THE FUTURE FOR CURING

In part one of their article, Laura Maybaum and Bea Purcell examine the potential for using LED technology with screen-printing inks

Advances in the last year in LED lamp technology and UV screen-printing ink formulations have proven LED curing as a viable alternative to medium-pressure mercury lamps. In this first part of a two-part series, we outline the differences between mercury lamps and LED lamps and the benefits to LED curing. The second part of this series provides a guideline as to the expected return on investment with implementing the conversion to LED lamps.

CURING UV INKS

Photoinitiators used in UV inks typically react to specific wavelengths within the 200 to 400 nanometer range. UV light triggers photoinitiators creating 'free radicals'. The free radicals connect with the molecules of the resins and monomers and they, in turn, cross-link with each other, forming chains of molecules we recognize as the 'cured' ink film. Although photoinitiators are most reactive at specific wavelengths, the overall curing reaction or polymerisation is achieved by the broad absorption range.

The most commonly used UV curing lamps are medium-pressure mercury, which supply intense UV output at the specific wavelength to activate the photoinitiators and provide a good broad spectrum of output. LED UV lamps, on the other hand, output at a narrow spectral output, mostly commonly at 365 or 395 nanometers with a +/- 20nm at the peak wavelength. While the photoinitiators in screen inks can be adjusted to react at these wavelengths, the curing lacks the reaction to the broad range of UV output. The challenge is a LED lamp head with an extremely high level of output at a single nanometer and screen ink fine-tuned to react to the specific wavelength. The diagram illustrates the relative intensity of a mercury lamp verses a 395 nanometer LED lamp through the UV spectrum.

Other than that, chemical reaction of curing the ink with mercury lamps versus LED lamps is the same. Keep in mind, this type of chemical reaction can be improved by introducing heat into the system. Mercury lamps have all sorts of heat associated with use (which will be covered later), while LED lamps exhibit little to no heat.

INTENSITY AND DOSE

For UV inks to cure properly, they must not only be exposed to the correct wavelengths, but a sufficient amount of energy needs to be directed to the surface of the printed substrate. The amount of energy is called the dose and is measured in millijoules (mJ/sq cm). The dose of energy a print receives is affected by the conveyor/belt speed as well as the number of times that it is exposed to the UV lamps.

The intensity of energy emitted by curing lamps is known as irradiance and is measured in watts (or milliwatts/sq cm). Irradiance is directly related to electrical power, lamp condition, and the geometry of the reflector that directs and focuses the lamp output. Irradiance does not vary with exposure time.

The depth of cure achieved in the ink film is directly influenced by the irradiance level of the lamp. Delivering higher, more intense energy at the surface of the ink will allow energy to penetrate the thickness of the ink film more thoroughly. Both mercury and LED lamps need to have sufficient dose and intensity in UV output to fully cure the ink.

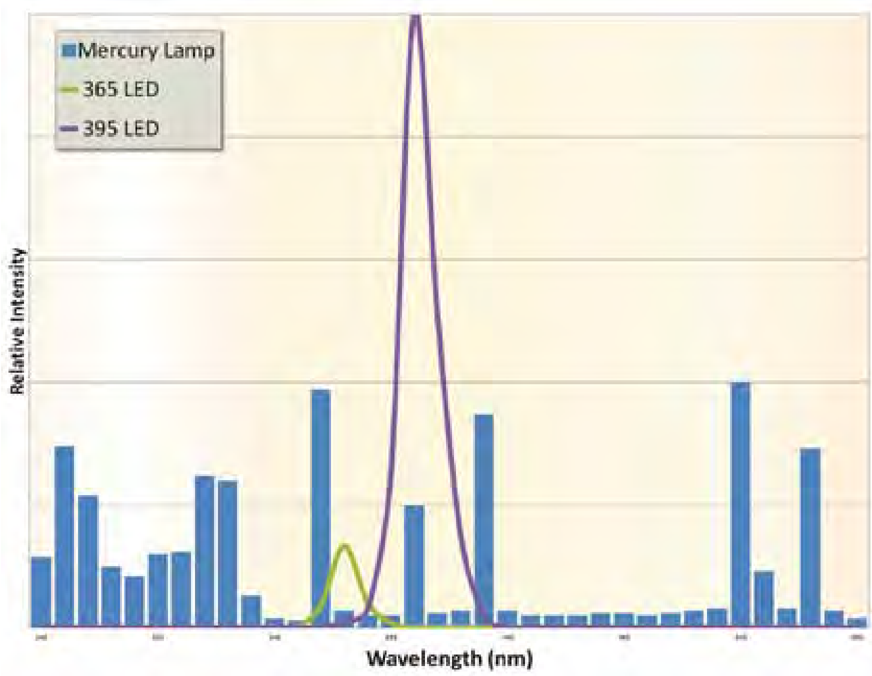
Recent improvements in LED technology have made available LED UV curing lamps which output UV energy at the 395 nanometer wavelength. In addition, both 4-watt and 8-watt power/intensity are options, with the 8-watt version allowing the printer more flexibility for better ink curing, lamp to substrate variability, and faster production speeds.

Mercury lamps typically output at 200, 300, up to 400 watts. In comparison, LED lamps use up and generate a lot more energy to cause the photoinitiators to react quickly.

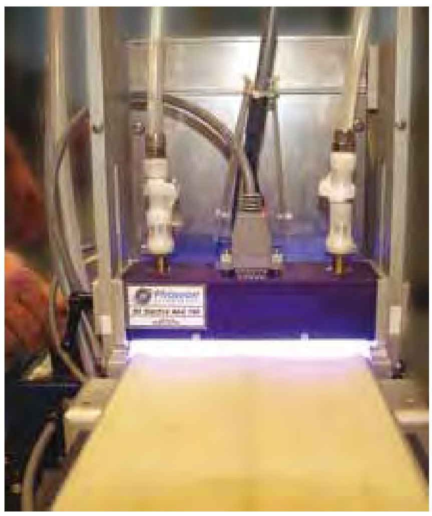
SCREEN INKS AVAILABLE

Until recently, the available UV screen inks have not been able to be used with LED curing. They did not have the processing latitude to overcome the restrictions of using LED lamps: lower wattage and single nanometer output. Nazdar has adopted new ink technologies to formulate viable inks that cure exceptionally well with 4 watt and 8 watt

Continued over

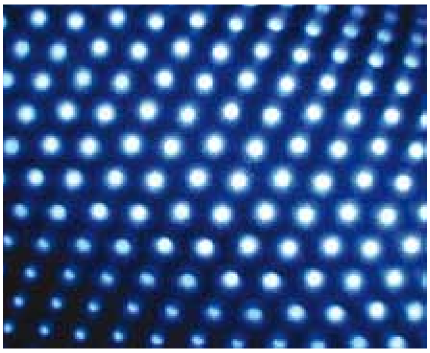


The relative intensity for mercury, 365 LED, and 395 LED curing



An LED curing unit


A medium pressure mercury curing unit


An LED light head array

LED 395 nanometer lamps at belt speeds of 30 to 120 ft/min. This curing speed range is directly related to the ink's colour, the ink deposit, and the substrate colour.

With a heavier ink deposit, more intense energy is needed to penetrate the thickness of the ink film. Previous attempts at formulating UV screen inks for LED curing could not overcome the variances in ink colour and deposit. Nazdar LED inks available today for both the membrane overlay and graphics markets have been market tested and cure extremely well.

BENEFITS OF LED

Despite the potential issues with utilising LED lamps, the market is starting to see practical lamps and inks coming into the market. The benefits to converting to LED curing are many, including reducing operating cost, reducing emissions, reducing the use of mercury containing bulbs, and increased safety. The most significant savings is the reduction of energy usage.

Most of the energy consumed by the printing press is to feed the mercury bulbs and cooling systems. High temperatures created by the IR energy that mercury lamps emit are an unfortunate by-product of this type of curing process. Preventing the heat from building up and damaging the lamp housing and sensitive substrates is a critical concern in UV curing. Systems for heat management in modern curing units pull from water cooling systems and fans to dichroic mirrors (which reflect UV but absorb IR energy) and automatic shutter systems.

LED lamps pull significantly less energy and in most cases can be plugged into standard wall outlets. In addition, the system is instant on/off; there is no need to keep the lamps running when not in use. There is little to no heat in the use of LED lamps, so the only cooling system required is an air fan or water cooling system readily available on the market. The total energy consumed by LED lamps is a fraction of the costs for mercury lamps.

Mercury lamps also emit ozone that needs to be removed from the printing area. Ozone is generated when an electric discharge passes through air or when oxygen is exposed to high-intensity UV energy; it can lead to respiratory problems for those who work near the curing units, so it is important to make sure that curing units are well vented to evacuate ozone from the work area. Ventilation pulls air from the printing area and expels it out of the building. The cost of displacing large amounts of air contributes to higher energy consumption and higher overhead costs.

LED does not emit ozone, so ventilation is not a requirement. In addition, venting ozone typically entails environmental emissions' tracking and control. Eliminating these emissions could reclassify a printer environmentally, further reducing cost.

Further environmental savings can be realised with LED lamps in two respects. First, mercury bulbs are no longer needed. Mercury is considered hazardous in most areas. Use and disposal of these bulbs containing mercury carries additional regulatory costs that will continue to be more and more significant. Most UV curing units use two bulbs per print station with a usable life of 2,000 hours. For average working conditions, bulbs would need to be replaced every eight to 12 months. LED lamps have a life in excess of ten years running continuously. With instant on/off and eight to 12 hours of use per day, the expected life of an LED lamp is well over ten years.

Because of the heat associated with mercury lamps, the reflectors in the lamp housing are susceptible to heat damage or fire damage and typically need to be replaced every two years for effective curing. LED lamps do not need reflectors replaced; at most, the protective glass cover to the bulb would need to be replaced at minimal cost. LED lamps provide a significant savings in both bulb and reflector maintenance with no to minimal cost for ten plus years.

Additional benefits to converting to LED lamps include:

- Safer worker conditions
- Consistent UV output over the life of the lamp
- Less substrate distortion and elimination of potential fires related to heat
- Less space required due to the elimination of ventilation and reduction in electrical supply


A cooling system with an LED curing unit

The two significant obstacles remaining in converting to LED are that press manufacturers and lamp manufacturers do not have readily available product; rather, partnering has just begun in earnest. Second, the current cost structure to implement in new machines or retrofit into existing machines has a significant up-front cost.

In Part Two of this series, the ROI (return on investment) for implementing LED Curing will be outlined. ■

Laura Maybaum is Nazdar's Graphics Market Segment Manager and Bea Purcell is Nazdar's Market Segment Manager for the membrane-switch overlay, in-mold decorating, industrial and container markets

Further information:
Nazdar Inc, Shawnee, KS, USA
tel: +1 913 422 1888
email: lmaybaum@nazdar.com, bpurcell@nazdar.com
web: www.nazdar.com