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Hand Washing Laboratory Glassware Study

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Summary

Hand washing laboratory glassware can consume a high volume of water. Although automatic glassware washers are often touted as being more efficient in water usage than hand washing, published water usage studies have not addressed laboratory glassware washers, rather only residential washers and a 12 place setting set of dishes. Since hand washing dishes in a residential setting is far different than washing flasks and beakers in the lab, Labconco conducted a study to determine the quantity of water used to hand wash laboratory glassware.

Three different workers of varying washing experience were given the task of hand washing the same 28 pieces of laboratory glassware (SEE TABLE 2) using a typical GMP washing protocol (SEE Procedure Section). The results of this data were compared to a commonly used preprogramed cycle of the Labconco line of Laboratory Glassware Washers, specifically the "GLASS" setting plus 1 purified water rinse. This setting, which is factory set to provide 2 wash cycles and 3 tap water rinses, has the option to add pure water rinses.

Results show that an average of 119 L of water was consumed in a single hand wash of the 28 pieces of glassware, which took 15.56 minutes to complete, and 11.88 L of water for the purified water rinse, which took an additional 11.9 minutes (SEE Table 1). The side-by-side comparison shows an automated washer saved approximately 211L of water and approximately 24 min in wash time (SEE TABLE 1). (Note: this time does not include drying time in the automated washer. Comparing only time elapsed during washing cycles).

Table 1

		Glass Cycle	Equivalent Hand Washing	Difference
Wash 1	Water Vol (L)	12.9	119	-106.1
	Elapsed Time (min)	5	15.56	-10.56
Wash 2	Water Vol (L)	12.9	119	-106.1
	Elapsed Time (min)	10	15.56	-5.56
Tap Rinse	Water Vol (L)	0	0	0
	Elapsed Time (min)	0	0	0
DI Rinse	Water Vol (L)	12.9	11.88	1.02
	Elapsed Time (min)	4	11.88	-7.88
	Total water (L)	38.7	249.88	-211.18
	Total Time (min)	19	43	-24

Materials

Table 2

Glassware	
Qty	Description
3	1-L volumetric flasks
3	500-mL volumetric flasks
2	100-mL volumetric flasks
1	50-mL volumetric flasks
9	600-mL Beakers
4	250 mL Erlenmeyer Flasks
6	10 mL Test Tubes

Procedure

Three individuals of varied washing experience carried out the procedure listed below.

- ***Analyst #1***: Residential and commercial dishwashing experience. No lab washing experience.
- ***Analyst #2:*** Residential dishwashing experience only. Neither lab washing nor commercial dish washing experience.
- ***Analyst #3:*** Experienced lab worker. Trained in GMP and GLP procedures.

Industry standards require that ***prior*** to washing, glassware needs to be drained, rinsed with solvent if required, and all potentially harmful substances removed along with labeling. This is usually followed by a water rinse to ensure removal of any residual chemicals, media, etc. Glassware used in the study met the above criteria.

In this experiment the glassware was washed and via the following procedure:

- Analyst turned the tap water to the rate at which he/she was comfortable washing dishes.
- Using a stopwatch and 1L graduated cylinder, flow rate was measured and recorded.
- The stopwatch was initiated at the time the washer commenced the washing procedure and continued until the washer was finished. The time elapsed was recorded.
- Washing consisted of the following in triplicate for each piece:
    - Adding water to the vessel
    - Scrubbing with appropriate brushes
    - Shaking or swirling of water as the user deemed fit
    - Emptying volume and placing in a holding area

In lieu of RO water, the tap flow rate was slowed to 1.0 L/min, which is the rate at which the majority of laboratory RO units produce and dispense water. This was verified by placing a 1-L graduated cylinder under the tap and recording the time it takes to fill it to 1L. Once the correct flow rate was established, a triple rinse of the glassware was timed in the same fashion as the washing step and the elapsed time recorded. This serves as one DI rinse cycle.

Results

Variation between analysts was wide, which mimics real life situations. As seen in TABLE 3, Analyst #1 used the highest flow rate and took the longest amount of time to wash and rinse using a total of 266L of water. Whereas Analyst #3 used the lowest flow rate but had the median usage of time, thereby leaving Analyst #2 with the median flow rate and the fastest time. It was also noted that each analyst filled the glassware to a different level before scrubbing or rinsing while still following the specified protocol. These differences show that the variation in time and volume of water used can be unpredictable and based on preference rather than precision.

TABLE 3

	Analyst 3	Analyst 2	Analyst 1	Mean
Wash Flow rate (L/min)	3.22	6.40	11.09	6.90
Wash Time (min)	15.000	9.066	22.617	15.56
Tap water consumed (L)	48.3	58.0224	250.8225	119.05
Rinse Flow Rate (L/min)	1	1	1	1
Rinse Time (min)	10.984	9.46	15.1895	11.88
Rinse water consumed (L)	10.984	9.46	15.1895	11.88
Total Water consumed (L)	59.284	67.482	266.012	130.9
Elapsed Time (min)	25.984	18.526	37.807	27.4

Discussion

Results show that an average of 119 L of water was consumed in a single hand wash of the 28 pieces of taking 15.56 minutes to complete and 11.88 L of water for the purified water rinse taking an additional 11.9 minutes. The side-by-side comparison seen in TABLE 1 shows an automated washer saved approximately 211L of water and approximately 24 min in wash time. (Note: this time does not include drying time in the automated washer. Comparing only time elapsed during washing cycles). In the laboratory, time spent doing “housekeeping” activities equates to time not spent on research-specific activities.

The variation of water volume and elapsed time is wide between analysts. It would be logical that the cleanliness of the glassware would have been varied as well. Consistency in the cleanliness of glassware can affect laboratory efficiency. If glassware washed by one analyst is less desirable than another, glassware may be subject to a second cleaning by another analyst (wasting more water and billable hours). Another outcome from inconsistent washing techniques could be cross contamination, which can be very costly to a laboratory. In many cases the laboratory work must halt until the source of contamination is confirmed, documented and all the necessary retesting completed. Again, dealing with cross contamination issues results in loss of billable hours to the lab and lost revenue on suspended billable projects. Glassware washers clean laboratory glassware consistently and can be validated. They offer separate pumps (one for incoming/clean water, and one for outgoing/dirty water) minimizing cross contamination risks. They also have preprogrammed cycles so that human error and personal washing preferences can be taking out of the equation.

Hand washing involves significant handling of laboratory glassware, which comes with an inherent breakage and injury risk to the user, resulting in downtime in the lab and glassware replacement. All of these have a cost factor that impacts the laboratory. By limiting the number of times glassware is handled, the risk may be decreased. For example, hand washing requires multiple manual contacts: wash, rinse, dry and return to storage. That is a minimum of 4 contacts which would be reduced through the use of an automated washer. Since the washer does all the washing and drying, the user would only be in contact once to load the washer and once to unload into the final storage cabinet.

Conclusion

Hand washing laboratory glassware is common and is seen as the more economical choice over investing in a glassware washer. However, when costs are broken out and compared, the reality is quite the opposite. The direct costs involved in hand washing glassware (greater water volume and labor) are compelling evidence that an automated machine will save money. In addition to direct costs, other costs such as the lost time and healthcare costs if a worker is injured, the cost of replacement glassware, and the lost time of a potential cross contamination investigation clearly indicate that an automated, validated machine can greatly reduce lab overhead and increase lab efficiency.