positive displacement pipette (MICROMAN® E) versus regular pipette

For each type of pipette, 100 µL of solution was pipetted and gravimetrically measured at room temperature without an extra step for tip pre-wetting. The percent of systematic error was based on the average of 10 gravimetric measurements per sample.

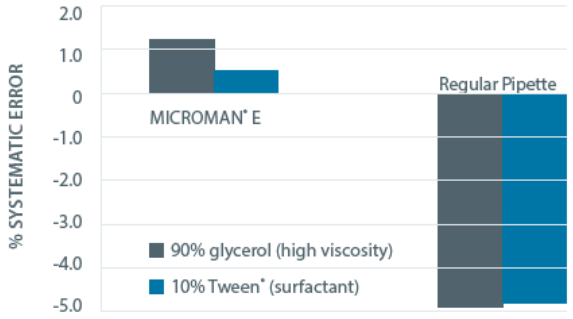

Figure 3
Viscous and surface-acting solutions: Pipetting of 100 µL of 90% glycerol and 10% Tween

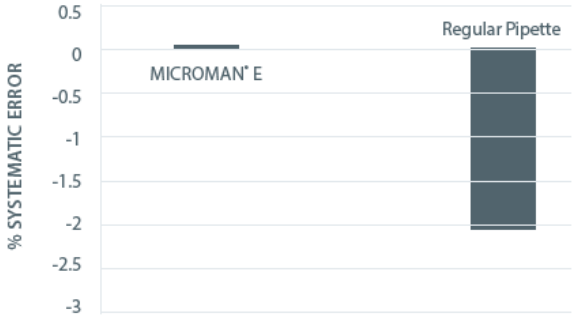

Figure 4
Volatile liquids: Pipetting 100 µL of acetone

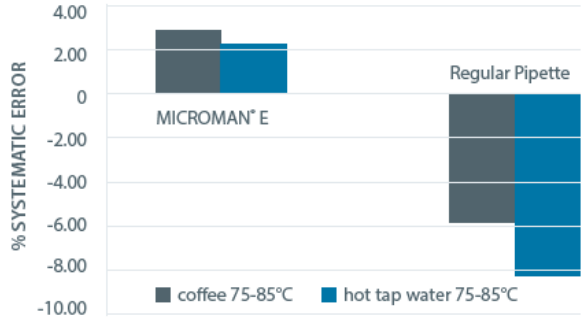

Figure 5
Hot liquids: Pipetting 100 µL of hot liquids

Prevent cross-contamination, residual sample carry-over and unsafe working conditions with positive displacement pipettes

Positive displacement pipettes combined with disposable capillary pistons with built-in ejectors offer clean and safe sample pipetting. Cross-contamination of nucleic acid samples for molecular biology or forensic science studies are significantly reduced because disposable capillaries and pistons are used for each sample and aerosols cannot be released. Infectious biofluids or radiolabelled solutions can be safely pipetted because researchers do not have direct contact with the sample.

Additionally, the pipette itself is protected because the shaft is not in direct contact with corrosive vapors or liquids such as acids, bases or radiolabelled material (Figure 6).

The use of air and positive displacement pipettes are carried out under strictly defined and monitored conditions by the ISO8655-2 standards. ISO 8655 is the volumetric measurement standard that defines the correct process, conditions, equipment, and data required for proper traceability to the SI unit.

Regular Air Displacement Pipette

Unprotected air space:

- Aerosol contamination
- Vapour contamination

MICROMAN E Positive Displacement Pipette

Protected air space:

- No Aerosol contamination
- No vapours
- No liquids

Figure 6
Preventing contamination with positive displacement versus air displacement

HOW EASY IS IT TO OPERATE MICROMAN E?

Key benefits from the MICROMAN® E pipette are:

- **As easy to use as a regular pipette thanks to QuickSnap system:** a unique patented feature that fits the disposable Capillary Piston on the MICROMAN® E, without hand contact and without risk of breakage because the CPs are in plastic-like tips for a regular pipette. This patented device does not require any effort and avoids possible errors when fitting the CP on the pipette. The CPs are pre-assembled and racked to make them as easy to use as regular tips (volume range from 1 µL to 1000 µL) (Figure 7).
- **Same working principle as regular pipette without purge:** it takes just one stroke to simply dispense the sample and a second stroke to eject the disposable CP with the built-in ejector.
- **As comfortable as a regular pipette:** thanks to a similar ergonomic shape with a large and comfortable finger hook, a large push button and lighter body than a regular pipette.
- **As secure as a regular pipette** with a volume control button preventing accidental volume changes.

Figure 7
Fitting the capillary pistons

1. Press your MICROMAN® E onto the Capillary Piston until it is firmly seated.
2. Pick up your CP from the rack.
3. Slowly press the push button until you feel and hear a slight click and pipette the liquid.

SUMMARY

With a positive displacement pipette, there is no piston in the pipette but in the disposable capillary, directly in contact with the sample. The depression created when the piston comes back up (push button released) enables liquids to be aspirated. Thus, this aspiration force remains constant and unaffected by the characteristics of problem liquids.

Experimental results obtained with positive displacement pipette like MICROMAN® E prove they are the best and fastest way to pipette microliter viscous, dense, surfactant, volatile, cold or hot liquids with high precision and accuracy.

Many researchers have already made the convenient transition from air displacement pipette to positive displacement pipette. MICROMAN® E now also makes it as easy and comfortable to use as regular pipettes.

References:

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