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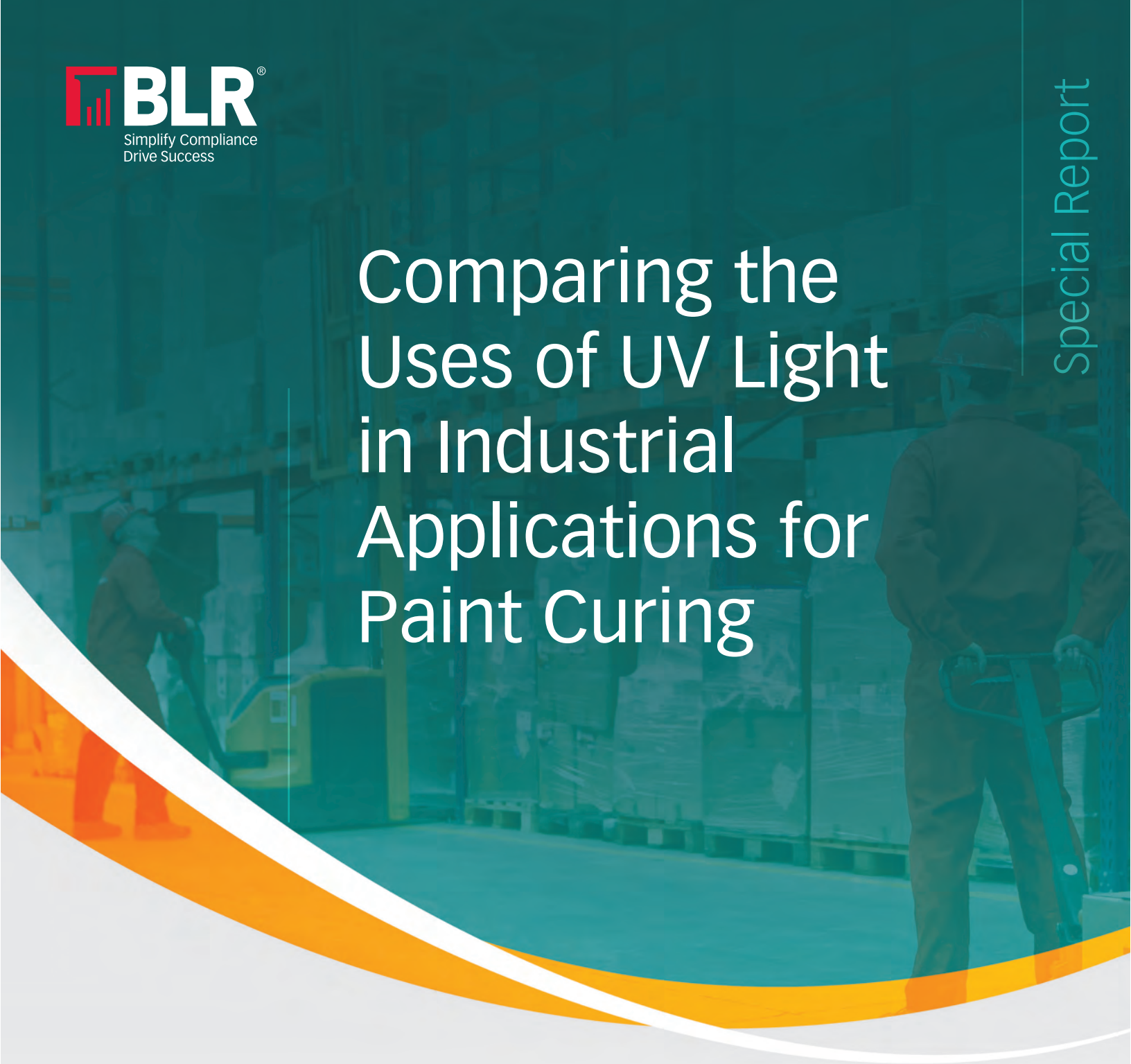
Special Report

Comparing the Uses of UV Light in Industrial Applications for Paint Curing



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1.0 Executive Summary

This report is a comprehensive comparison of the various uses of ultra-violet (UV) light in industrial settings. Specifically, the purpose of this study is to expound on the application of UV light for paint curing. The study covers its implementation in several fast-moving sectors, such as automobile, medical manufacturing and housing. Managers, engineers and other professionals can use the compilation to understand and maximize the usability of UV light in daily operations.

In line with the latest industrial trends, the report shines light on UV paint curing best practices respectively in sectors that apply the robust technology. Lastly, Larson Electronics provides solutions for groups that are looking for a customized, hands-on approach to UV lighting solutions. Through the publication of the study, the company hopes to deliver fresh insights on paint curing with UV light.

2.0 Introduction

In today's competitive environments, the need to streamline production has never been greater. UV paint curing comes in as a universal solution to address the obstacles commonly associated with coatings, adhesives and finishes. The adoption of the practice has increased prolifically in the past decades, since its inception in the 1960s.

Benefits for using UV light for paint curing and coating includes the following:

- Increased durability and product quality
- Minimal waiting period for setting, products can be handled almost immediately
- Less scrap and wastage
- Little to no volatile organic compounds (VOCs)
- Cost-effective compared to conventional curing methods
- Increased service and production line speeds
- Less floor space needed, in comparison with traditional drying ovens

According to Heraeus Noblelight America, UV curing accounts for roughly four percent of the industrial coatings market. Furthermore, the multi-billion dollar industry is growing at a consistent rate of 10 percent per year. Businesses are turning away from traditional water and solvent-based thermal drying processes, and replacing them with UV paint curing methods due to its efficient and eco-friendly advantages.

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3.0 UV Light and Paint Curing

3.1 What is UV Paint Curing?

UV paint curing is a fast and efficient curing method that uses high intensity, electrically-generated ultraviolet light to initiate a photochemical reaction. The process is designed to instantly cure inks, adhesives, paint and coatings. To facilitate the reaction, the following base coatings are applied directly on the sample:

- Liquid monomers (acrylates as dilution agents)
- Liquid oligomers (polyester resins)
- Photoinitiators

(Pigments and additives can also be added, depending on the needs of the process)

The elements used contain molecular accelerators that react rapidly when exposed to UV energy. They are also clear in nature, to streamline the process and allow UV rays to penetrate the resin fully. It is important to consider that the catalysts, in their natural state, are inactive. It is only when the coating is hit with UV waves (roughly 300-450nm in wavelength) that the reaction takes place. During this stage, the UV light triggers the curing of the paint resins. The actual curing happens in a 2-step process. First, the photoinitiators act as a sponge and absorb the UV energy. This also initiates the formation of free radicals that react sporadically with the resin. Next, the crosslinking reaction causes the materials to harden instantly, allowing professionals to handle the sample immediately after curing.

The entire curing process typically takes 30-120 seconds, taking all steps into account, from the application of the coatings to the UV light exposure. The process is only successful when the UV light activates all of the molecules from the coatings. Because of this, the UV lamp is administered within close proximity to the object. To boost exposure and accuracy, UV light machines are covered to trap the light waves. Handheld UV devices, commonly used in the automobile industry during paint jobs, come with an external flap that cups a small area. While larger machines, usually found in manufacturing plants, feed the object through it, where the UV light is applied in a controlled environment. To minimize contact with the coatings and exposure to the UV light, professionals use gloves and protective eyewear (glasses or masks).

Unlike solvent-based processes that rely on heat to initiate the reaction, and air to dry and evaporate the solution, UV curing is considered to be less harmful to the environment. Moreover, the latter does not shrink the coating in terms of volume and thickness, compared to

solvent-based products that promote recoiling of the application by more than 50 percent. As a result, companies that apply the process to their service or manufacturing operations often experience higher productivity and lower pollutant emissions.

3.2 UV Paint Curing Best Practices

For optimal results, the object or surface must be exposed to the right wavelength light, coupled with the right level of intensity and rate of exposure. For top surface curing, ultraviolet light in the C spectrum (UVC) with a range of 200-280nm is used. Ultraviolet light in the B spectrum (UVB) with a range of 280-315nm is applied to jobs that require moderate curing penetration. Ultraviolet light in the A spectrum (UVA) with a range of 315-380nm is designed for curing deep layers, such as pigmented lacquers and thick varnish.

The most common types of UV light sources for paint curing are mercury-based lamps and light-emitting diodes (LEDs). Arc or electrode lamps that use mercury have been around far longer than UV LEDs, and are the industry standard due to their simple and powerful properties. The source uses high voltage to vaporize mercury atoms. As the atoms shift from a high energy state to a ground state, they emit a sudden burst of UV light. Inside the lamp, the mercury is located at both ends of the sealed quartz tube, which vary in length (from a few inches to a few feet), depending on the needs of the business.

Over time, the lamps have a tendency to lose its efficiency, as it darkens near the terminals. The natural degradation is caused by the persistent evaporation of the electrodes, which results in a decrease of UV output. Electrode lamps cannot be rapidly toggled on and off. Some units take as long as 20 minutes to start up. As a solution, businesses deploy a shutter feature that allows the lamps to stay on in a “stop and go” manufacturing line.

UV LEDs rely on a completely different technology to push out UV light. Such sources use semiconductor chips instead of mercury. During the paint curing process, UV LEDs do not generate large amounts of heat, making them ideal for materials that are sensitive to heat, such as electronics, plastic and wood. They can also be toggled on and off instantly without a shutter mechanism. Without the presence of electrodes, the light produces consistent UV output with longer lifespans (20,000+ hours), compared to mercury lamps (2,000+ hours). Initially, costs for UV LED machines are high in industrial settings. As the size of the curing area increases, the need for more semiconductor chips also increases. However, the manageable aspects of the lamps (low energy consumption, minimal downtime and recyclability) outweigh the costs in the long term.

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4.0 Industrial Uses and Applications

4.1 UV Paint Curing and Automobiles

In the automobile industry, UV curing lights are designed to support original equipment manufacturer (OEM) and body shop operations. The paint curing method presents several time-saving advantages for both the specialist and the customer. For specialists, the complete curing process of two minutes (in most cases, less) and the instant handling of the surface reduces bottlenecks on the line. Unlike traditional solvent-based methods, specialists do not need to work on another project while waiting for the car part to cure.

The two types of UV machines commonly found in the industry are large lamps mounted on carts and small, handheld lights. Both vary in uses, depending on the needs of the job. Large UV paint lights, roughly 4-8 feet in height, are used to speed up the curing process for wide surface areas, such as hoods and doors. Such pieces are composed of several lights (between 4-12) that emit UVA bands. For portability and safety, the machines are DC battery operated, with the power source located at the base of the cart. The lights are supported by adjustable arms, which allows the specialist to position the lights within close proximity to the surface during the process.

Small jobs, including patch work and repair, do not rely on mounted UV lamps for paint curing. Instead, handheld equipment is used to administer intense UV flash at set intervals after the application of each coating or film. During the process, the machine deploys an electrical discharge that generates the UV flash. To increase accuracy, the lights are cupped with external flaps that reduce leakage. The flaps also help maintain a feasible distance between the light and surface. For three-dimensional objects, special reflectors are used to distribute the UV light evenly.

4.2 UV Paint Curing for Flooring and Wood

In housing and flooring sectors, UV light is used to cure concrete, vinyl and tile floors. UV curing floors increases the durability of the surface by up to 4-10 times, boosts stain resistance and helps preserve the quality of the shine. There are several curing methods available, depending on the needs of the job. For multiple coatings (primer, secondary and topcoat), UV light is administered after each layer. Because UV-cured coatings emit close to zero VOCs, there is no toxic odor after the finish. Individuals can immediately reoccupy the site after completion of the job.

There are two types of UV floor curing machines: a wheel-propelled UV curing cart, and a handheld UV curing machine. The first type contains a pad of UV lights (12-36 inches wide) with a range of 300-10,000 watts. The operator slowly pushes the cart evenly across the floor, at the

pace of roughly 30 linear feet per minute. To achieve a consistent pace, a panel located on top of the cart displays the speed of the process. It is important to note that only one UV light curing session is required after a coat. Additional UV curing sessions (after the application of a coat) will not make the floor harder.

The bulkiness and size of a UV cart does not allow it to cover tight spaces, irregular surfaces and corners. For such cases, a handheld UV curing machine with 250-1,800 watts of power and a curing width of 6-12 inches is used. To initiate the curing process, operators hold the unit directly over the surface. An LED indicator located behind the light advises the operator on the distance between the light and the surface.

4.3 UV Paint Curing for Digital Printing

Businesses are turning to UV curing to streamline the printing of logos, pictures and lettering. Card manufacturing companies rely on the curing method for personalization and branding. The process can be applied on a wide range of products, ranging from plastic bottles and calendars to cards and metals. UV paint curing in such establishments take the form of a machine that administers the light at speeds up to one tenth of a second. Products are fed through the machine (sometimes 4-8 pieces at a time, depending on the size and capabilities of the unit), and UV energy is generated in a closed environment. Due to the fast pace of the curing process, the machines are ideal solutions for scaling operations and meeting mass production goals. Compared to solvent inks, UV ink jet results in better quality for high resolution printing. The solution is also more cost effective, from a cost-per-piece standard.

4.4 UV Paint Curing and Medical Manufacturing

Medical manufacturing companies are using UV paint curing to support the production of the following equipment:

- Test stripes
- Uniform badges
- Hearing aids
- Dialysis machines
- Medication patches
- Syringes
- Hydrogel

This method replaces the use of traditional thermal oven drying processes. Similar to digital printing, the sector relies on UV ink jet technology to mark equipment. An example of this usage includes measurement markings and serial numbers.

The flexibility of the curing method allows groups to apply the process on paper, glass, plastics and metals. UV machines for medical adhesives typically cure with long wavelength light (350-430nm) for a thorough and efficient cure. While decorative inks rely on shorter wavelengths, ranging between 250-300nm. In the medical sector, UV formulations tend to be more costly (per volume) compared to traditional, manual formulations. However, the reduction of labor costs, VOCs and waste often offsets these figures in the long term. This holds especially true for mass production manufacturing.

4.5 UV Paint Curing and Metals

UV curing can be applied to the production of metal-based products, such as mechanical tubing, galvanized steel pipes and sprinkler systems. The process is used to administer a coating and/or pigment to increase the anti-rusting qualities and corrosion resistance of surfaces. UV machines used for this type of manufacturing contain more lamps inside the curing chamber, due to the circular shape of the products. In most cases, the number of lamps needed is related to the diameter and/or shape of the pieces, as well as the speed of the production line. UV light can also be used to apply paint and decorations on metal substrates (steel and aluminum).

5.0 Larson Electronics UV Lighting Solutions

Larson Electronics (LE) offers robust lighting solutions for UV paint curing. The company's UV curing products are ideal for commercial, industrial security applications and military environments. Businesses that work with paint spray booths, adhesives, coating, UV printing, non-destructive testing, inspection and food processing may find the company's solutions beneficial.

Below is a short list of UV curing products that LE carries:

- Battery operated UV paint curing LED light cart dolly (395nm and 365nm options)
- Explosion proof LED UV light (67 watts, 400nm-315nm)
- Explosion proof fluorescent UV light (UVA, UVB and UVC wavelength options)
- Explosion proof LED UV light (33.5 watts, 208-100nm)
- Explosion proof UV LED light with base stand mount (100 watts, 365nm)
- Explosion proof UV LED light fixture (100 watts, 380-350nm)
- Industrial UVB LED light fixture (100 watts, 315-280 nm)

6.0 Conclusion

UV paint curing technology is a viable process for today's demanding industrial settings. The need to drive productivity, while maintaining green practices is currently fueling the adoption of the cutting-edge curing method. Furthermore, businesses that are seeking out cost effective solutions to large-scale manufacturing, printing and traditional solvent-based processes, are becoming increasingly drawn to the application of UV curing systems.

Helping advance the development of UV paint curing equipment is LED technology. UV LED lights presents numerous advantages over mercury-based lamps, including low energy consumption, instant toggling and long lifespans. This trend will likely continue, as more businesses apply the low-risk curing method to heat-sensitive materials, such as electronics and thin plastics.

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Larson Electronics' explosion proof lighting is your heavy duty, high output lighting solution for hazardous locations. Our customizable lights come in mobile, fixed and tower configurations and can illuminate enclosed areas such as tanks and containers. We also provide lighting systems for wide open classified work sites, including anywhere hazardous chemicals and vapors are present.

Larson Electronics also offers cart and skid based power distribution systems that enables crews the ability to set up and break down 3-phase power distribution panels to each area with great flexibility which makes quick turn-arounds possible.

We can also custom build our hazardous location lights and power distribution systems to meet each customer's needs. With expedited shipping, we help you cut back on delays for maintenance, so down time is at a minimum.

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