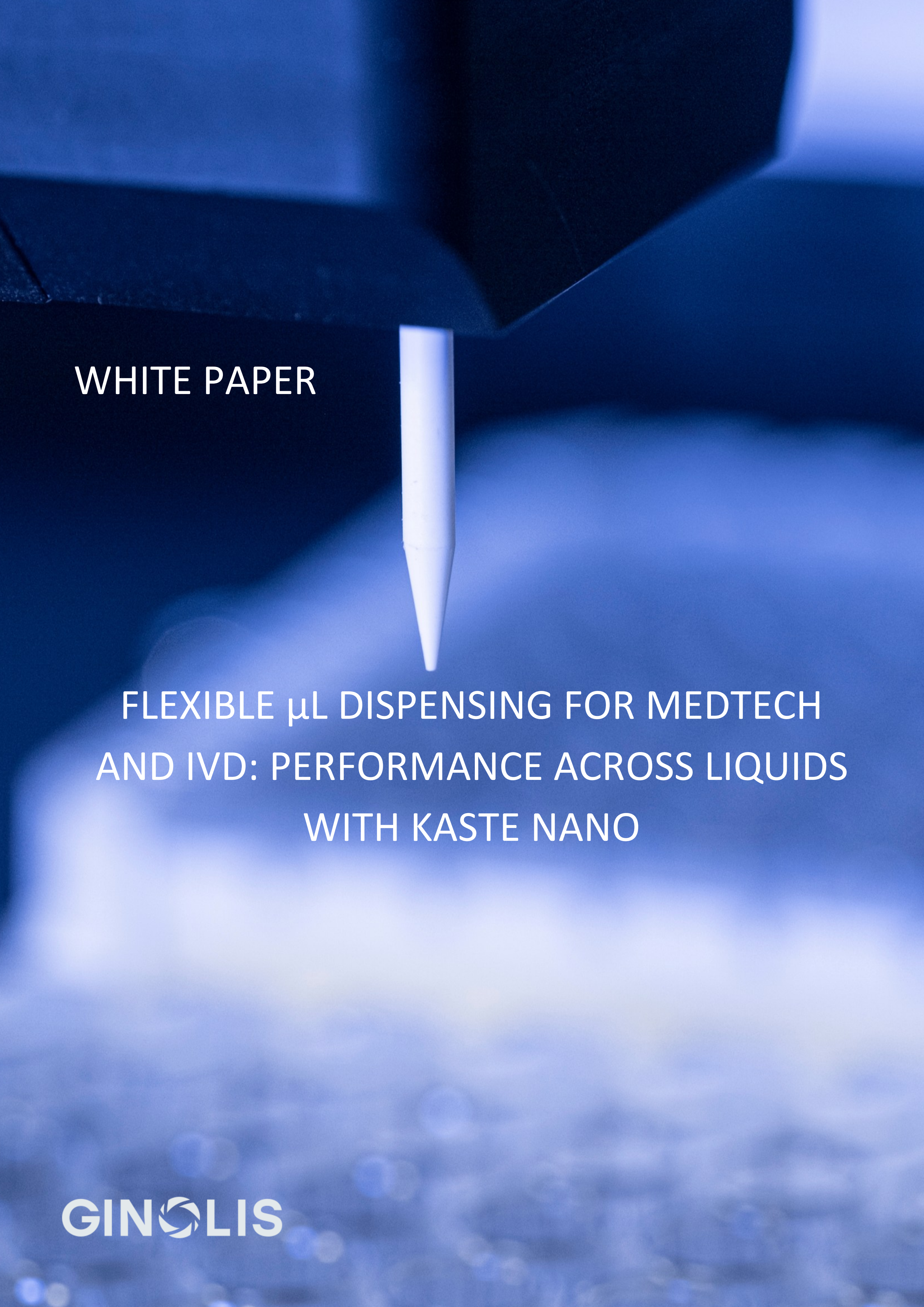


WHITE PAPER

FLEXIBLE µL DISPENSING FOR MEDTECH AND IVD: PERFORMANCE ACROSS LIQUIDS WITH KASTE NANO

GINOLIS

1 EXECUTIVE SUMMARY

MedTech and In Vitro Diagnostics (IVD) development frequently requires dispensing microliter-scale volumes of liquids that vary widely in viscosity, surface tension, and volatility. Switching between reagents can introduce setup changes, parameter tuning, and validation work that slows iteration. This white paper presents an evaluation of the Ginolis Kaste Nano II positive-displacement pump to understand how dispensing performance behaves across different liquid types using a controlled gravimetric measurement approach.

The testing described here used a microbalance-based gravimetric method and included a set of representative liquids such as water, ethanol, glycerol–water mixtures (up to ~20 mPa·s), and commonly used buffers (PBS and TBST with dye). Results are reported across multiple runs per liquid to assess repeatability under the stated conditions and setup.

Overall, the reported data indicates stable dispensing behavior across the evaluated liquids. In the presented measurements, average volume deviation remained below ~0.6% of target and coefficient of variation (CV) remained below ~0.6%. Pressure traces provide additional context: bulk dispensing produced stable pressure behavior within runs, while aspiration-based dispensing of more viscous liquids showed expected pressure trends without a corresponding loss of repeatability in the reported volume results. These findings suggest the positive-displacement approach can support workflows where multiple liquid types are used, while acknowledging that performance depends on the full system configuration and operating conditions described in this paper.

Key takeaways

- Evaluated Kaste Nano II dispensing consistency across liquids with different properties (e.g., volatility and viscosity), using gravimetric measurement on a microbalance.
- Tested water, ethanol, glycerol–water mixtures up to ~20 mPa·s, and common buffers (PBS and TBST).
- In the reported results, average volume error stayed below ~0.6% of target and CV below ~0.6% under the described setup and test conditions.
- Bulk dispensing showed stable pressure behavior within runs; aspiration-based viscous tests showed expected pressure trends without compromising reported volume repeatability.
- Results indicate the approach can reduce the need for extensive re-tuning when moving between liquid types, supporting faster iteration in R&D and smoother transition toward manufacturing—subject to application-specific validation.

2 INTRODUCTION

The paper evaluates low-volume dispensing performance of the Ginolis Kaste Nano II positive-displacement pump using a controlled gravimetric measurement setup, complemented by pressure monitoring.

It tests multiple liquid types relevant to MedTech/IVD workflows (from aqueous buffers and solvents to more viscous formulations) to understand how dispensing repeatability behaves when liquid properties change.

Results compare bulk and aspiration-based dispensing across these liquids using volume statistics and pressure traces, then summarize what this may mean for flexible R&D/scale-up use—while noting final performance depends on the full system configuration and use case.

Modern MedTech and In Vitro Diagnostics (IVD) workflows increasingly rely on dispensing very small liquid volumes with high repeatability. In development and early production environments, teams may need to dispense a wide range of liquids—such as aqueous buffers, solvents, and more viscous formulations—often within the same project or even the same day. Because these liquids differ in properties like viscosity, density, surface tension, and volatility, dispensing systems can require frequent parameter adjustments and re-validation when changing from one liquid to another.

The Ginolis Kaste Nano II is a positive-displacement pump designed to support consistent low-volume dispensing. Unlike approaches that are highly sensitive to liquid properties, positive-displacement dispensing aims to deliver a defined volume through controlled mechanical displacement. The purpose of this white paper is to evaluate dispensing behavior across multiple liquid types using a controlled gravimetric measurement method, and to provide practical insight into repeatability and pressure behavior under the described test setup.

This paper is structured to be easy to scan for both technical and business readers:

- Materials and methods describe the pump setup, measurement equipment, the tested liquids, and the gravimetric approach used to calculate accuracy and precision.
- Results present dispensing performance for both bulk dispensing and aspiration-based dispensing across liquids of increasing viscosity and selected buffers, supported by volume statistics and pressure traces.
- Conclusion summarizes the key observations and discusses what they may imply for applications where multiple liquid types are used—while noting that final performance depends on the complete system configuration and the intended use case.

By combining quantitative volume measurements with pressure behavior, the paper aims to help readers assess how the Kaste Nano II pump can support flexible dispensing needs during R&D and scale-up, and what considerations may matter when transitioning toward manufacturing.

3 MATERIALS AND METHODS

Setup: Kaste Nano II pump was used to perform dispensing trials at Ginolis laboratory in Oulu, Finland. Dispensing accuracy and precision were determined by the gravimetric method using a microbalance.

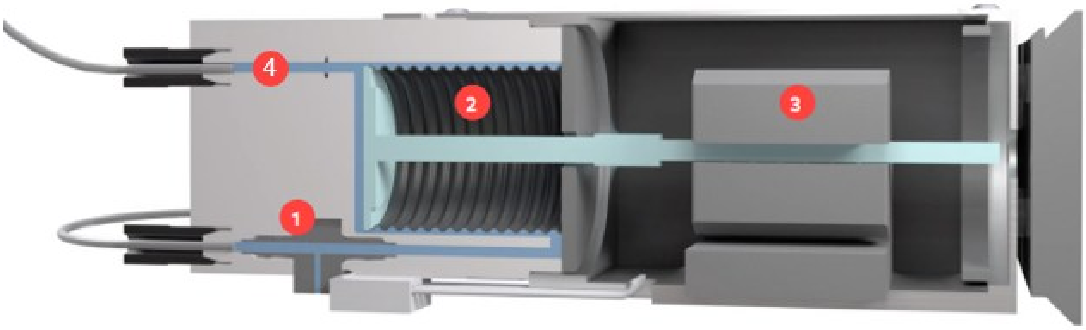
Liquids: Different types of liquids were chosen to show the capability of Kaste Nano pump technology.

Methods: Slightly customized Kaste Nano pump calibration run was performed with different liquids. Whole pump stroke was dispensed in 5 µl aliquots (5 x 1 µl) and weight of each aliquot was recorded.

All tests were performed at Ginolis headquarters laboratory in Oulu, Finland. Laboratory room does not have temperature or humidity control.

Kaste Nano pump

Kaste Nano pump is a positive displacement pump. Inside the pump there is a bellows which is contracted and expanded inside a closed chamber to displace a desired volume that is aspirated or dispensed. Bellows is connected to a highly accurate piezomotor with integrated linear positioning encoder. The pump and fluid line around the pump is filled with degassed system fluid (typically water). A high-quality solenoid dispensing valve is connected to pump via tubing. The valve has short response time and valve opening is controlled by the pump with high timing precision. A nozzle is connected to the valve. After the pump has displaced the dispensed volume, the solenoid valve is opened for pre-defined time to release the volume which is then ejected from nozzle.



1. Pressure sensor
2. Bellows
3. Piezo motor
4. Liquid path

Figure 1 Cross section of Kaste Nano II pump

Figure 1 shows the insides of the Kaste Nano II pump which has a stroke volume of 1500 µl. Stroke volume means the volume that is displaced inside the bellows chamber when maximum movement distance of the bellows is performed. Blue color in figure 1 shows the liquid path of the pump. Liquid is outside the bellows. There is no friction anywhere in fluid line due to the bellows design. Therefore, the pump performance does not change over time, and no maintenance is required.

Kaste Nano pump has an integrated pressure sensor in fluid line. Pressure information can be used in multiple ways. Common uses are clog, leak and air detection, pre-pressurizing, and quality control during dispensing.

Test equipment

Relevant equipment and parts used to perform all dispensing tests are listed in Table 1.

Table 1 Equipment used in tests

Equipment, part description	Model	Serial number	Other information
Kaste Nano II pump	GMA101012	5123002	RS232 was used as communication interface. Firmware #18

Degasser	OEM Mini Vacuum Degasser	81016518	480 µl degassing channel
Dispensing valve	X00330	Manufactured in 2021	Solenoid valve
Back side valve	X00329	Manufactured in 2021	Solenoid valve
Tubing	Standard Kaste Nano II tubing set 1.588 mm (1/16 ”) ID dispensing tubing for high viscosity dispensing		Standard tubing set has 5.0 meter long 0.762 mm (0.03”) ID FEP tubing as dispensing tubing.
Dispensing tip	Ginolis X22124		190 µm orifice ceramic tip
Microbalance	Mettler Toledo XPR10	C225285100	External calibration performed 12.2.2025 K029-166803. Internal calibration before each test.

Picture of setup is shown in Figure 2. Microbalance is on stone table next to the Kaste Nano II pump. Dispensing tubing is on a roll above the dispensing valve and tip.

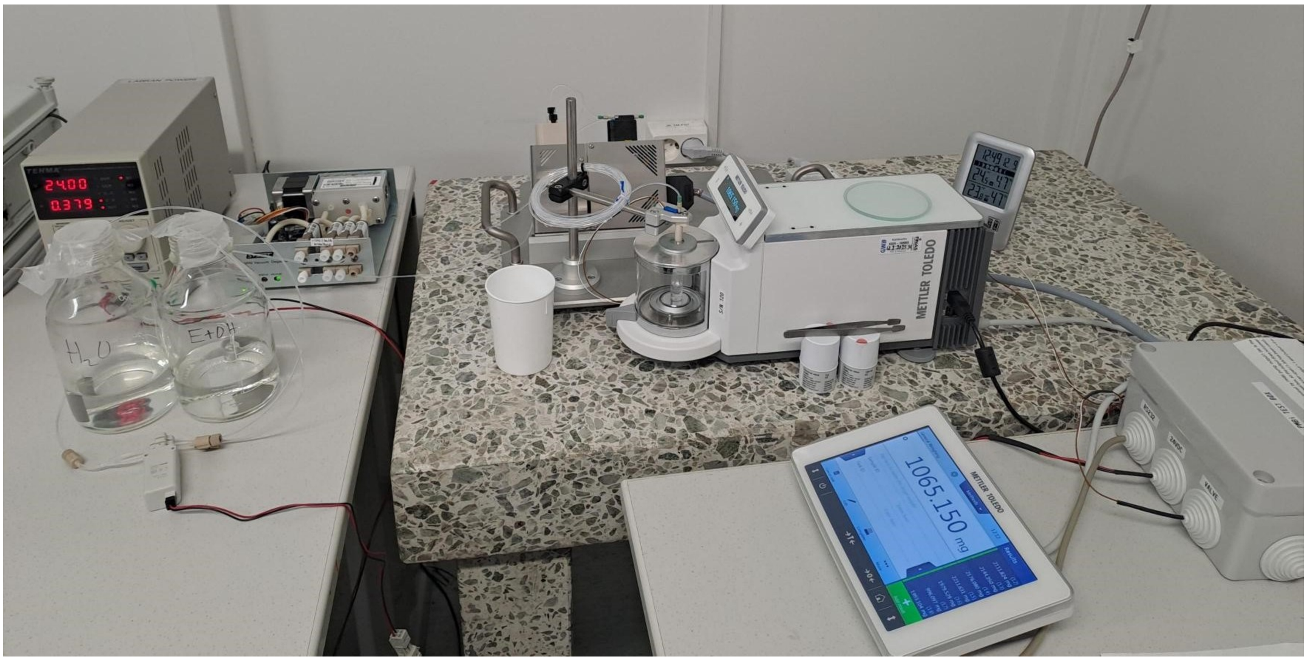


Figure 2 Setup used in tests

Inline degasser is used to remove most of the dissolved gases from the pump system fluid. This prevents accumulation of air inside the fluid line. The whole pump fluid line schematics are presented in figure 3. Water is normally used as the pump system fluid. Ethanol is used for cleaning purposes and to flush the fluid line of possible air bubbles. A switch valve is used between ethanol and water bottles for choosing system fluid.

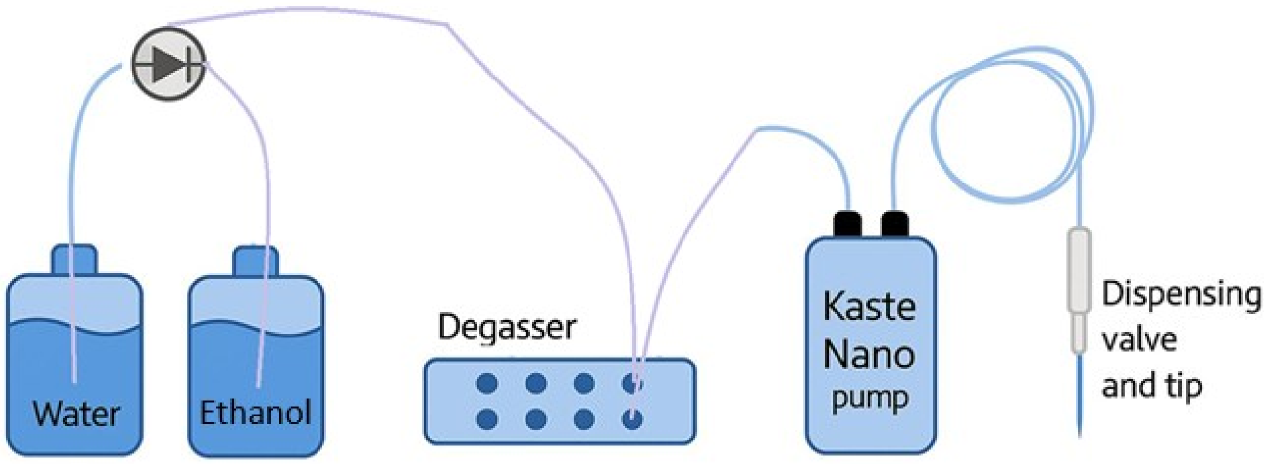


Figure 3 Kaste Nano pump fluid line schematics

Liquids

Information about used liquids is shown in Table 2. Viscosities and densities of glycerol-water mixtures were gotten from online calculator located at University of Reading website[1]. Viscosities and densities shown on table 2 are shown at the temperature at which the test was performed. Most literature sources give the density of used buffers to be 1.005 mg/µl. These or other densities might not be exact.

Table 2 Viscosities and densities of used liquids

Liquid description	Viscosity, mPa*s	Density, mg/µl	Other information
Water	~1	0.998	VWR, Water purified by RI % CDI. 10l canister, 90200.9010
Ethanol	~1	0.807	Etax A13. Contains 91.2% ethanol, 5.8% water, denaturated with n-butanol. Manufacturer gives density as 0.807 kg/l.
50% (w/v) Glycerol-water	~6	1.1254	VWR, Glycerol bidistilled 99.5%, 500ml bottle, 24388.260. Water specification above.
65% Glycerol-water	~15	1.1675	VWR, Glycerol bidistilled 99.5%, 500ml bottle, 24388.260. Water specification above.
69% Glycerol-water	~20	1.1776	VWR, Glycerol bidistilled 99.5%, 500ml bottle,

[1] https://www.met.reading.ac.uk/~sws04cdw/viscosity_calc.html

			24388.260. Water specification above.
Phosphate-buffered saline (PBS) buffer with blue dye (0.025%)	~1	1.005	PBS x 1, Thermo 70011044. Dye: Comassie Brilliant Blue G-250, M140-10g
Tris-buffered saline with 0.1% Tween® 20 (TBST) buffer with blue dye (0.025%)	~1	1.005	TBST, G-Biosciences, R043, MC 2/7/22, 10mM Tris.HCl, 150mM NaCl, 0.05% Tween® 20 at pH 7.5 Dye: Comassie Brilliant Blue G-250, M140-10g

Methods

All preparative tasks to Kaste Nano pump were done with Kaste Control software. These include priming and aspiration processes. Dispensing sequence on microbalance was performed using Ginolis internal pump calibration program. Same program is used to calibrate pumps after assembly by dispensing the whole pump stroke in 5 µl aliquots on microbalance. Calibration dispensing run verifies that volume dispensed by a pump is accurate and precise within the whole pump stroke and it consists of following steps:

1. Pump is initialized (moved to zero volume position) and 1500 µl of water is aspirated from back side reservoir bottle
2. Pump is pressurized with 1 µl steps until pressure is over a set threshold
    - Default target pressure 30000 Pa which typically requires 10 µl volume displacement with valves closed
3. 1 µl dispenses are performed until pump volume is 1450 µl
    - Default valve open time 19000 µs used with FEP 0.03” ID 1250 mm long tubing
4. 5 x 1 µl is dispensed non-contact into a cup on microbalance and after a set scale stabilization time the dispensed weight is automatically recorded
5. Step 4. is repeated 290 times
6. Weight is translated into volume. Density of water is known, and evaporation of water is compensated for (typically only 1-3 µg per measurement).

To test different types of liquids, the dispensed liquid was first aspirated into the dispensing tubing without air gap (aspirated liquid comes in contact with system fluid water). Aspiration volume of 2200 µl was used as it was expected that 1500 µl of that could be used for dispensing without the dispensed liquid being diluted with the pump system fluid. If there were dilution, it would be seen with higher density liquids (69% glycerol density is 1.178 mg/µl) by decreased mass towards the end of dispensing run. As the 2200 µl is more than the pump stroke, the aspiration was performed in two steps: Aspirate 1100 µl with speed 20 µl/s, then move pump back to zero volume position (done to back side reservoir bottle), then aspirate 1100 µl again.

Bulk dispensing tests were performed with water, ethanol and 50% glycerol. Bulk dispensing means that the dispensed liquid is primed through the pump and whole pump fluid line from reservoir bottle to the tip.

Multiple runs (3) were performed with each liquid to confirm the repeatability of pump performance. Between runs (if liquid was aspirated through the nozzle) the pump was primed/flushed with 10 ml of water to remove remains of aspirated liquid from tubing, valve and nozzle.

The 5 µl volume that is weighed was chosen as it is large enough to not cause significant errors coming from the weight measurement itself. 5 x 1 µl was chosen as it can be dispensed faster than for example 100 x 50 nL. Same results would be expected to be obtained with both cases. 1 µl is also more challenging than 50 nL with higher viscosity liquids as larger volumes are more difficult to dispense non-contact as there is higher risk of liquid not ejecting from the tip (liquid could gather outside the tip end).

In general, the most difficult circumstances were chosen for all the tests. It can be assumed that lower aspiration volume and dispensing volumes will work with highest viscosity liquids used in the tests.

To show that results are similar whether 5 x 1 µl or single 1 µl aliquots are measured, single 1 µl measurements were also performed with water and 50% glycerol.

Pump pressure was recorded with every weight measurement with all performed test run. Pressure information can be used to detect anomalies or issues with dispensing in real time. Here the pressure data was mostly used for demonstrating purposes to show whether theoretical expectations are realized in the test runs.

Pump was pre-pressurized to different levels depending on tubing size or viscosity of dispensed liquid. By doing this, less pre-dispensing is required for the pressure to stabilize. Same pressures could have been used in all tests, but then slightly more pre-dispensing could have been required.

4 BULK DISPENSING STABILITY ACROSS SOLVENTS AND VISCOUS MEDIA

Presents bulk dispensing results for water, ethanol, and 50% glycerol, including run-to-run repeatability and the effects of tubing size on pressure behaviour.

Summarizes achieved dispensing performance in the presented measurements (average volumes close to target, low CV) and explains observed differences using pressure/flow behaviour.

Includes an extended single-aliquot test (1 µL measured individually) to validate that the measurement approach does not materially change the conclusions on repeatability.

Bulk dispensing

Bulk dispensing is a simple process in the sense that no aspiration is required through the dispensing nozzle. Especially an automated aspiration process requires more complicated design from the system. Bulk dispensing is preferred if dispensed reagent is inexpensive or if large amounts of reagent are dispensed in one batch. There is a fixed amount of wasted reagent as the whole fluid line of pump and surrounding tubing needs to be filled with dispensed reagent, and when dispensing process is finished the remaining reagent is usually wasted.

When dispensed liquid is run through the whole fluid line, the conditions do not change when dispensing continues. Pump pressure (and dispensed volume) is expected to be stable. In contrast, when high viscosity liquid is aspirated into dispensing tubing, the amount of viscous liquid inside the tubing decreases while dispensing continues. Therefore, the resistance to flow decreases and pressure can decrease when dispensing continues (less viscous material left in fluid line).

Three liquids were bulk dispensed: water, ethanol and 50% glycerol. For ethanol a 5,0 meter long 0.762 mm ID FEP dispensing tubing was used. For 50% glycerol (higher viscosity) and water, a 1.25 meter long 1.588 mm ID FEP dispensing tubing was used to reduce the resistance to flow. Water could have been dispensed with smaller tubing, but larger tubing was selected so comparisons could be made with 50% glycerol tests. With less resistance to flow with larger tubing, the pump could be primed faster.

Ethanol bulk dispensing volume results are presented in figure 4. Figure 5 shows the pump pressure during dispensing run. Table 3 shows the numerical results. Valve opening time was 25000 µs for the single 1 µl dispenses and pump was pre-pressurized to 55000 Pa. Three runs were performed.

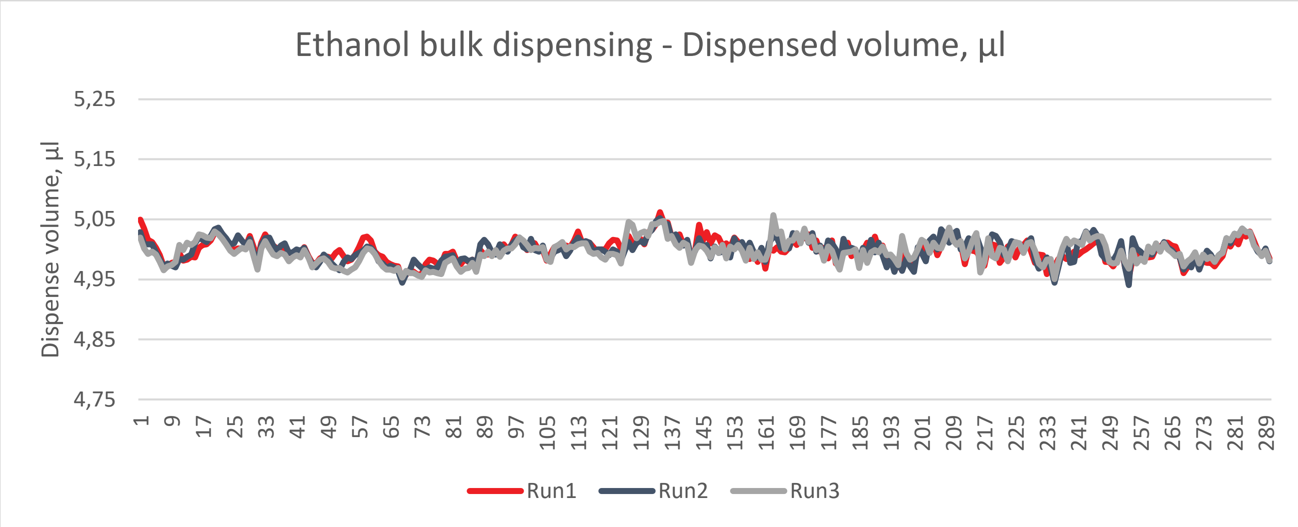


Figure 4 Dispensing volume results of ethanol bulk dispensing

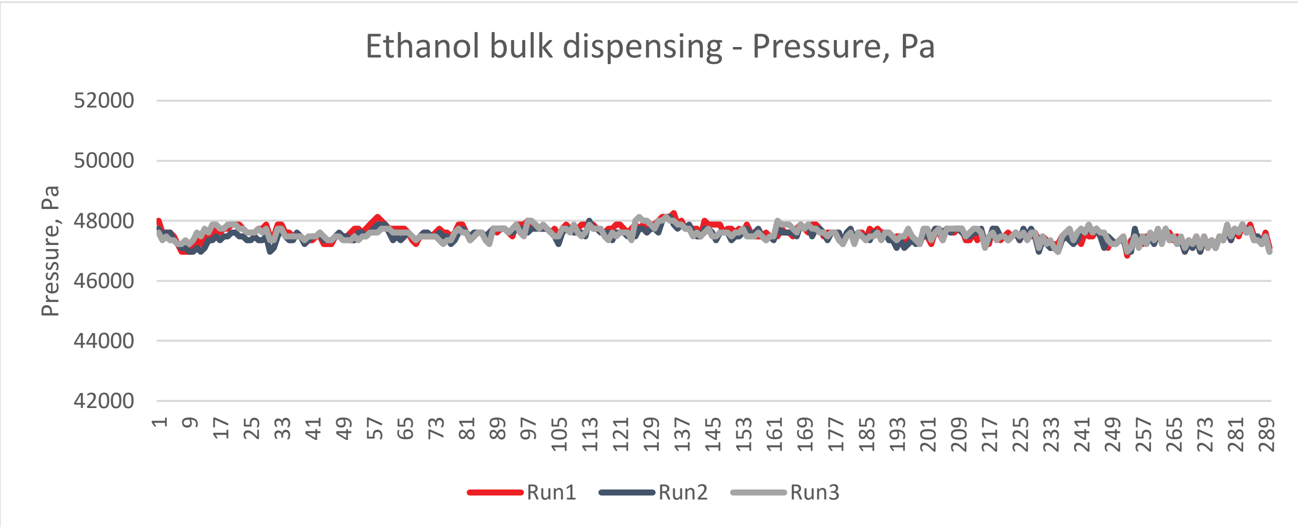


Figure 5 Pressure during ethanol bulk dispensing

Table 3 Average mass, volume and CV% of bulk ethanol dispensing tests

	Average mass, mg	Average volume, µl	CV%
Run1	4.023	4.998	0.361
Run2	4.025	4.999	0.384
Run3	4.022	4.996	0.394

Larger 1.588 mm ID tubing was used with water and 50% glycerol bulk dispensing. Results are shown in figures and tables below. Valve opening time was 20000 µs for a single 1 µl dispense

(masses of 5 x 1 µl measured). In water runs the pump was pressurized to 13000 Pa before dispensing and with glycerol mixture to 30000 Pa.

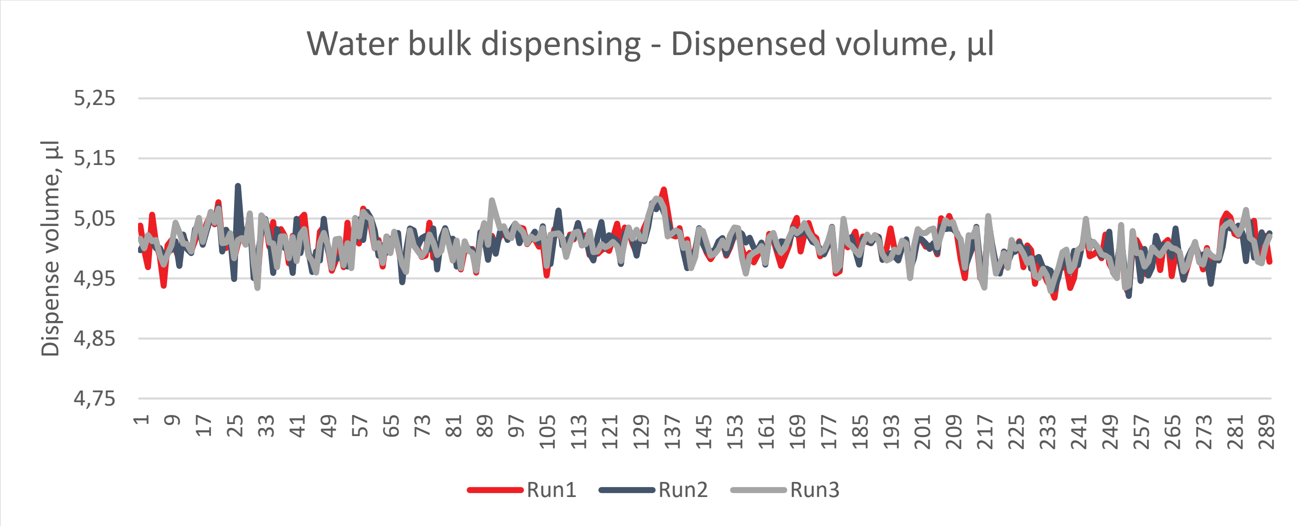


Figure 6 Dispensing volume results of water bulk dispensing

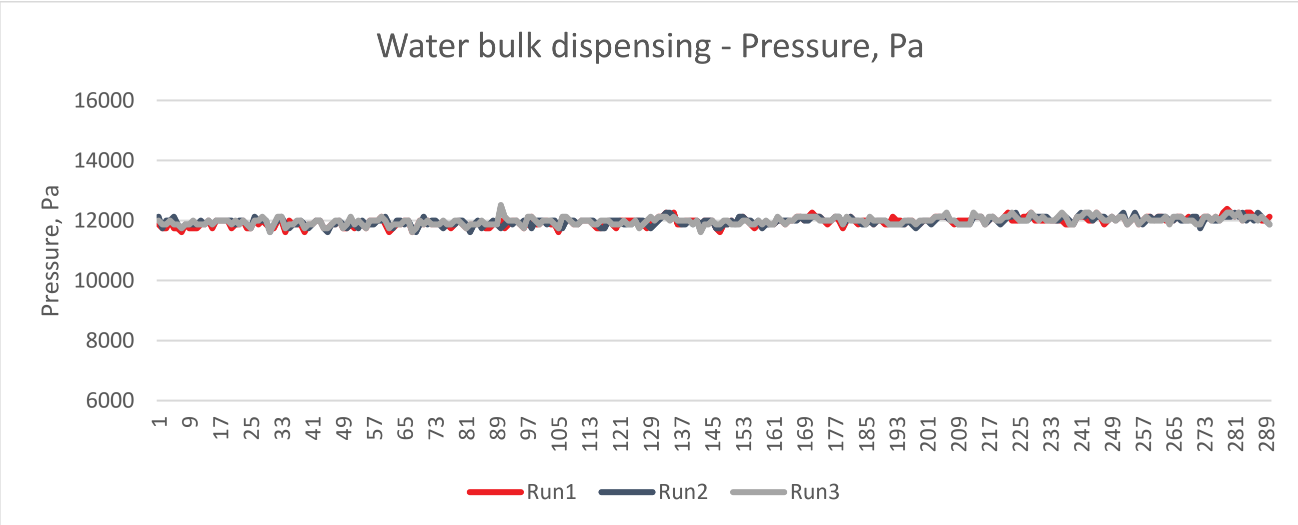


Figure 7 Pressure during water bulk dispensing

Table 4 Average mass, volume and CV% of bulk water dispensing tests

	Average mass, mg	Average volume, µl	CV%
Run1	4.993	5.004	0.587
Run2	4.992	5.005	0.543
Run3	4.994	5.007	0.559

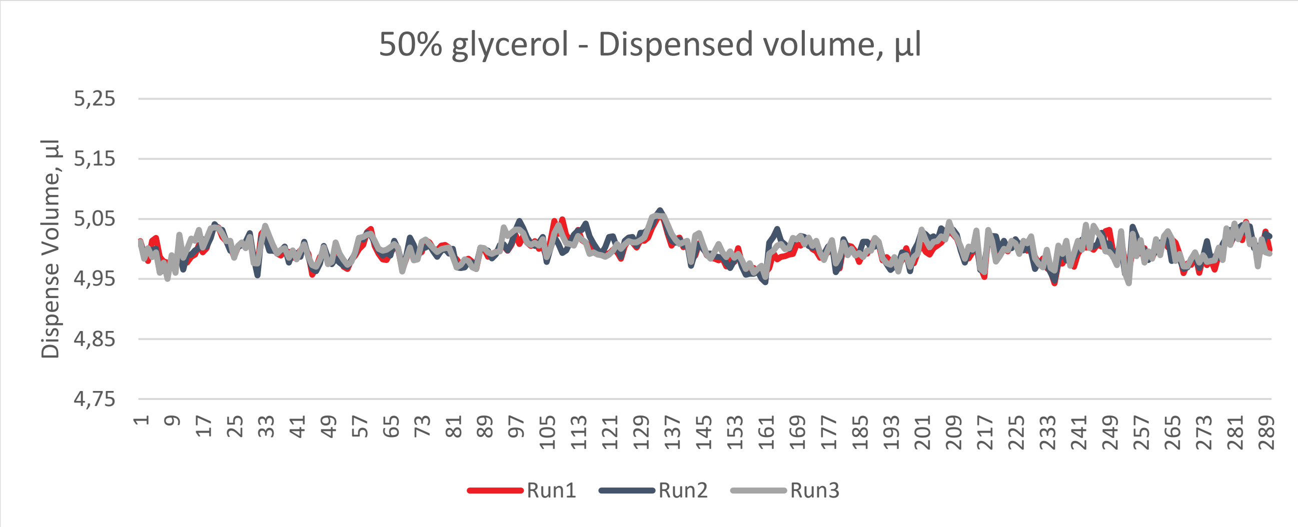


Figure 8 Dispensing volume results of 50% glycerol bulk dispensing

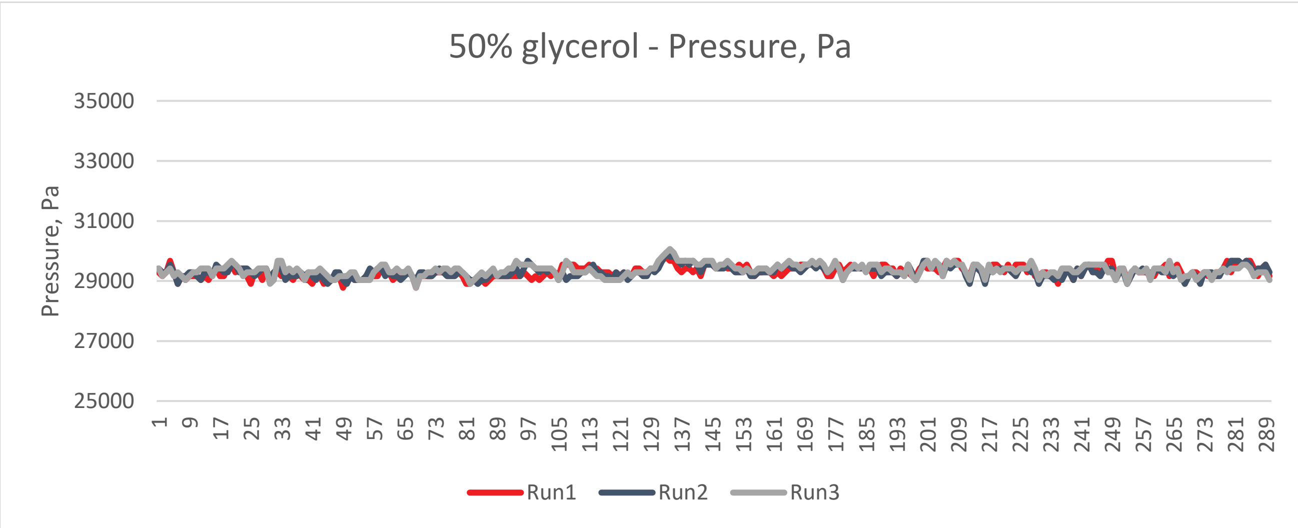


Figure 9 Pressure during 50% glycerol bulk dispensing

Table 5 Average mass, volume and CV% of bulk 50% glycerol dispensing tests

	Average mass, mg	Average volume, µl	CV%
Run1	5.623	4.997	0.377
Run2	5.626	5.000	0.425
Run3	5.627	5.001	0.415

Average volume in all runs with all liquids was within <0.2 % of target volume of 5 µl. All CV values were <0.6% with all liquids. This shows that the properties of liquids do not affect the dispensed volume or do not cause significant variation between dispenses. With water the

CV% was slightly higher than with ethanol or glycerol mixture. This can be explained by pressure being significantly lower as the used tubing was larger than with ethanol and viscosity of water (~1 mPa*s) is lower than with the glycerol mixture (~6 mPa*s). With low pressure and low viscosity, the drop cut-off from tip, when liquid is ejected non-contact, can be more chaotic as the velocity is lower and viscosity is not holding the liquid together.

Pressure was highest with ethanol (48000 Pa), second highest with 50% glycerol (29000 Pa) and lowest with water (12000 Pa). This makes sense as with ethanol smaller and longer tubing was used (half the diameter of larger tubing used with water and glycerol). Resistance to flow was therefore significantly higher, which caused higher pressure even though valve opening time was 20% lower. Water and glycerol-water mixture were dispensed with identical setup and parameters. As 50% glycerol has higher viscosity than water, the observed higher pressure was to be expected. Pressure was stable during all runs within each liquid. This was also expected as there is no change in any conditions.

A longer dispensing test was performed with 50% glycerol where single 1 µl dispenses were weighed and pressure recorded after each dispense. There were 1450 measured weights compared to 290 with 5 x 1 µl. Results are shown in figures and table below.

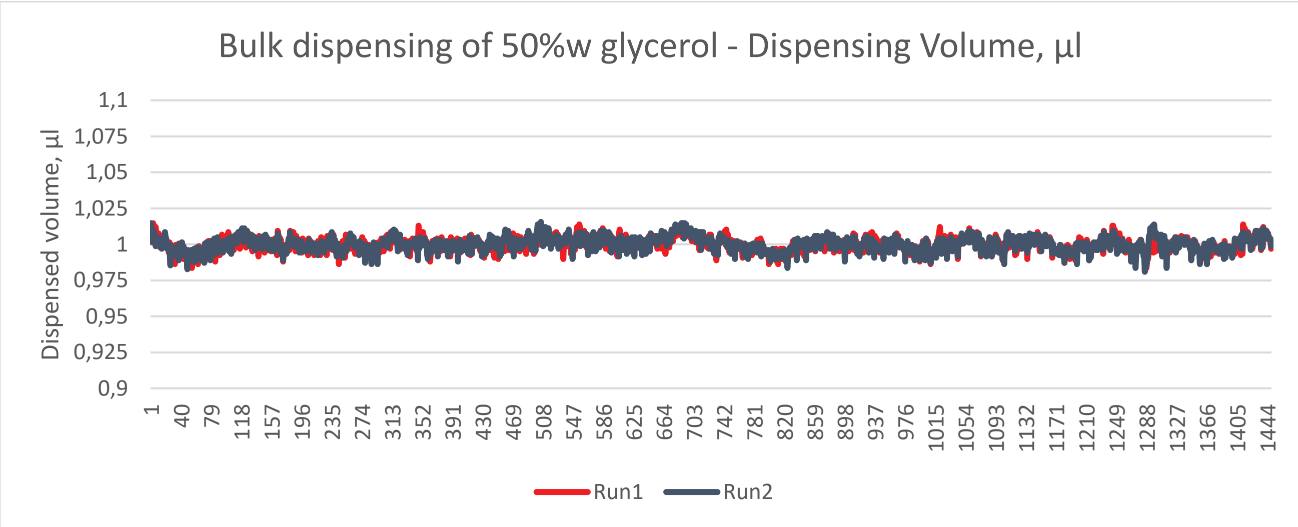


Figure 10 Dispensing volume results of 50% glycerol bulk dispensing with each 1 µl measured

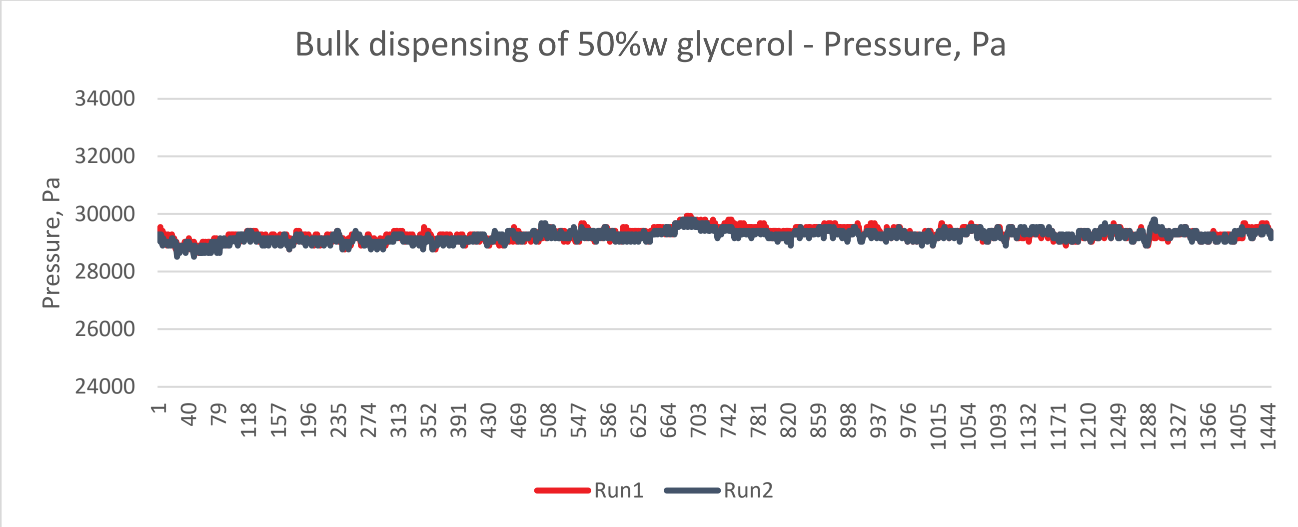


Figure 11 Pressure during 50% glycerol bulk dispensing with single 1 µl measurements

Table 6 Average mass, volume and CV% of 50% glycerol bulk 1 µl dispensing tests

	Average mass, mg	Average volume, µl	CV%
Run1	1.125	1.000	0.488
Run2	1.125	1.000	0.507

Average volume of single 1 µl dispenses was accurate and CV was 0.5% which was slightly higher than with 5 x 1 µl which is to be expected as there is likely more variation from measurement itself. This shows that there is not a significant difference whether single 1 µl would be measured compared to 5 x 1 µl. Pressure was the same (29000 Pa) as with 5 x 1 µl runs.

5 ASPIRATION-BASED DISPENSING FOR VISCOUS AND BIOLOGICAL REAGENTS

Evaluates aspiration-based dispensing across increasing glycerol–water viscosities and common buffers (PBS and TBST), using the same gravimetric method and repeated runs.

Interprets pressure trends during aspiration (expected changes as viscous segments move through the line) and links those trends to observed volume stability in the reported data.

Notes practical system-level considerations observed during testing (e.g., valve behaviour with higher-viscosity or “sticky” liquids) relevant for application-specific design and validation.

Aspiration and dispensing with glycerol-water mixtures

Different viscosity glycerol-water mixtures were aspirated and dispensed:

50% (w/w) glycerol-water, viscosity ~6 mPa*s

65 (w/w) glycerol-water, viscosity ~15 mPa*s

69 (w/w) glycerol-water, viscosity ~20 mPa*s

Higher viscosity mixtures were tested, but there were issues with the used solenoid dispensing valve. Valve did not open if it was not left idle for over ten seconds. Opening of valve also became more difficult with higher back pressure (pressure pushes valve seal close with higher force). Issues with valve opening are likely more due to "stickiness" properties of glycerol than actual viscosity.

Larger 1.588 mm ID FEP tubing was used in the tests. Same dispensing parameters were used with all viscosities. Valve opening time was 20000 µs for a single 1 µl dispense.

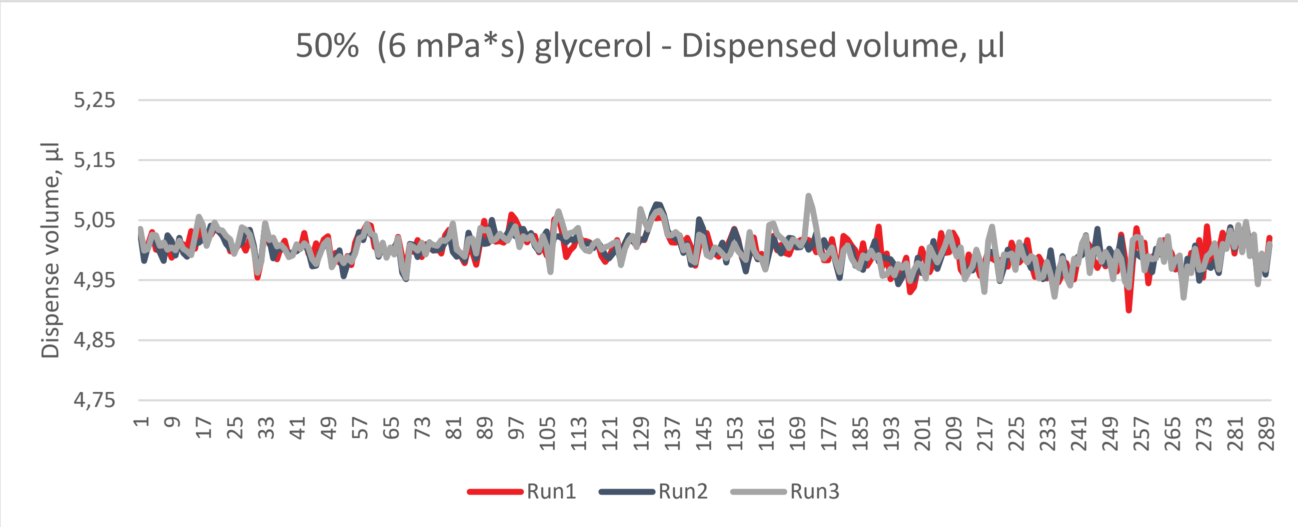


Figure 12 Dispensing volume results of 50% glycerol dispensing with aspiration

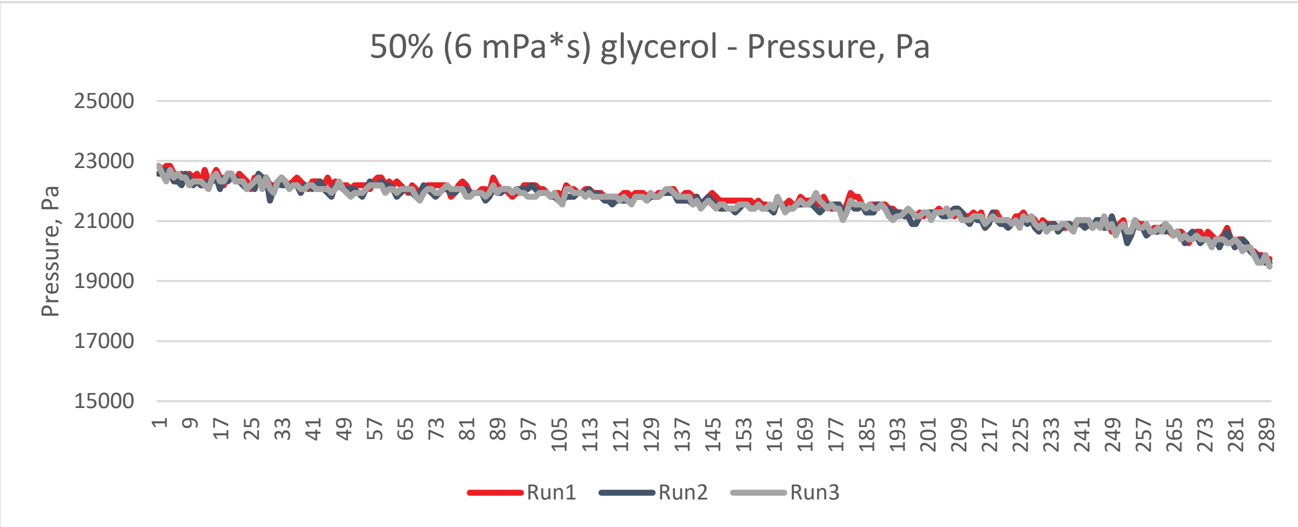


Figure 13 Pressure during 50% glycerol dispensing with aspiration

Table 7 Average mass, volume and CV% of 50% glycerol dispensing tests with aspiration

	Average mass, mg	Average volume, µl	CV%
Run1	5.628	5.001	0.492
Run2	5.626	4.999	0.486
Run3	5.629	5.002	0.540

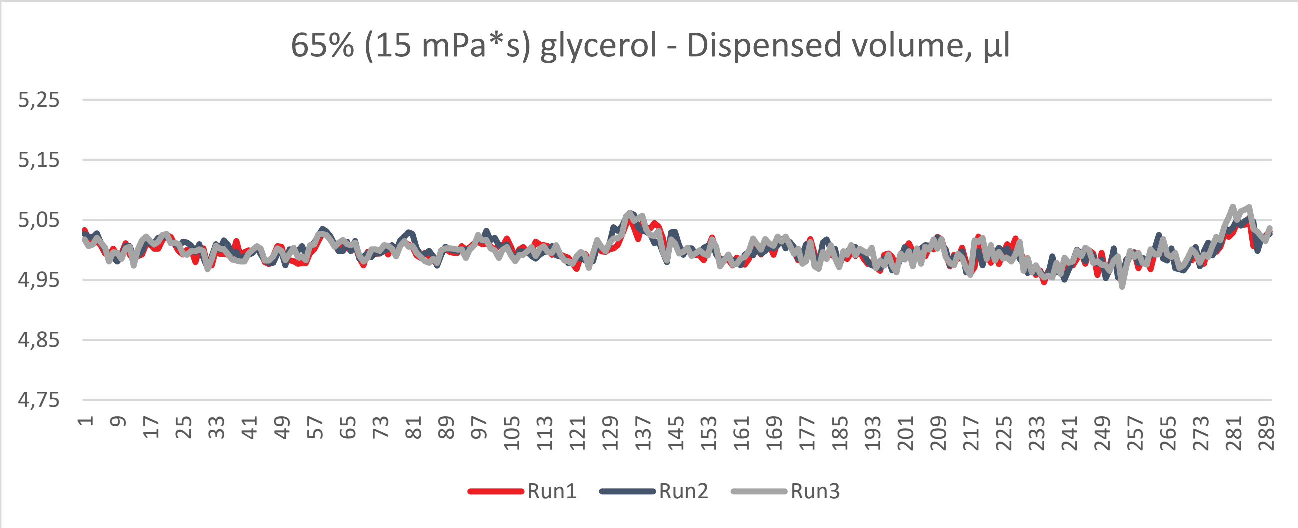


Figure 14 Dispensing volume results of 65% glycerol dispensing with aspiration

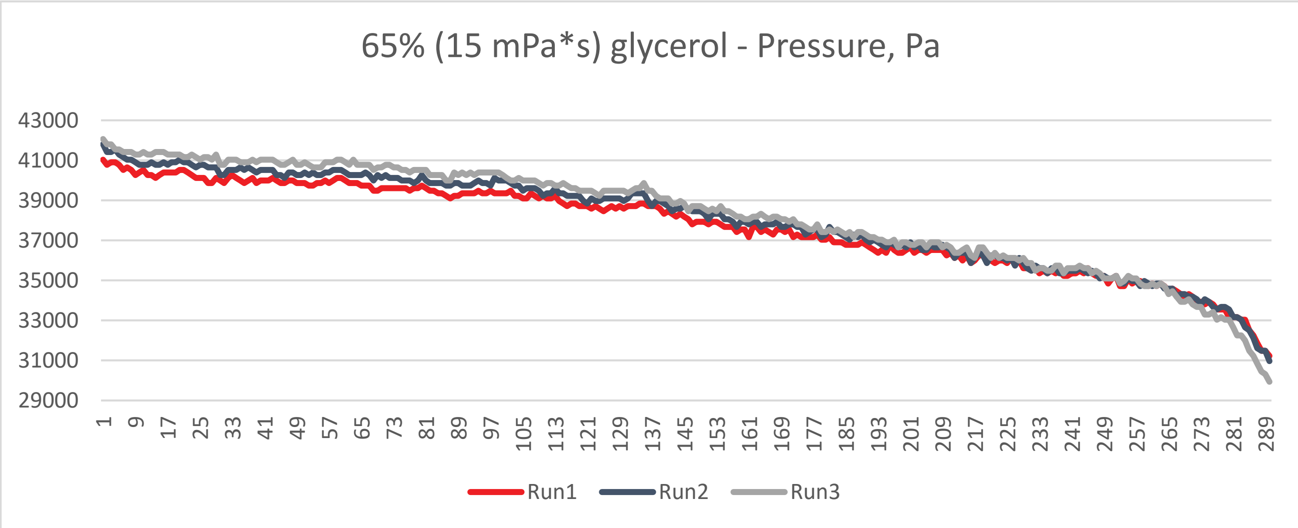


Figure 15 Pressure during 65% glycerol dispensing with aspiration

Table 8 Average mass, volume and CV% of 65% glycerol dispensing tests with aspiration

	Average mass, mg	Average volume, µl	CV%
Run1	5.833	4.997	0.361
Run2	5.834	4.998	0.392
Run3	5.835	4.998	0.411

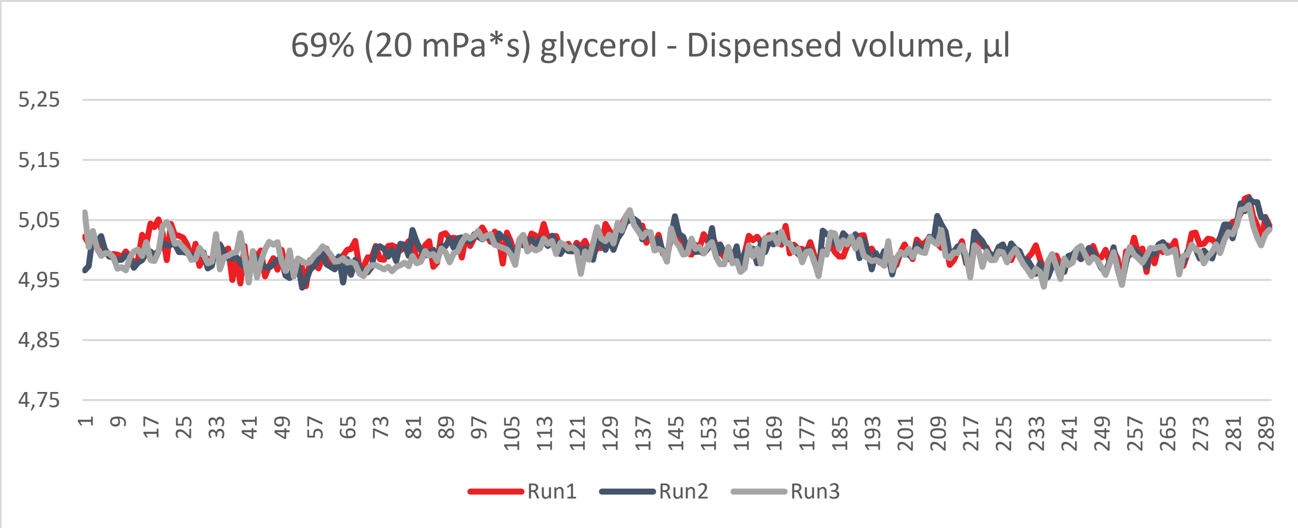


Figure 16 Dispensing volume results of 69% glycerol dispensing with aspiration

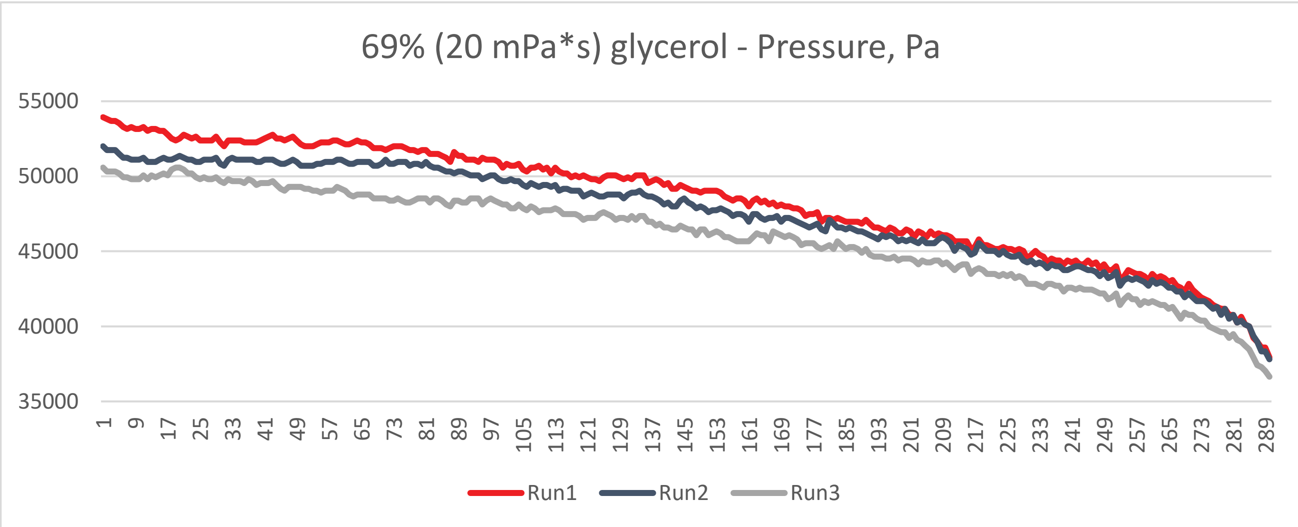


Figure 17 Pressure during 69% glycerol dispensing with aspiration

Table 9 Average mass, volume, CV% and temperature of 69% glycerol dispensing tests with aspiration

	Average mass, mg	Average volume, µl	CV%	Temperature, °C
Run1	5.893	5.004	0.454	20.5
Run2	5.890	5.000	0.476	20.9
Run3	5.887	4.997	0.450	21.7

Average volume was within 0.1 % of target volume in all runs with different viscosity glycerol mixes. CV values were below 0.6 % with all runs. This shows that viscosity of dispensed liquid does not affect the dispensing accuracy or precision with liquids < 20 mPa*s.

In all runs there is a decreasing trend in pump pressure within the dispensing sequence. This is understandable as 2200 µl of glycerol solutions were aspirated and close to 1500 µl of that were dispensed (1450 µl + pre-dispensing). Therefore, the volume of glycerol solution in tubing decreases from 2200 µl to 700 µl during the runs. This means that resistance to flow decreases as there is more water coming from the pump to replace the dispensed glycerol in tubing. With higher glycerol content (more viscous), the pressure decrease was higher. If pressure is decreasing during dispensing of multiple of doses, this means that the dispensing volume is higher than the displaced volume by the pump. As the pressure decrease occurs during over a thousand microliter dispense sequence, the impact to volume is low enough that it is not seen in volume results. Slight increase in volume can be seen in the last dispenses when pressure decrease is highest. There was a short length (5 cm) of smaller tubing (0.762 mm ID) near the dispensing valve to which the larger tubing was attached. It is assumed that the higher decrease in pressure is due to water or diluted glycerol entering this part of fluid line in the end of dispensing sequence.

Small differences in pressures were observed between 65 % glycerol runs. For the 69 % glycerol run the room temperature was recorded with each 69 % glycerol run (previously only recorded once before first run). Average volumes were calculated with same density without temperature being considered. Average volume slightly decreased when temperature rose with 69 % glycerol runs. Volumes between runs would be even closer to each other if density was calculated more precisely with temperature.

Run1 had lowest temperature and therefore highest viscosity. Pressure was highest with run1 as would be expected.

Viscosity and temperature differences can be observed in pump pressure, but not in dispensed volume, which tells that the positive displacement method of the pump is not sensitive to these factors at least when they do not change radically in short time.

To determine the effects of tubing size, the smaller 0.762 mm ID tubing (5 meters long) was used to dispense 50% glycerol with same aspiration volume and dispensing sequence. Difference in dispensing runs was that valve opening time was increased from 20000 µs to 25000 µs and pump was pre-pressurized to 90000 Pa. Results are shown in figures below.

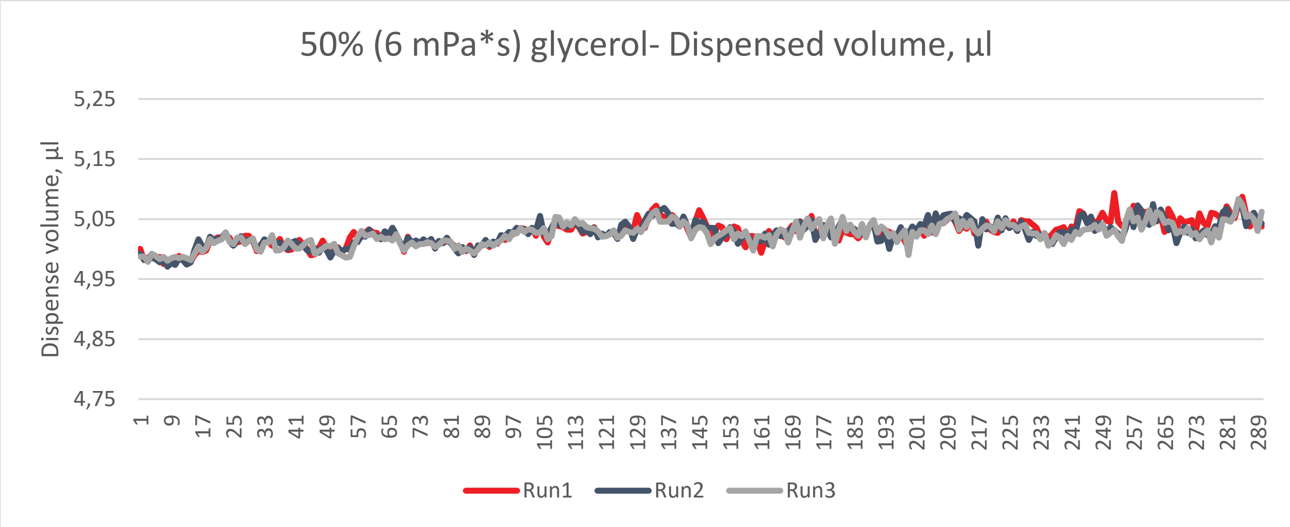


Figure 18 Dispensing volume results of 50% glycerol dispensing with aspiration and smaller tubing

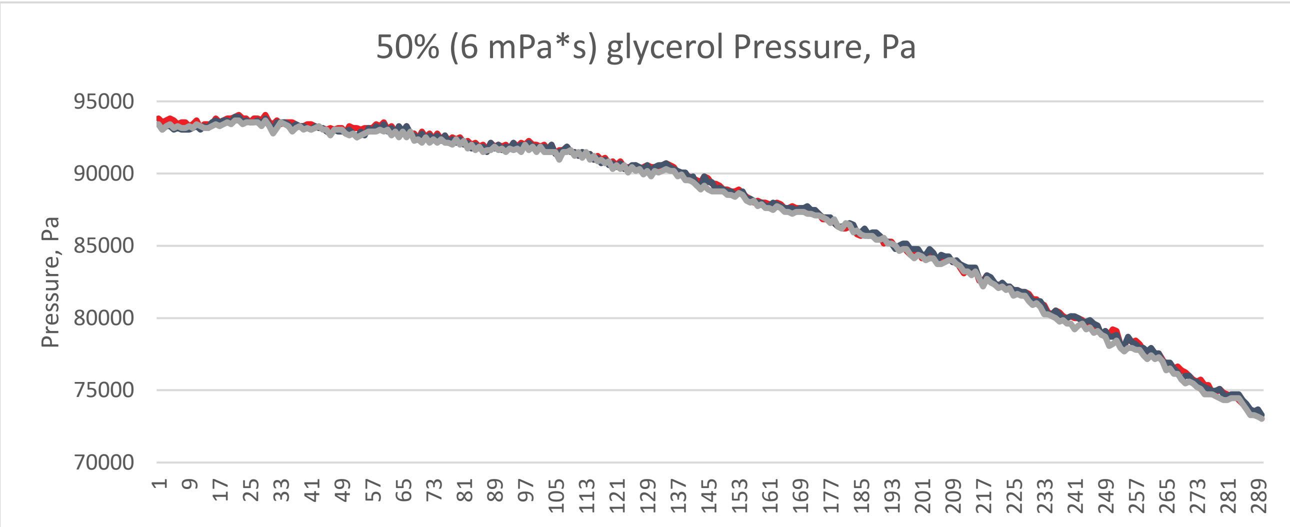


Figure 19 Pressure during 50% glycerol dispensing with aspiration and smaller tubing

Table 10 Average mass, volume and CV% of 50% glycerol dispensing tests with aspiration with smaller tubing

	Average mass, mg	Average volume, µl	CV%
Run1	5.657	5.027	0.417
Run2	5.655	5.026	0.407
Run3	5.653	5.024	0.381

Average volume was slightly higher than in previous tests while CV% was still low around 0.4% with all three runs. With smaller tubing the pressure was significantly higher than with larger tubing even with 25% higher valve opening time. Pressure was 93000 Pa at the start of dispensing runs and decreasing to 73000 Pa during the run as resistance to flow decreased. With larger tubing the pressure was around 20000 Pa.

Aspiration and dispensing of buffer solutions

Commonly used buffer solutions in biological research PBS and TBST were aspirated and dispensed similarly to the glycerol solutions. Blue dye was added to buffers to make the aspirated liquid visible in tubing (see figure 20). Smaller 0.762 mm ID FEP tubing was used. Same dispensing parameters were used with both buffers. Valve opening time was 25000 µs for a single 1 µl dispense and pump was pressurized to 48000 Pa before dispensing was started.

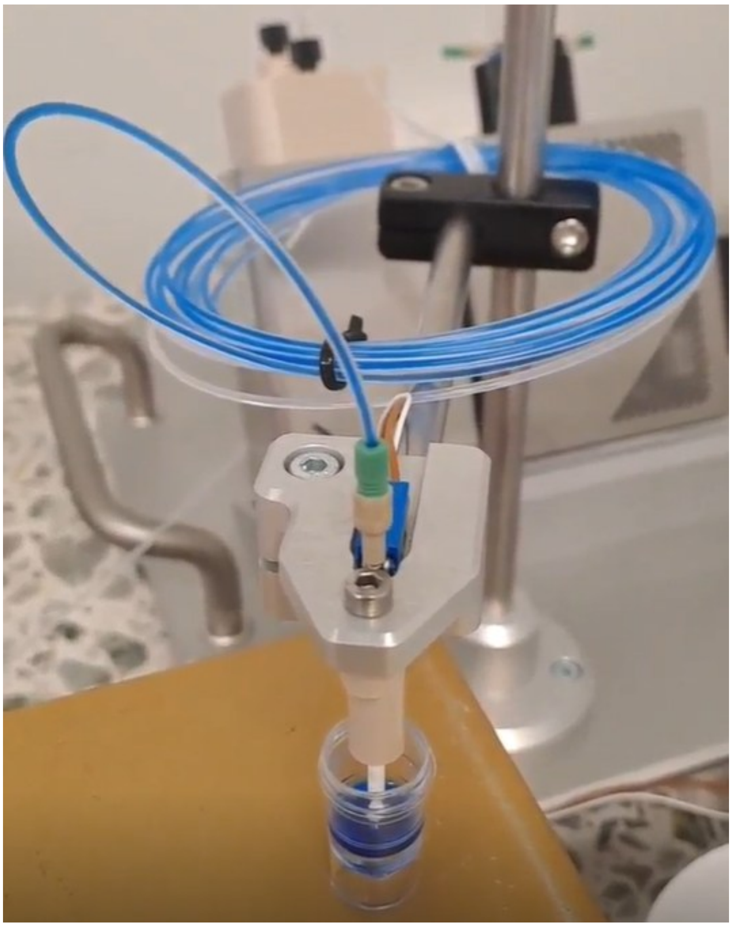


Figure 20 Buffer with dye being aspirated into the dispensing tubing

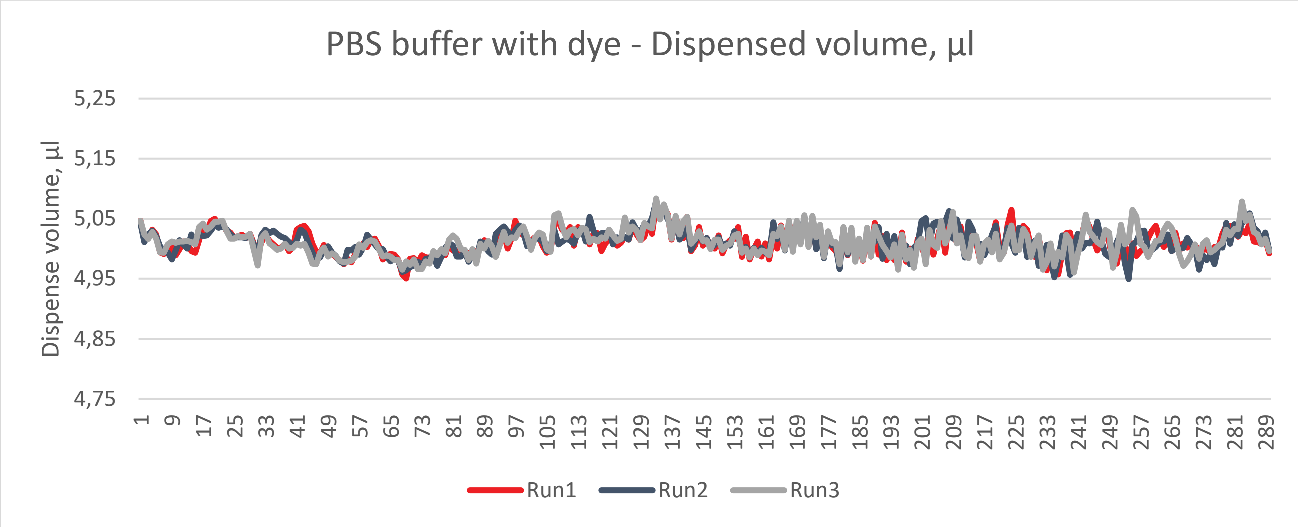


Figure 21 Dispensing volume results of PBS buffer dispensing with aspiration

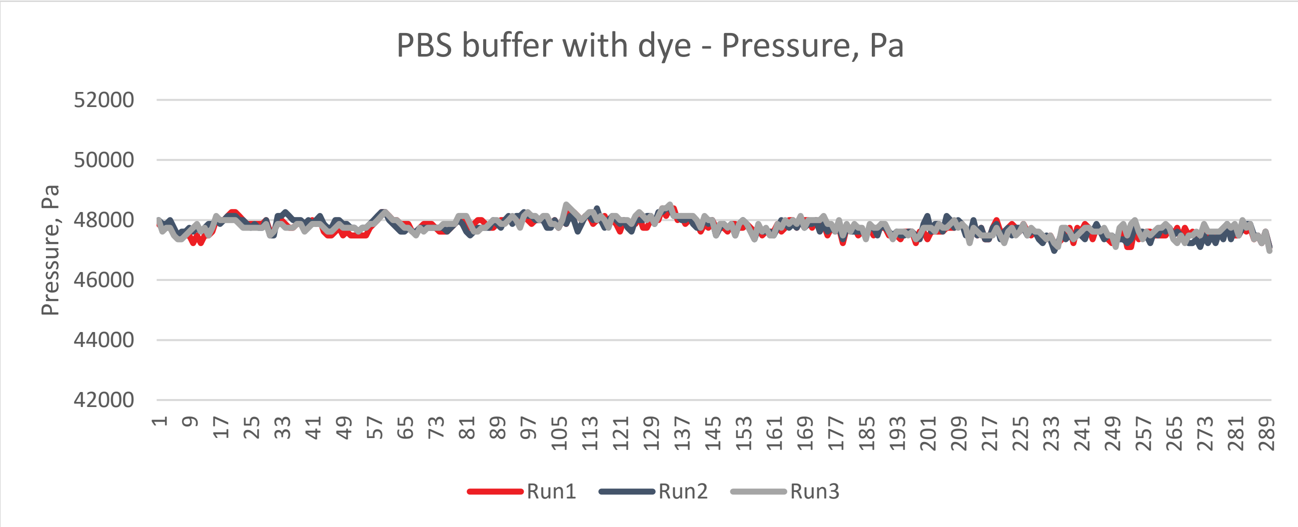


Figure 22 Pressure during PBS buffer dispensing with aspiration

Table 11 Average mass, volume and CV% of PBS buffer dispensing tests

	Average mass, mg	Average volume, µl	CV%
Run1	5.033	5.010	0.416
Run2	5.034	5.011	0.439
Run3	5.034	5.011	0.457

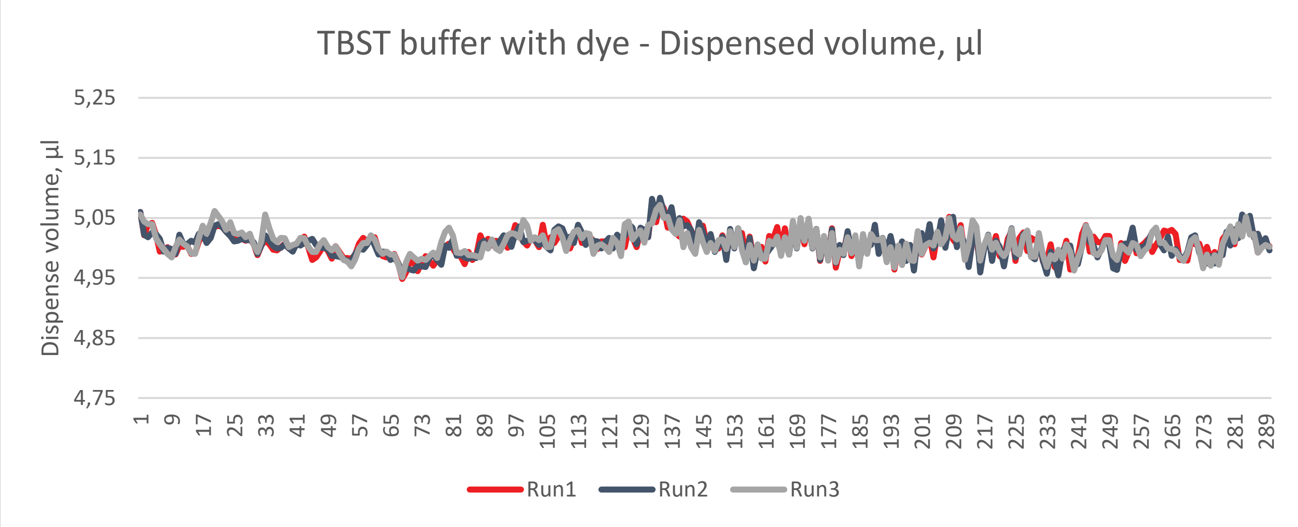


Figure 23 Dispensing volume results of TBST buffer dispensing with aspiration

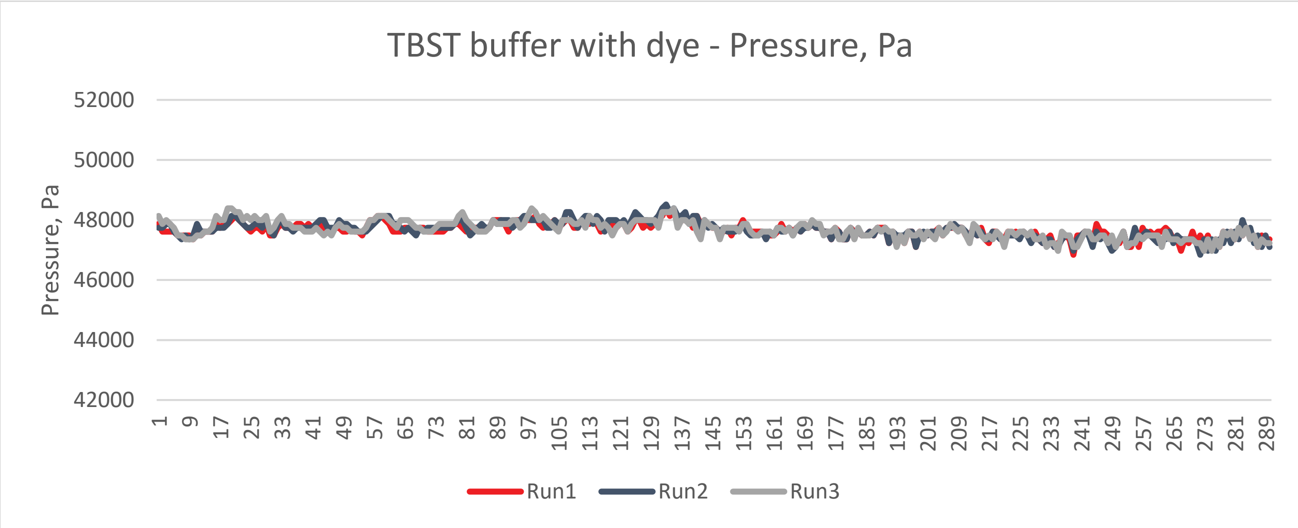


Figure 24 Pressure during TBST buffer dispensing with aspiration

Table 12 Average mass, volume and CV% of TBST buffer dispensing tests

	Average mass, mg	Average volume, µl	CV%
Run1	5.029	5.006	0.416
Run2	5.029	5.006	0.440
Run3	5.030	5.007	0.422

The average volume was accurate (within 0.22% of target) and CV values were <0.5% with all runs with both buffers. Slight differences in average volumes between buffers is likely due to real densities not being exactly 1.005 mg/µl with both buffers.

Pressures were stable during dispensing runs as the viscosity of buffers is close to water and therefore the resistance to flow did not significantly change as dispensing runs progressed.

Results demonstrate that buffers, even with surfactant added (TBST), do not affect the dispensed volume accuracy or precision.

6 CONCLUSION

This study evaluated the ability of the Ginolis Kaste Nano II positive-displacement pump to dispense microliter-scale volumes consistently across liquids with different physical properties. Dispensing accuracy and precision were measured using a gravimetric method on a microbalance, and performance was assessed over multiple repeated runs per liquid to confirm repeatability.

Across the tested conditions—including water, ethanol, glycerol–water mixtures up to ~20 mPa·s viscosity, and common biological buffers (PBS and TBST)—the system delivered volumes close to target with low variation. Reported results show average volume deviation remaining below ~0.6% of target and CV values below ~0.6% across the presented tests, indicating robust repeatability and limited sensitivity to typical liquid-property changes.

Pressure data collected during dispensing provided additional operational insight. As expected, bulk dispensing produced stable pressures within each run because conditions in the fluid line remain constant. In aspiration-based tests with viscous glycerol solutions, a gradual pressure decrease was observed during the dispensing sequence, consistent with changing flow resistance as the aspirated viscous segment in the tubing is replaced. Despite these pressure trends, the measured volume stability remained strong in the reported data, supporting the practicality of positive-displacement dispensing for mixed liquid types without extensive retuning.

From an application perspective, the results support the use of Kaste Nano technology to simplify early-stage development and technology transfer by reducing the need for frequent hardware changes and repeated parameter optimization when switching between reagents. Where highly viscous or “sticky” liquids create valve-related challenges, these should be treated as system-level considerations (valve selection, dwell times, and operating pressure margins) rather than intrinsic limitations of the displacement principle.

7 WHAT TO DO NEXT

If you are evaluating low-volume dispensing for an R&D workflow, pilot line, or production-scale platform, the next step is to confirm performance in your specific use case—your liquids, your consumables, and your process constraints.

- Share your dispensing requirements: target volume range, tolerance/CV targets, cycle time, and expected liquid types (viscosity range, solvents, buffers, surfactants, additives).
- Run an application-fit evaluation: replicate key conditions from your process (tubing length/diameter, nozzle/valve selection, aspiration vs bulk mode, temperature) and validate performance using your preferred verification method (gravimetric and/or in-process checks).
- Review system integration options: determine how Kaste Nano II fits into your automation architecture (controls, interfaces, footprint, compliance expectations) and what configuration best supports scaling from development to manufacturing.
- Plan for transfer and validation: define acceptance criteria, documentation needs, and a path to process validation aligned with your quality system and regulatory requirements.

To start, contact Ginolis (info@ginolis.com) to discuss your application and arrange an evaluation of your liquids and target volumes.

Contact

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