MRG-059-G: Accuracy test of liquid handling of SWAVE robot

Date: 2024-06-18
Tags: HTE MRG ACCURACY TEST
Status: Done
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Literature/reference experiments

Literature	Chemspeed manual
Reproduction	/
Related experiment	

Reagents

Name	CAS Number / Experiment Number	Amount [mmol]	concentration	Equivalents	$Mass_{theo}$ [mg]	$Mass_{exp}$ [mg]	Molar mass [g/mol]	Volume [ml]
Deionized water	7732-18-5	/	/	/	/	/	18.015	different volumes (see tables)

Procedure/observations

Date	Time	Step	Observations
18.06.24		for information regarding parameters of the test, see: "2024_06_18-further_procedure_information.docx"	
	07:30-07:45	all vials which were utilized were weighed on a scale with 0.1 mg accuracy (right scale in ZAF 121) and the masses were entered into a table for storage and later calculation of the deviations. For samples up to 1 mL standard screw top SEC vials were utilized. For samples from 3 mL to 7 mL snap cap glass vials with a volume of 10 mL were utilized.	utilized scale; utilized scale type label

	08:24	The rack (80 x 2 mL vial rack) with the vials for the test for Dilutor 1 was placed inside the robot and the program "2024_06_18 - volume_transfer_accuracy_test" was started	overview of setup; overview of program (1); overview of program (2); height of rack overview; height of rak closer look
	-08:28	rinsing of needle 1 (Dilutor 1) to flush the tubing --> better accuracy regarding to Chemspeed manual	
	-09:45	test for Dilutor 1 (different volumes (see .xlsx for closer information)) vials were always closed with a lid within a timeframe of ca. 5 min after filling during the experiment	
	09:45 - 09:50	Rinsing of tubing of Dilutor 2	
	09:50 - 11:05	test for Dilutor 2 (different volumes (see .xlsx for closer information)) vials were always closed with a lid within a timeframe of ca. 5 min after filling during the experiment	
	11:05 - 11:10	Rinsing of tubing of Dilutor 3	
	11:10	start of test for dilutor 3	at low flow rates (1 mL/min --> dilutor sounds trembling)
	11:10 - 11:17	vials were closed with a lid directly (0.5 mL) (like for all others before (for Dilutor 1 and 2) --> lunch break -->	
	11:17 - 11:42	other vials (0.6 mL, 0.7 mL, 0.85 mL) not directly closed --> stood open until return from lunch break (0.6 mL: ca. 20 min, 0.7 mL: ca. 15 min, 0.85 mL: ca. 5 min)	
	11:42	all vials again closed directly after dispensing	
	11:58	start of 3 mL aspiration -->problem that the aspiration could not be done because the dilutor could not use the 3 mL/min flow rate for aspiration --> set to 3.5 mL/min --> restarted with rinsing in the beginning (program: "2024_06_18 - volume_transfer_accuracy_test_after_problem")	3.5 mL/min seem to work but nevertheless, the pump/dilutor does not sound great
	-13:50	further filling of vials and measuring of them --> see results in "2024_06_18-SWAVE-accuracy handling-measurement values.xlsx"	

Analysis

Date	Dilutor	Analysis method	Analytical device	Data	Interpretation
18.06.24	1 (1 mL)	gravimetrical analysis	analytical scale	in xlsx (sheet with Dilutor 1), also: Dilutor 1_results	for all volumes absolute errors between -2 and -6 µL --> got bigger with increasing volume (however, only 2/3 µL) relative deviation got smaller with rising volume (from -1.50% (0.2 mL) to -0.5% (1 mL)) absolute deviation increased with increasing volume (from -2 µL (0.2 mL) to -6 µL (1 mL)
18.06.24	2 (1 mL)	gravimetrical analysis	analytical scale	in xlsx (sheet with Dilutor 1), also: Dilutor 2_results	or all volumes absolute errors between -4 and -8 µL --> got bigger with increasing volume (however, only 4/5 µL) relative deviation got smaller with rising volume (from -1.75% (0.2 mL) to -0.75% (1 mL)) absolute deviation increased with increasing volume (from -4 µL (0.2 mL) to -8 µL (1 mL)
18.06.24	3 (10 mL)	gravimetrical analysis	analytical scale	in xlsx (sheet with Dilutor 1), also: Dilutor 3_results	larger deviations for small volumes <= 1 mL than with the 1 mL dilutors still errors way below 1% of nominal volume maximum error ca. 40 µL for 7 mL dispensed volume with 7 mL/min flow rate for 5 mL: error ca. 30 µL --> acceptable for reactions (below 1% deviation from desired volume)

Qualtitative Interpretation

For 1 mL syringes:

generally small deviations (maximum 8 µL) --> deviations got smaller with increasing volumes (threshold to less than 1% relative deviation = 0.5 mL volume)

deviations for Dilutor 1 smaller than for Dilutor 2 --> use Dilutor 1 in the future for critical volume transfers

in general very good accuracy --> alway less than 1% of the nominal volume (1 mL)

For 10 mL syringes:

deviations bigger than for 1 mL syringes (ca. 1.5 -2 times as high in absolute errors) --> expectable because of bigger nominal volume

relative deviations below 1% for transfers above 3 mL volume

generally always deviation below 1% of nominal volume --> very good

Overall:

all deviations are in negative direction (underfilling of vials) --> probably a systematical error --> however, the error is in such a small range, that we can accept it

accuracies are within the range of Eppendorf-pipettes which would be the manual reference system to use

Future recommendations

Smaller volume transfers (e.g. sacrificial oxidant, buffers, ruthenium solution)

use for all transfers smaller than 1 mL Dilutor 1 --> best relative and absolute accuracy for this area of transports

use for all transfers smaller than 1 mL 1mL/min as flow rate

let the needle tip dip into the solution to avoid droplet build up and, hence, inaccurate transfers

utilize extra volume and air gap for transfers

Bigger volume transfers (water)

utilize dilutor 3

utilize slower flow rate (before: 8 mL/min --> now 5 mL/min (for aspiration and dispensing))

include rinsing after water addition

let the needle tip dip into the solution to avoid droplet build up and, hence, inaccurate transfers

utilize extra volume and air gap for transfers

Attached files

2024_06_18-further_procedure_information.docx

sha256: c475c2d66c3d26cf4f5da28b9d2054ff7eebf0bbcc2d40d04d6f6de2f1f0109a

Chemspeed-Master-Manual.pdf

2024_06_18-volume_transfer_accuracy_test_after_problem.app
sha256: 60f3e9c238a108c1b1be2e39df6a2694fd124b4956d9498a1f0e2d2b7c5adef6

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2024_06_18-SWAVE-accuracy-handling-measurement-values.xlsx
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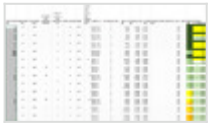

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Unique eLabID: 20240618-44ce5758ddfc18560fd2ef13a012e058501d5a97
Link: https://elab.water-splitting.org/experiments.php?mode=view&id=1111