Designing LEDs for hazardous environments

Yoelit Hiebert - October 12, 2017

The conversion to LED lighting is happening everywhere, and hazardous environment facilities like oil rigs and heavy manufacturing are no exception. Designing LED lighting systems for these environments poses a special challenge in making sure that the products hold up under extreme temperatures and exposure to highly corrosive airborne chemicals. So what makes a successful hazardous-environment LED lighting product? To find out, I asked John Peck, Dialight’s VP of Engineering. Dialight began its foray into LED lighting with panel indicators, and now offers a full line of LED lighting for hazardous environments.

As you might expect, component selection for both the LED circuit boards and drivers should include a high level of derating. In addition, projected lifetime performance should be evaluated by:

1. Component selection based on calculations, which can provide a statistical design-based projection.
2. Results of verification through industry standard Highly Accelerated Lifetime Testing (HALT) and long-term in-house operational simulation testing.
3. Stress testing during production.

Oil refinery outfitted with LED hazardous-environment lighting. (source: Dialight)
Evaluation of failure mechanisms identified by QA testing of returned product.

All of these methods ideally contribute to an overall understanding of expected lifetime performance and, more importantly, of failure mechanisms that can be addressed through changes to the design and/or manufacturing processes. Elimination - to the extent possible - of components with known wear-out mechanisms (like capacitors and seals), and also of materials and components that degrade during storage is also essential to attain desired long-term performance goals.

Overvoltage conditions are often more likely in hazardous environments due to heavy equipment operation. John provided more clarity, saying that “although meeting high ratings is important, there are other considerations as well.” Addition of surge protection components like MOVs might facilitate successful standards testing, but may not actually make much difference in terms of the dirty power and other line fluctuations typical of hazardous environments. Instead, designers should focus on making the final product as robust as possible by building in more than just the surge protection needed to pass industry tests.

Because overttemp conditions have by far the most significant effect on LED lumen maintenance, thermal management is one of the most important aspects of the overall system design. LED luminaires operating in hazardous environments must be tightly sealed, meaning that conduction is the only way for heat to travel from the LED packages to the outside ambient. What’s the secret to an effective thermal management design? The only comment John would make is that, “proprietary methods are used to manage heat to ensure performance targets.” However, he did allow that minimizing the number of thermal interfaces between the LED packages and the outside ambient is the key to a good thermal management design.

With proper thermal management, LEDs can last many thousands of hours, so degradation or failure of the luminaire lens and housing may become more of a limiting factor in overall system performance. Even with IP ratings of 68 or 69, for Class 1/Division 1 (US) or Zone 1 flameproof protection methods (international), the lens material needs to be strong enough to withstand the pressure of an internal explosion due to inadvertent infiltration of volatile gases in the ambient environment. The most common lens materials for hazardous locations are glass, and polycarbonate - primarily for impact resistance - although acrylic is used in some non-hazardous industrial applications.
Die- or sand-cast aluminum is primarily used for hazardous environment housings because of the ease of incorporation of mechanical features and heat-dissipation fins. Aluminum alloys that minimize copper provide the best corrosion resistance in typical hazardous environments that may include extreme pH, salt fog, or sulphur. Painting the housing provides protection against corrosive elements, and powder coating is the most common approach. Much like thermal management design, the painting process can be proprietary.

Last but not least, as I’ve talked about previously, LED lighting is rapidly becoming a key component in implementing sophisticated sensor and networking schemes throughout a facility. All sorts of sensors can be integrated into LED luminaires: For hazardous environments, sensors have the potential to improve overall safety by detecting smoke or chemical leaks for example. But because the owners of these facilities are sensitive to potential outcomes in the event of a hardware or software failure, sensor and networking adoption has been more tentative than in other commercial sectors. According to John, “Industrial IoT is still in its infancy stage, but it’s definitely going to happen.”

Also see:

- [LED lighting design considerations for smart cities](#)
- [Harsh environments conquered—Components for extreme high temperature applications](#)
- [150-W adjustable, pole-top LED targets hazardous locales](#)
- [What about Power over Ethernet in a hazardous environment?](#)
- [Circuit protection for outdoor LED lighting](#)
—Yoelit Hiebert has worked in the field of LED lighting for the past 10 years and has experience in both the manufacturing and end-user sides of the industry.