Overview
- Non-contact dispenser for the microliter range
- Driven and regulated by pressure
- Direct control of the dispensed volume
- Autonomous temperature compensation
- One parameter change for 500 nl to 10 µL
- Viscosities from 1 to 17 mPas

Introduction
The precise non-contact dispensing of volumes between 250 nl and 25 µl is an important issue for in vitro-diagnostics (IVD), high-throughput screening (HTS) and industrial applications [1, 2]. Covering such a large volume range with high precision is a challenging problem, especially when non-contact dispensing of different liquids is required. Pipetting tools currently used present two main problems:
1 – Cross-contamination risks and cleaning protocols
2 – No online monitoring of the dispensed volumes
3 – Calibration for different liquids needed
Our system addresses these problems by using a pressure actuation and a pressure sensor to control the dispensed volume (patent pending).

Materials
Valve: Vermes MDV 3020A
Nozzle: PEEK – diameter 150 µm
Stepper motor:
Syringe: Braun Syringe 20 ml
Pressure sensor: HDIM100UF8P3 (SensorTechnics)
Difference pressure sensor 100 mbar
Sensitivity 10 mV/mbar
µController: MSP430F149 – 8 MHz

Working principle
- pressure sensor
- gas volume \( V_g \)
- sample liquid
- syringe reservoir
- piston

Typical dispense run
1 – Initial state \( P_0 \) = atmospheric pressure
2 – Syringe displacement \( P_1 \) = elevated pressure
3 – Opening of the valve Fluid is dispensed an pressure drops to end value \( P_2 \)

Why?
Because the volume of fluid dispensed \( V_{\text{fluid}} \) is proportional to the pressure integral \( I \)

\[
V_{\text{fluid}} = \int Q_{\text{fluid}} dt \approx \frac{1}{R_{\text{fluid}}} \int \Delta P dt \propto I
\]

R_{\text{fluid}} is the unknown fluidic resistance

How much fluid is dispensed?
Use of the Boyle-Marriott law after the dispense:

\[
p_0 \cdot V_g = p_1 \cdot V_1 = p_2 \cdot V_2
\]

and

\[
V_{\text{fluid}} = V_2 - V_1 = V_g \cdot p_0 \left[ \frac{1}{p_2} - \frac{1}{p_1} \right]
\]

⇒ Direct relation between \( I \) and \( V_{\text{fluid}} \)
⇒ No calibration required
⇒ Autonomous correction based on measured sensor signal

Results
Liquid mass measurement by gravimetric method [3]:

Thermal drift compensation

Several fluid dispensed:
- 1 and 10 µL
- 24 dispenses/run
- Viscosities 1 → 17 mPas
- Surface Tension
- 30 → 70 mN
- Magnetic beads

Conclusion
- New pressure driven and regulated system
- Online verification of the dispensed volume
- Good accuracy (<3%) and precision (<5%) at 1 and 10 µL over a large range of fluids without calibration
- Successful real-time compensation of accuracy drift caused by viscosity changes due to temperature drift

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References

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