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A Candid Look at LED PAR38 Lamps

There are about 90 million PAR38 lamps installed in the U.S., mainly in commercial applications, where they illuminate retail shelves, museum displays, lobbies, and other settings that require high-intensity spot lighting with excellent color rendering. Many PAR38s are on for 12 or more hours a day, which presents a prime opportunity to save energy. However, the incumbent halogen PAR38s constitute formidable competition because of their effectiveness and utility, and LED PAR38s have only scratched the surface in terms of consumer adoption.

To determine how LED PAR38s measure up against their halogen counterparts, DOE's CALiPER testing program began a series of investigations on LED PAR38 lamps in 2013. The final two reports in that series—CALiPER Reports 20.3 and 20.4—were recently published and offer valuable insights.

The first report in the series, CALiPER Application Summary Report 20, described the results of photometric testing, with the second, CALiPER Report 20.1—which is accompanied by a video—focusing on human-evaluated characteristics (beam quality, shadow quality, and color quality), and the third, 20.2, concentrating on dimming, flicker, and power quality.

Report 20.3 looked at robustness and found that, on average, the 32 LED lamp models tested were substantially more robust than the eight conventional benchmark lamps. As with other performance attributes, however, there was great variability in the robustness and design maturity of the LED lamps. Several LED lamp samples failed within the first one or two levels of the 10-level stress plan, while all three samples of some lamp models completed all 10 levels.

However, it would be incorrect to assume that the robustness of LED lamps is improving, because the opposite is just as likely. Although lamp designs are continually refined, there is market pressure to reduce cost, and this can lead to less-robust designs, which may be acceptable or even preferred for some applications. With mature product designs, all samples of a given lamp will ideally fail after about the same number of hours of operation, indicating a single, consistent failure mode. This facilitates predictable replacement times and potentially lower maintenance costs for users.

Report 20.4 considered lumen and chromaticity maintenance. On average, the lumen maintenance of the LED lamps was substantially better than the average for the other lamp technologies. After nearly 14,000 hours, the average lumen output for the non-catastrophically failed LED lamps was 94%, compared with 68% for the CFLs and 62% for the ceramic metal halide (all of the halogens failed, after typically reaching about 80% of initial output).

However, while the average lumen maintenance for the LED lamps was very good, there was considerable variation from lamp model to lamp model. At the end of the test period, some lamp models had an average lumen output greater than the initial average, whereas two models had an average output less than 80% of the initial average. All but three of the LED lamp models had average relative output between 87% and 101%.

On average, the LED lamps exhibited superior chromaticity maintenance compared to the benchmarks, but the average $\Delta u'v'$ of two of the LED lamp models exceeded the ENERGY STAR® limit of 0.007 and would likely be problematic in an application where color stability is important. A key takeaway of Report 20.4 is that the long-term performance of LED lamps can vary greatly from model to model, although the lamp-to-lamp consistency within a given model is relatively good. Another important finding is that performance was generally not correlated to the manufacturer's rated lifetime for the product.

For more details on these instructive studies of LED PAR38 lamps, see the complete reports, which are available on the DOE website.

As always, if you have questions or comments, you can reach us at postings@akoyaonline.com.