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Softened Water Benefits Study: New

Reports Related to Detergent and More Energy Savings

MARCH 8, 2011

by Pauli Undesser, CWS-VI

The [Water Quality](http://www.wcponline.com/glossary/water-quality/) Research Foundation (WQRF) released two new reports in February that, in combination with WQRF's 2009 Study on [Benefits of Removal of Water Hardness](http://www.wcponline.com/glossary/hardness/) (Calcium and [Magnesium](http://www.wcponline.com/glossary/magnesium/) Ions) From a Water Supply (also known as the Battelle Study) are encompassed in a body of research called the [Softened Water](http://www.wcponline.com/glossary/softened-water/) Benefits Study. The two new reports are: [Evaluation of Relative Effects of Hardness](http://www.wcponline.com/glossary/hardness/), [Detergent Dose and Temperature to Evaluate Stain Removal Efficacy and/or Use of Less Laundry Detergent](http://www.wcponline.com/glossary/detergent/) at Lower Water Temperatures (the Laundry Study) and [Evaluation of the Effect of Water Hardness](http://www.wcponline.com/glossary/hardness/) on Performance of Automatic Dishwasher [Detergents and Savings Possible by Softening](http://www.wcponline.com/glossary/softening/) Water (the Dishwasher Study).

How typical! Just when the debate regarding the advantages and disadvantages of water softeners appeared to be simmering down, a new report comes along to shake things up again. This happens often in the scientific world because researchers evaluate high-profile topics to the nth degree. Any subject that is investigated from infinite points of view will provide observations that can seem to contradict each other or disturb general perceptions. To reach the pinnacle of understanding, it takes a significant amount of research to connect seemingly disconnected information and to provide [clarity](http://www.wcponline.com/glossary/clarity/) to the overall topic. Water has been researched in infinite ways, but new water-related research still has the power to surprise us. Various researchers are trying their hardest to achieve the ultimate level of detail for high-profile topics, which means that we need to continuously evaluate new data and reassess general perceptions.

Traditional [cation exchange](http://www.wcponline.com/glossary/cation-exchange/) water softeners have only been around for about 110 years (it seems like forever), and have been heavily researched to assess their breadth of [contaminant](#)

[\(http://www.wcponline.com/glossary/contaminant/\)](http://www.wcponline.com/glossary/contaminant/) reduction

[\(http://www.wcponline.com/glossary/reduction/\)](http://www.wcponline.com/glossary/reduction/) capabilities. Water softeners have not been thoroughly investigated from infinite points of view, and the data that we do have does not even come close to reaching a pinnacle of understanding that helps assess the full impact these devices can have. More research will occur over time and seeing new reports may not come as such a surprise, but each of the findings might be worth reviewing. The latest reports confirm information that stress the utility of water softeners, tweak general perceptions and spur suggestions for further investigations. General explanations about the report findings are discussed in this article.

The tangible results

Both the *Laundry Study* and *Dishwasher Study* compare results of washing with water ranging from softened (zero gpg) to very hard (30 gpg) using various temperatures and [detergent](http://www.wcponline.com/glossary/detergent/) [\(http://www.wcponline.com/glossary/detergent/\)](http://www.wcponline.com/glossary/detergent/) doses. It is generally known that [softening](http://www.wcponline.com/glossary/softening/) [\(http://www.wcponline.com/glossary/softening/\)](http://www.wcponline.com/glossary/softening/) water increases the efficacy of soaps and detergents. These studies quantify the increase in efficacy through [reduction](http://www.wcponline.com/glossary/reduction/) [\(http://www.wcponline.com/glossary/reduction/\)](http://www.wcponline.com/glossary/reduction/) in [detergent](http://www.wcponline.com/glossary/detergent/) [\(http://www.wcponline.com/glossary/detergent/\)](http://www.wcponline.com/glossary/detergent/) dose and go further to investigate the [reduction](http://www.wcponline.com/glossary/reduction/) [\(http://www.wcponline.com/glossary/reduction/\)](http://www.wcponline.com/glossary/reduction/) of temperature and, in turn, energy savings. The *Laundry Study* investigated stain removal where [detergent](http://www.wcponline.com/glossary/detergent/) [\(http://www.wcponline.com/glossary/detergent/\)](http://www.wcponline.com/glossary/detergent/) usage was 50, 75 and 100 percent of the manufacturers recommended level; water [hardness](http://www.wcponline.com/glossary/hardness/) [\(http://www.wcponline.com/glossary/hardness/\)](http://www.wcponline.com/glossary/hardness/) ranged from 0 to 513 [ppm](http://www.wcponline.com/glossary/ppm/) [\(http://www.wcponline.com/glossary/ppm/\)](http://www.wcponline.com/glossary/ppm/) (30 gpg) and wash temperature was 60, 80 and 100°F (15.5, 26.6 and 37.7°C). Nine different popular phosphate-free detergents were tested on nine different standardized stains. Statistical analysis was conducted to compare the ability of [softened water](http://www.wcponline.com/glossary/softened-water/) [\(http://www.wcponline.com/glossary/softened-water/\)](http://www.wcponline.com/glossary/softened-water/) to mitigate adverse effects of lower [detergent](http://www.wcponline.com/glossary/detergent/) [\(http://www.wcponline.com/glossary/detergent/\)](http://www.wcponline.com/glossary/detergent/) dosage and lower wash temperature, in turn decreasing costs and energy usage. The most significant conclusion of the *Laundry Study* is the fact that stain removal is increased more by [softening](http://www.wcponline.com/glossary/softening/) [\(http://www.wcponline.com/glossary/softening/\)](http://www.wcponline.com/glossary/softening/) water than by increasing [detergent](http://www.wcponline.com/glossary/detergent/) [\(http://www.wcponline.com/glossary/detergent/\)](http://www.wcponline.com/glossary/detergent/) dose or by increasing temperature. Decreasing [hardness](http://www.wcponline.com/glossary/hardness/) [\(http://www.wcponline.com/glossary/hardness/\)](http://www.wcponline.com/glossary/hardness/) demonstrated to be up to 100 times more effective at stain removal (depending on the stain) than increasing [detergent](http://www.wcponline.com/glossary/detergent/) [\(http://www.wcponline.com/glossary/detergent/\)](http://www.wcponline.com/glossary/detergent/) dose or temperature. Figure 1 and

Table 1 display a comparison of Case 1: very hard water (<http://www.wcponline.com/glossary/hard-water/>)/high-detergent (<http://www.wcponline.com/glossary/detergent/>) dose/high temperature versus Case 2: medium-hard water (<http://www.wcponline.com/glossary/hard-water/>)/medium-detergent (<http://www.wcponline.com/glossary/detergent/>) dose/medium temperature versus 3: softened water (<http://www.wcponline.com/glossary/softened-water/>)/low-detergent (<http://www.wcponline.com/glossary/detergent/>) dose/low temperature.

([| Case | Whiteness |
|--------|-----------|
| Case 1 | 8.5 |
| Case 2 | 10.2 |
| Case 3 | 11.8 |](http://www.wcponline.com/wp-</p>
</div>
<div data-bbox=)

content/uploads/2011/03/Undesser_Charts_purple.jpg)

Pattern	Hardness, ppm	Dose, %	Temperature, °F
Case 1	513	100	100
Case 2	256.5	75	80
Case 3	0	50	60

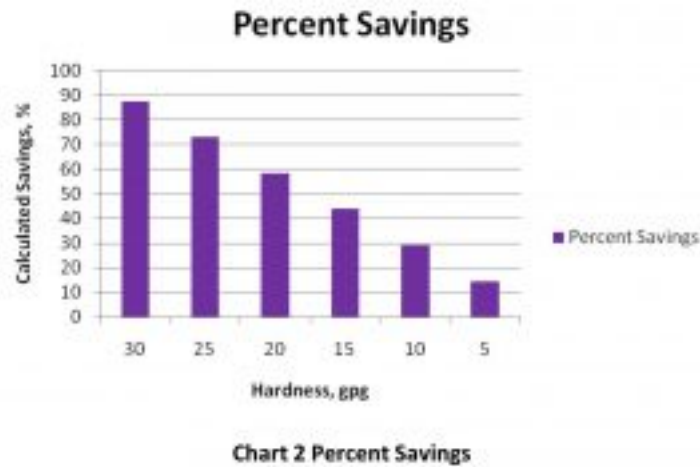
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The fact that softened water (<http://www.wcponline.com/glossary/softened-water/>) combined with the least amount of detergent (<http://www.wcponline.com/glossary/detergent/>) and lowest temperature provides the highest degree of whiteness compared to increased hardness (<http://www.wcponline.com/glossary/hardness/>) with the highest level of detergent (<http://www.wcponline.com/glossary/detergent/>) and temperature is a noteworthy finding. The main conclusion of this study is that when hard water (<http://www.wcponline.com/glossary/hard-water/>) is softened prior to its use in washing, detergent (<http://www.wcponline.com/glossary/detergent/>) use can be reduced by 50 percent, and washing can be carried out in 60°F (15.5°C) cold water instead of 100°F (37.7 °C) hot water, and yet still achieve the same or better stain removal and yield (<http://www.wcponline.com/glossary/yield/>) whiter clothes. This was found to be true for all stains and all detergents tested. The significance of this finding impacts waste-stream

remediation and energy consumption, though the full implications have not been quantified. These calculations are included in discussions regarding future endeavors that will spin off of this research.

Detergent (<http://www.wcponline.com/glossary/detergent/>) savings was also evaluated for dishwashers. The *Dishwasher Study* included tests for removing difficult soiling in addition to spot and film evaluation. The relationship between detergent (<http://www.wcponline.com/glossary/detergent/>) dose and hardness (<http://www.wcponline.com/glossary/hardness/>) was investigated with three name-brand, non-phosphate automatic dishwashing detergents with two consecutive wash-dry cycles for spot and film. One detergent (<http://www.wcponline.com/glossary/detergent/>) was evaluated for five cycles to ensure that effects do not change with an increased number of cycles.

Statistically significant improvements made by softening (<http://www.wcponline.com/glossary/softening/>) water with hardness (<http://www.wcponline.com/glossary/hardness/>) were observed in spotting and filming performance, as well (<http://www.wcponline.com/glossary/well/>) as in better soiling removal in automatic dishwashing. Detergent (<http://www.wcponline.com/glossary/detergent/>) savings up to 70 percent was observed for dishwashing when softened water (<http://www.wcponline.com/glossary/softened-water/>) was used compared to hard water (<http://www.wcponline.com/glossary/hard-water/>). Depending on the soiling, hardness (<http://www.wcponline.com/glossary/hardness/>) reduction (<http://www.wcponline.com/glossary/reduction/>) was found to be up to 12 times more effective at removal than increasing detergent (<http://www.wcponline.com/glossary/detergent/>) dose. Hardness (<http://www.wcponline.com/glossary/hardness/>) reduction (<http://www.wcponline.com/glossary/reduction/>) was approximately six times more effective at reducing spotting, and twice as effective at reducing filming as increasing detergent (<http://www.wcponline.com/glossary/detergent/>) usage (see Figure 2).



content/uploads/2011/03/Undesser_graphics.jpg) **Figure 2. Percent savings**

The *Dishwasher Study* also briefly evaluated [persistence](http://www.wcponline.com/glossary/persistence/) (<http://www.wcponline.com/glossary/persistence/>) of the [hardness](http://www.wcponline.com/glossary/hardness/) (<http://www.wcponline.com/glossary/hardness/>)-dose relationship, air-drying benefits and tablet detergents. A [detergent](http://www.wcponline.com/glossary/detergent/) (<http://www.wcponline.com/glossary/detergent/>) that was run for an additional three cycles did show that the [hardness](http://www.wcponline.com/glossary/hardness/) (<http://www.wcponline.com/glossary/hardness/>)-dose performance relationship persists. Air drying as a way to save electrical energy for dishwashing is promising and may give better results when [softened water](http://www.wcponline.com/glossary/softened-water/) (<http://www.wcponline.com/glossary/softened-water/>) is used rather than [hard water](http://www.wcponline.com/glossary/hard-water/) (<http://www.wcponline.com/glossary/hard-water/>). Further experiments are required to fully substantiate this claim. Lastly, the results using [liquid](http://www.wcponline.com/glossary/liquid/) (<http://www.wcponline.com/glossary/liquid/>) detergents were confirmed with tablet detergents. The beneficial effect of [softening](http://www.wcponline.com/glossary/softening/) (<http://www.wcponline.com/glossary/softening/>) wash water was notably greater than the beneficial effects generated by the use of two tablets rather than one.

The *Softened Water* (<http://www.wcponline.com/glossary/softened-water/>) *Benefits Study* has provided new research to ponder regarding the benefits of water softeners. First, the *Battelle Study* evaluated energy savings from water upon maintaining the [efficiency](http://www.wcponline.com/glossary/efficiency/) (<http://www.wcponline.com/glossary/efficiency/>) of appliances as well (<http://www.wcponline.com/glossary/well/>) as limiting impacts on fixtures. It was demonstrated that for gas storage tank water heaters, up to 24-percent [efficiency](http://www.wcponline.com/glossary/efficiency/) (<http://www.wcponline.com/glossary/efficiency/>) can be lost with hard-water usage. Moreover, the *Detergent* (<http://www.wcponline.com/glossary/detergent/>) *Savings Study* investigated [detergent](http://www.wcponline.com/glossary/detergent/) (<http://www.wcponline.com/glossary/detergent/>) [reduction](http://www.wcponline.com/glossary/reduction/) (<http://www.wcponline.com/glossary/reduction/>) and further energy savings through decreasing wash temperature in laundry operations, and the possibility of using air drying in dishwashing.

Overall, it is still unclear whether these benefits outweigh the negative impacts of softeners, such as chloride introduction in the waste stream and extraneous water usage for [regeneration](http://www.wcponline.com/glossary/regeneration/) (<http://www.wcponline.com/glossary/regeneration/>). It is also not clear how alternative devices may fit into this research. We are far from reaching complete understanding on this topic, but the research will continue and someday will hopefully resolve the debate of softener advantages versus disadvantages.

To get more detailed information about the *Battelle Study*, the *Laundry Study*, and the *Dishwasher Study*, you can access the executive summaries, full reports and other resources by visiting the [Water Quality](http://www.wcponline.com/glossary/water-quality/) (<http://www.wcponline.com/glossary/water-quality/>) Association (WQA (<http://www.wcponline.com/glossary/wqa/>)) website at www.wqa.org (<http://www.wqa.org>). Note that some information may be restricted to [WQA](http://www.wcponline.com/glossary/wqa/) (<http://www.wcponline.com/glossary/wqa/>) members only. The website also offers valuable information about water contaminants and how they can be addressed, and listings of manufacturers of certified water [treatment](http://www.wcponline.com/glossary/treatment/) (<http://www.wcponline.com/glossary/treatment/>) products. You can also learn how to support research projects through WQRF, become a member of [WQA](http://www.wcponline.com/glossary/wqa/) (<http://www.wcponline.com/glossary/wqa/>), and find contact information for local water professionals [who](http://www.wcponline.com/glossary/who/) (<http://www.wcponline.com/glossary/who/>) are members of [WQA](http://www.wcponline.com/glossary/wqa/) (<http://www.wcponline.com/glossary/wqa/>).

About the author

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