High Efficiency Washers in North America

1. Background on Laundry Machines

1.1 Over the past 50 years, home laundry washing machines in the U.S. have traditionally been vertical axis (VA) deep fill machines with center post agitators. Most VA washers suspend the clothes in a tub of water for washing and rinsing, which typically requires about 150 L (40 gal) of water for each load. The conventional VA washer meets the consumers' needs of cleaning a clothes load, but consumes a substantial quantity of water and energy. As a result of government mandates to reduce energy usage and through industry competition, laundry products have significantly improved their energy efficiency over the past ten years. The majority of U.S. appliance manufacturers now offer high efficiency (HE) clothes washers. These machines are two basic types: 1) horizontal axis (HA) design (also called front-loading machines) in which the clothes load tumble through a small bath of water rather than being immersed in a tub of water as is conventionally done with most VA washers or 2) a modified VA design in which low-post or no-post agitators are used with spray wash and spray rinses. These HE washers use significantly less water and estimates have shown that these washers use approximately 20-66% of the water consumed by a conventional VA washer.

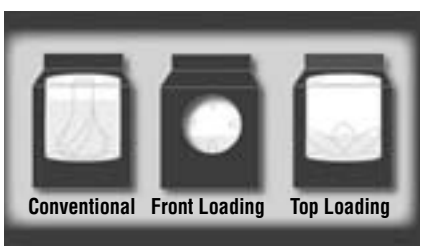

Fig. 1—Different Types of Laundry Washers in North America[1]

1.2 The tumble-action principle of the HA washer and the modified VA design represents a major design change from the conventional design. Front loading washers tumble clothes back and forth through the water bath as the drum rotates clockwise and counterclockwise. Top loading HE washers use special mechanical agitators, described by different manufacturers as "wobblers," "nutating" plates, or "impellers," to create agitation that is gentler than center post agitators. Currently, front loaders comprise about 90% of the HE market.

2. Energy and Water Regulations

2.1 For a clothes washer, the U.S. Department of Energy (DOE) quantifies washer efficiency using the modified energy factor (MEF). The MEF is an energy efficiency metric that corresponds to the clothes washer capacity in cubic feet divided by the total energy consumption per cycle in kWh. Total energy consumption takes into account the energy to run the washer (motors and controls), the energy to heat the water and the energy used by the dryer to remove moisture from the clothes load. The formula used to calculate the MEF is as follows:

$$MEF = \frac{C}{M_E + E_T + D_E}$$

where:

C = capacity in cubic feet or liters,
M_E = machine electrical energy consumed per cycle,
E_T = energy consumed in heating the water per cycle, and
D_E = energy consumed in drying the load.

MEF is expressed in cubic feet (or liter) per kilowatt-hours per cycle. The higher the MEF, the more efficient the clothes washer is.

2.2 It is estimated that over 80% of a washer's energy consumption goes to heating the water.[2] The average front loading HE washer uses 60-65% less water than traditional VA washers, and because less energy is needed to heat the smaller amount of water, there are significant energy savings. Additionally, the higher spin speeds of the front loading HE washer (900-1300 rpm) result in clothes that contain significantly less residual moisture at the end of the wash cycle; therefore, less drying time is required and utility costs are further reduced.

2.3 On January 1, 2007, all washing machines sold in the U.S. must comply with a revised Modified Energy Factor (MEF) of 1.26. Manufacturers are required to meet specific energy and water efficiency guidelines set by the DOE. Products that exceed the minimum criteria are eligible for the special Energy Star rating. All current HE washers are Energy Star qualified machines and clean laundry using 50% less energy than traditional style washers.[3]

3. HE Detergent

3.1 Because of the low quantity of water used in HE machines, it is important to use an HE detergent (low sudsing) which is specially formulated to work best under these conditions. The two most important considerations are suds control and soil concentration. First, the tumbling action in an HE machine generates more suds than in a deep-fill top load washer. Tumbling the clothes in and out of the water breaks the water surface causing air to be trapped in the solution, creating suds or foam. Multiple problems can occur from over sudsing, such as flooding from suds overflowing out of the machine, formation of a suds cushion during the tumbling action which reduces mechanical energy (i.e., lower cleaning), and "suds lock" which prevents the machine from effectively spinning out the water. In the situation of suds lock, the machine attempts to suppress the foam by stopping the cycle momentarily to allow the suds to dissipate and then adding cold water. This routine the machine goes through to correct for over sudsing results in loss of energy and water savings and can significantly lengthen the cycle time (sometimes by as much as 2x). HE detergents are equipped with robust suds control systems to prevent over-sudsing and allow for better rinsing of suds. The second important factor for an HE detergent is soil management. Though HE washers use about 1/3 of the water of a deep-fill top loader, the concentration of soil in the load is much higher due to the larger loads. To handle the higher amount of soil, many HE detergents are specially formulated with soil suspending ingredients to prevent soil from re-depositing onto clothes. Today, HE detergents are sold at all major food, drug, and mass outlets and are specially marked with the HE industry logo.

4. Trends in HE Washers

4.1 Common Features – HE washers became more widely available in the U.S. by the late 1990s. Sales were relatively modest compared to conventional style machines, but within the past five years, the market has experienced rapid growth. For example, manufacturer shipments of

[1] www.cleaning101.com.

[2] *Journal of Surfactants and Detergents* 2, Oct. 1999, pp559-562.

[3] www.energystar.gov.

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front load washers have tripled over this time period, increasing from 9% in 2001 to 29% in 2006.[4] This strong growth is driven not only by water and energy savings, but also by new features that manufacturers can offer to make HE machines more appealing to consumers, such as: larger capacity to do larger and fewer loads, more cycle selections to better care for garments, displays that detail cycle time, and sleeker, more aesthetically appealing designs. Additionally, as home designs move the laundry room out of the basement or garage into more prominent and visible areas of the home, consumers are more concerned about the appearance of their laundry appliances. Manufacturers have responded with more color choices and styles than have been offered in the past. Furthermore, machines are being designed to operate quieter and minimize the vibrations resulting from the higher spin speeds.

4.2 Another common feature on many higher-end HE washers is the capability to boost the water temperature in use via on-board heaters. This capability is also used for special sanitary cycles that enable the wash solution to reach temperatures above 60°C (140°F). Another feature that many manufacturers now offer is automatic load sensing (via interplay of absorbency and water level sensors). This further increases efficiency by more accurately determining the amount of water needed for each load.

4.3 Special *Features* – Manufacturers are investing in HE machines to promote new technology innovations for improved performance. Current examples include wrinkle removal, sanitization, water-proofing, re-freshening and detergent-less washing.

5. Conclusion

5.1 The prominence of HE washers in consumer homes today has implications to AATCC test methods that should be noted. First, test procedures need to include both front loading and top loading HE machines for full scale testing. The differences in tumbling action, wash concentration, water levels, and wash temperature significantly affect the performance compared to traditional machines.[5] Secondly, testing under HE conditions requires the use of an HE detergent. The impact of over sudsing and rinseability, as mentioned above, is too important to overlook. In order to keep test methods current and reflect relevancy in the market, AATCC will need to be aware of market dynamics and update their methods accordingly.

6. History

6.1 Reaffirmed and editorially revised history to align with AATCC Style Guide in 2021.

6.2 Editorially revised 2019; numbered in 2011.

6.3 Developed in 2008 by AATCC Committee RA88.

[4]Association of Home Appliance Manufacturers.

[5]For testing under HE wash conditions, washing machine selection should be based on models representative of the broader U.S. HE washer market. At the time this monograph was written (2008), representative front load washers include the Whirlpool Duet models GHW9150P and GHW9400P. For testing under top load HE conditions, representative models are the Whirlpool Cabrio WTW6400S and WTW6600S.

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