

UV CURING LAMPS & REFLECTORS

First, let's address the Ultraviolet (UV) curing process for readers who are not as familiar with the process as they might be.

UV curing defines the application of light or more specifically, short wavelength electromagnetic energy (predominately in the 250 nanometer-400 nm band) to **turn a reactive fluid material into a solid**. The chemical process is also described as **cross-linking**.

100% solid (virtually zero VOC), UV curing inks, coatings, varnishes and adhesives are formulated with selective materials that react to UV energy. Curing or cross-linking is fast and occurs rather instantly, resulting in high productivity, and high performance end products.

Useful UV energy is supplied by UV lamp systems. These consist of three major components, lamps/irradiator (dryer), control module and power supply. In this TechTalk, as the title indicates, two key components of UV curing equipment will be discussed.

UV lamps

The most effective source of UV energy for graphic arts applications is the medium-pressure mercury arc lamp. Lamp power is variable in watts/inch or cm of lamp length. Less than 30% of the light produced is within the useful UV light spectrum. The remainder is divided among visible light and infrared (I-R). For many applications the high heat producing I-R emission is an issue to be managed.

A mercury vapor lamp consists of a transparent quartz tube about 1 inch in diameter or smaller. The tube is filled with a precise quantity of mercury (Hg) and an inert starter gas, argon (Ar) or xenon (Xe). At rest, before the lamp is powered up almost all of the mercury is in its familiar normal liquid state (quicksilver). Medium pressure mercury arc lamps are energized by end of the tube electrodes, or by microwave energy. Once energized, the electrodes at each lamp end generate an arc across the starter gas. The arc conducts the applied electricity, increasing the lamp temperature, causing the mercury to vaporize. This vaporization takes anywhere from two to fifteen minutes, a period known as warm-up or stabilization period. During this time lamp UV output is not at the rated output. When cold starting a lamp, the lamp not the power supply determines the amount of energy it takes to bring the lamp to production ready stabil-

ization. Characteristically, after 5-15 minutes, depending on the lamp, voltage will lessen and level off signifying that all of the contained mercury has vaporized. This stabilization is a baseline for an individual lamp's actual operating performance. Most lamp suppliers suggest that a lamp's effective output span is reached at 70% of the original performance. The baseline is important to measuring when a lamp should be replaced. Measuring equipment exists, that allows a reading to be made of a lamp's energy draw, indicating lamp performance. Monitoring the decrease in voltage used, allows lamp performance to be charted to predict the end of useful lamp life. The output of a mercury vapor lamp deteriorates with the length of time used. For example a 200-watt/inch of length lamp, after 1000 hours of use, sees a 15% decrease in useful UV energy emission. Lower use power settings effectively slow this emission decline. Some replace a lamp after 1000-hrs use to guarantee useful performance.

Care and proper **maintenance** of UV lamps is critical to their effectiveness as emitters of useful UV curing light. Lamps must never be touched because fingerprints will be etched onto the lamps quartz tube when the lamp is powered up and the quartz reaches 600+ degrees C. Similarly dust, lint, or residue from ill advised cleaning solutions could be etched onto hot quartz. Etching (devitrification) causes the transparent quartz tube to become opaque. This opacity absorbs co-emitted I-R energy causing the lamp to run hotter, plus the opacity blocks the emission of desirable UV energy. Whenever this happens curing efficiency is compromised. Maintain the cooling and air exhaust system as lamps can be run too hot or too cool. Overheating causes lamp sag. Overcooling causes UV output loss as vaporized mercury condenses. Proper maintenance can increase a lamp's effective useful life span. Lamps must be wiped with an alcohol (IPA) soaked lint-free, non-abrasive cloth before use. Once installed, routine cleaning is recommended. Handle lamps only using disposable cotton gloves. Clean lamps before first use and routinely during use, following lamp supplier recommendations. Rotate lamps 90 degrees after each cleaning to prevent lamp sag, extending useful life.

Reflectors

Because UV light is similar to visible light, traveling in a straight line, it must be focused to optimize energy where curing is to occur. Reflectors of various designs are therefore an integral part of irradiator design. Considering that UV lamps operate at 600+ degree C temperatures, lamp housings must be cooled.

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Lamp reflectors are typically made available in designs featuring focused elliptical or wide field parabolic shapes to direct UV energy effectively to the desired curing zone. A variety of polished aluminum alloys are used for reflectors. They typically offer in the area of 85+% reflectivity when new and clean. Some reflectors called diachronic filters feature vacuum coated surface materials. Diachronic filters help minimize I-R heat build-up near a substrate on which UV cured materials are being irradiated to effect cure. At the same time they optimize the emission of UV energy.

Because UV curing is dependent on optimizing the UV curing energy output of a systems lamps, it is essential that all of the energy be focused where needed - in the curing zone. Any deterioration in lamp UV output or focused energy concentration diminishes a systems designed curing potential.

It is critical to effective UV curing that reflector efficiency is maintained. Any impairment will compromise curing in that the lamp generated UV energy will not be concentrated in the curing zone where you want it.

Reflector maintenance is a must. They must be clean and free of fingerprints, dust and lint before installation. During use they must be examined on a planned schedule to assure cleanliness and high UV reflectivity. Inspection by eye will not easily reveal a reflector s condition, as reflectivity is not easy to quantify by eye. Periodic replacement of reflectors should be part of every maintenance schedule.

During UV equipment use, reflectors routinely become dirty from air born dust or deposits from various ink and coating materials being cured. When reflectors are dirty or frosted over, lower wave lengths of UV energy become distorted leading to less energy being available for the surface curing of UV materials.

When cleaning a mounted reflector the UV lamp should be first allowed to cool, stabilize to room temperature and then be removed from the housing. Remember it is critical that a UV lamp never be touched with bare hands.

Recommended reflector cleaners are Simple Green and Windex without ammonia. Don t use abrasive cleaners or polishes. Alcohol including IPA (isopropyl) are not recommended. Be careful not to select other commercial reflector cleaners that contain ozone depleting 1, 1, 1, trichloroethene. Spray type cleaners should never be sprayed directly onto

the reflectors surface. Spray them onto a clean cotton cloth and use it. When in doubt refer to your reflector/UV equipment supplier.

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