Lab Test Bulletin: Dishwasher Drying Performance Research Highlights

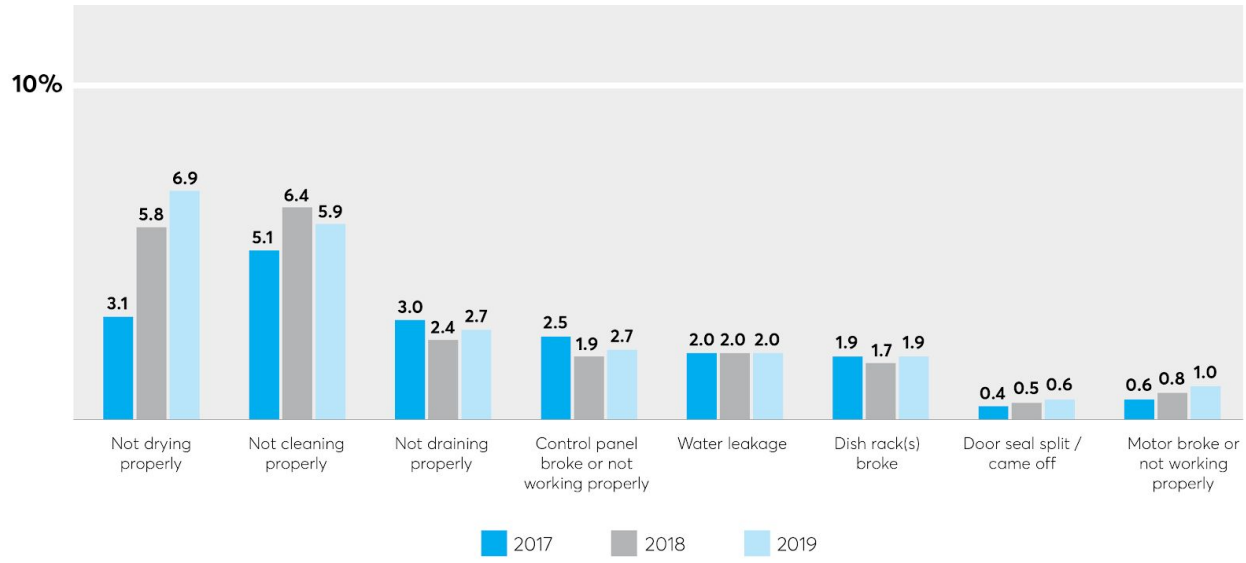
October 2020

Consumer Reports has produced this industry report to share preliminary highlights of a new drying test approach for our Dishwasher lab tests. CR will likely implement this new drying test later in 2020 and eventually incorporate it into the Overall Score (timing is still to be determined). CR plans to provide advance notice as to when this new drying test will be included in the Overall Score. In the meantime, underlying data will be available via CR's Data Intelligence subscription.

Background:

CR continually studies changes in consumer behavior and preferences to ensure that our product testing focuses on the product attributes that are most valuable to consumers. Our existing dishwasher drying performance measure is based solely on the ability to dry plastic items, which have traditionally been considered the most difficult to dry. However, in recent research, we have seen an increase in consumer complaints on the failure to dry dishes and in that problem area.

Problem Areas (%) among Dishwashers

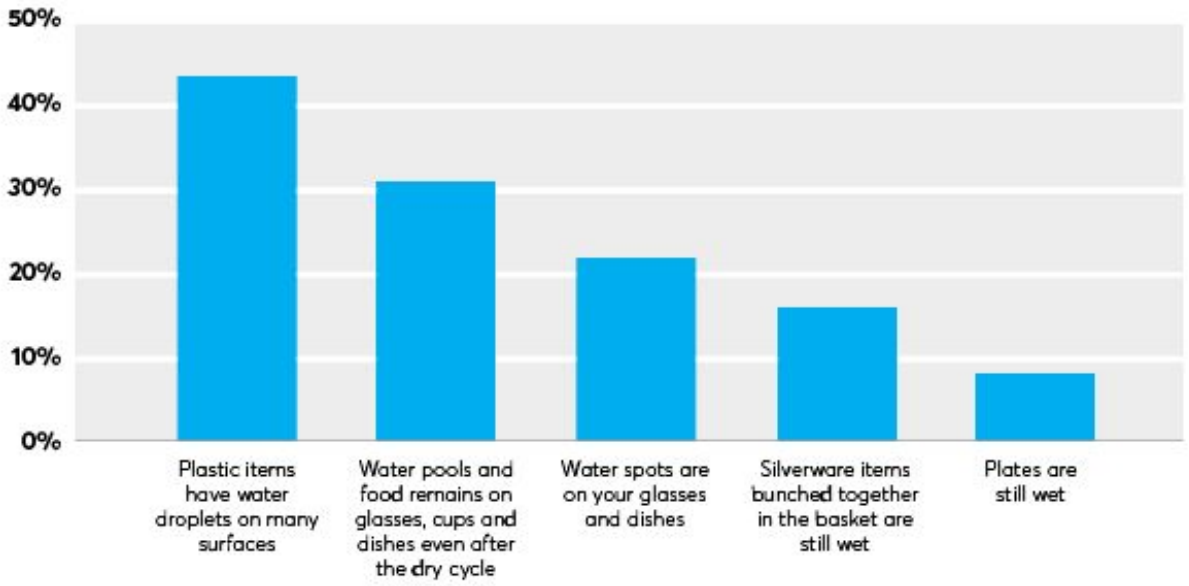


Source: CR Quarterly Member surveys 2017-2019

To gain a better understanding of consumer concerns, we enlisted our Consumer Experience & Usability Research group to conduct a Q-study with dishwasher owners. We found that Drying was more important when compared with other attributes tested, including Cleaning, Ease of Use, Noise, Cycle Time, Water, Energy. A lot of participants were frustrated with how poorly their dishwashers dried, especially glassware. This

created extra work for them; improperly dried dishes with spots had to be dried by hand. We also tested this information in our quarterly Member surveys and found similar results below.

Frequency of wet items and other wet problems after running the dishwasher (% Sometimes/Always)



Source: CR Quarterly Member survey 2017

Research Testing:

We determined that research testing was needed to address the key question: *Are there measurable and meaningful differences in drying performance between machines and drying technologies?*

And if so, then develop a scientific method to determine the dishwasher drying performance and replace our current subjective judgements of the dryness of plastic sippy cups.

We performed several different tests to evaluate differences in drying performance. A list of the models with their primary cycle of interest are in Appendix, Part II (the same models were also used with different drying cycles when offered). All tests beyond the initial pilot tests were performed in an environmental chamber.

Test Version 1: Evaluation of water droplets on dishes using paper towels

The first test evaluated only the water left on the dishes at the end of the cycle and not the water off the door, walls or base of the dishwasher. The initial test used a paper towel to dry off the dishes and weighed the towel afterward to measure the amount of water left. However, any water left in the coffee cup indents would spill out and end up in the dishwasher and not on the dishes. Another issue was that it would take several paper towels to perform the test and the weight of each paper towel was not uniform. Repeating variations of this test found that the results were not repeatable. One additional finding was that the walls and tub were difficult to wipe down without removing all the racks inside.

Findings: This test did not yield replicable and uniform results.

Test Version 2: Evaluation of wetness on dishes and door of the machine using a sponge

The testers migrated to a sponge to soak up the water and focused only on drying the dishes and the door of the machine. We ran 10 runs using the same cycle and collected the water weight absorbed by the sponge after each cycle was completed. The 10 runs showed that the method we chose was repeatable and we could continue using this method from this point on.

Findings: This test produced results that were repeatable.

Test Version 3: Effect of elapsed time after cycle on amount of water collected

Residual water collected at these intervals:

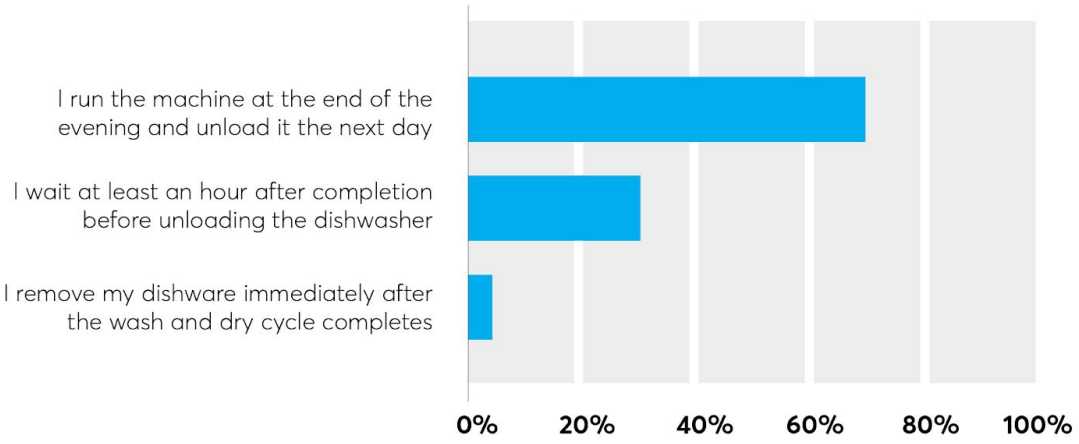
1. Zero hours after the cycle ends
2. Four hours after the cycle ends
3. Twelve hours after the cycle ends

We used the same wash cycle (Normal with heated dry) that is the basis for our cleaning tests as the starting point for this measurement.

Reasons for choosing these time intervals included:

- Current plastic drying test is done at zero hours; correlations could be explored.
- The CR Member survey found that most consumers run their dishwashers at night and unload the clean dishes the next day. Four hours after cycle end was chosen to replicate the consumer behavior of starting the dishwasher before work and unloading when they return. Twelve hours replicated an overnight run.

Dishwasher unloading practices



Source: CR Quarterly Member survey 2017

<u>Findings</u>: No difference was found between the 4 and 12 hour results so we ran all future tests using 0 hours for plastic cups and 4 hours for dishes.

Test Version 4: Focus on drying technology

Selected dishwashers utilize different technologies to dry dishes which include fans, heaters, heating up rinse water, auto-opening doors, desiccants and combinations. Four machines were chosen that provided all the different drying technologies under review.

Findings: **Results showed that air dry alone was least effective and auto-open door was the most effective. There was no statistical difference in performance in other technologies. This analysis is only directional due to the low number of models tested.**

Test Version 5: Impact of room conditions

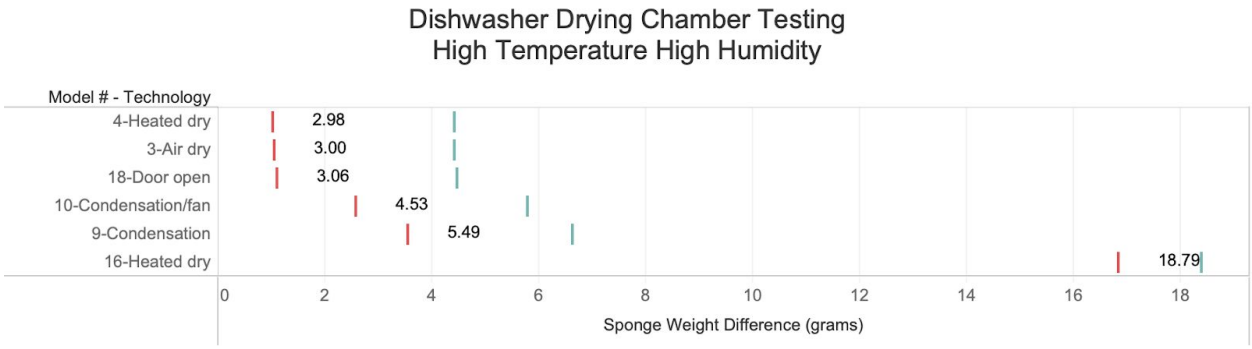
Data from the 0 hour and the 4 hour test was analyzed to explore the impact of temperature and humidity on drying performance. We also analyzed the temperature and humidity effect on these results to see if an adjustment would need to be made based on the room conditions.

Findings: The room conditions did have an effect on the drying performance.

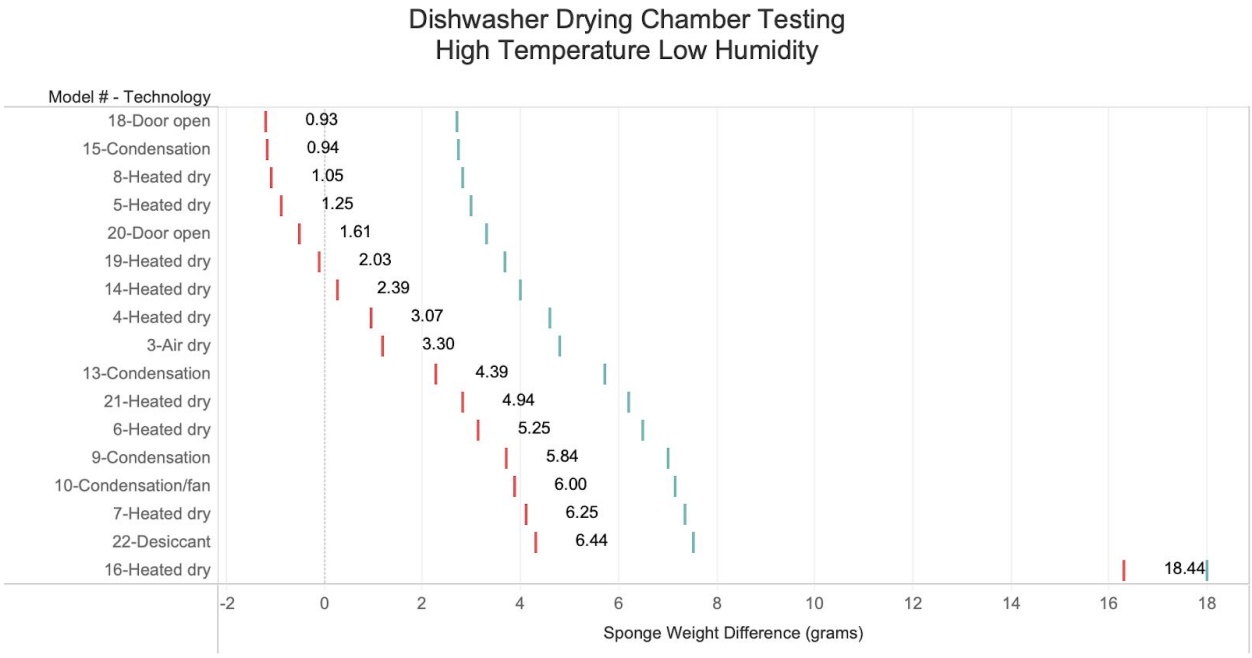
Test Version 6: Controlled chamber testing

Testing was moved to the environmental chamber to control both temperature and humidity. Two different temperatures and two different humidity ranges were selected: 70°F (low temp) and 80°F (high temp), which represent what our labs usually see throughout the year; the relative humidity was 60% (high humidity) and 10% (low humidity), which are respectively the humidity recorded over the summer and in the winter (in the lab when we don't operate humidifiers or dehumidifiers). Tests were repeated on the same models in the chamber and these results were compared to the results from testing under lab conditions. In addition to testing the four "Reference" models, an additional 10 more models were added. (See charts on the next page.)

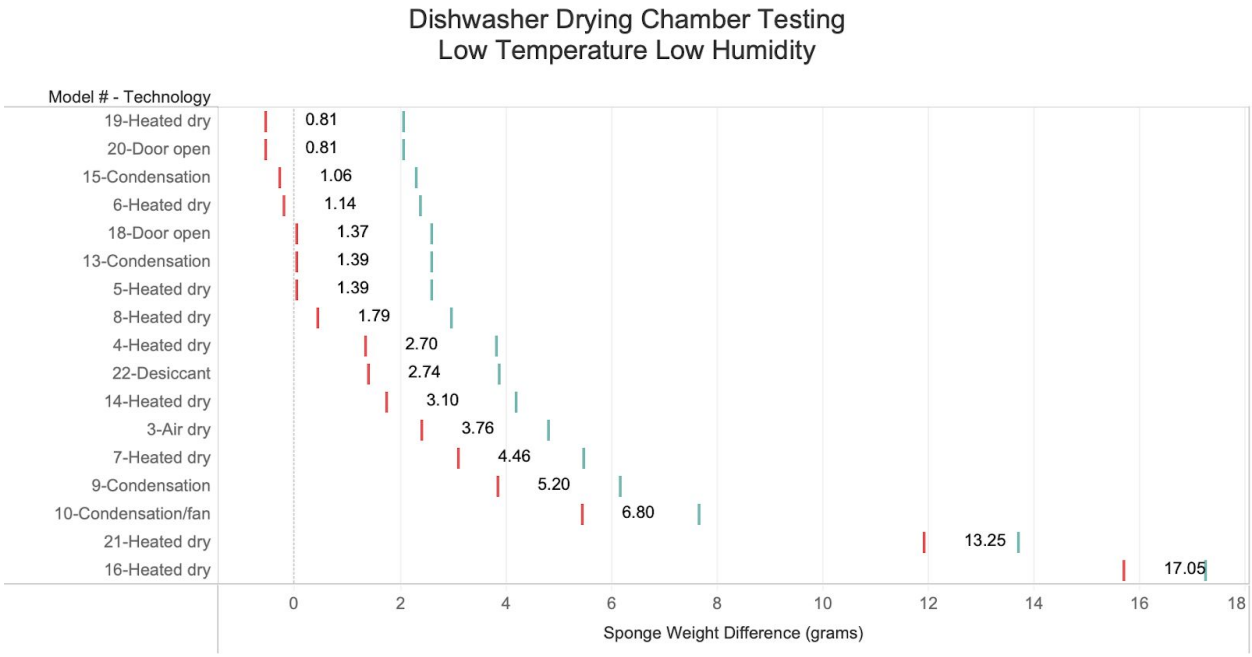
Findings: Initial analysis showed that the highest degree of separation between dishwasher model drying performance is achieved with low temperature/low humidity conditions, suggesting that further testing should take place in an environment with similar ambient conditions.



Approximate MSD = 3.96. p-value = <.0001. Numbers represent the Least Squares Mean for each tested model. Colored bars represent the approximate MSD limits.



Approximate MSD = 4.30. p-value = <.0001. Numbers represent the Least Squares Mean for each tested model. Colored bars represent the approximate MSD limits.



Approximate MSD = 2.74. p-value = <.0001. Numbers represent the Least Squares Mean for each tested model. Colored bars represent the approximate MSD limits.

Conclusions:

CR will move forward with a new drying test approach leveraging the results of the aforementioned research testing. Measurable differences in drying performance were found in our initial analysis, some of which are related to technology.

An additional finding was that for consistency, we will need to test under controlled conditions. Differentiation was maximized at low humidity levels and that would be difficult to achieve without environmental chambers.

CR will keep the industry informed on progress and timing, and will update the external audience protocol accordingly.

Appendix

List of models included in the study

Brand	Model	Key Drying Technology
Frigidaire	FFCD2413US	Heating coil
Frigidaire	LFID2459VF	Heating coil
Frigidaire	FFID2426TS	Fan
Frigidaire	Gallery FGIP2468UF	Heating coil
GE	GDT565SSNS	Heating coil
GE	GDF630PSMSS	Heating coil
LG	LDP6797ST	Air dry
LG	LDT7808BM	Condensation
LG	LDT5665ST	Condensation
Maytag	MDB4949SHZ	Heating coil
Miele	Classic Plus G4977SCVISF	Condensation
Samsung	DW80N3030US	Heating coil
Samsung	DW80R9950US	Auto Door open
Samsung	DW80M2020US	Heating coil
Samsung	DW80M9960US	Auto Door open
Thermador	DWHD770WFM	Desiccant dry
Whirlpool	WDT730PAZ	Heating coil