THE FUTURE FOR CURING

In their second of two features, Laura Maybaum and Bea Purcell investigate the payback period for LED curing screen-printing inks

In the first part of this article we compared LED curing to medium-pressure mercury vapour curing of UV screen-printing inks. The advantages to LED curing include lower heat emission, reduced energy consumption, elimination of the use and disposal of mercury bulbs, and elimination of ozone emissions. All of these benefits are attractive, both economically and environmentally.

Recent technology advancements have been implemented in initial field testing that prove LED curing to be suitable to meet current production levels for nameplate and point-of-sale graphic applications. This success is just starting to push press manufacturers to incorporate LED curing as part of their presses, and accurate return on investment (ROI) formulas, or payback periods, have only just begun to be fine-tuned and balanced against costs to retrofit presses or build into new presses.

There are three areas of concern that remain. First, a total package is not readily available to source; lamp manufacturers and press manufacturers are just starting to team up. Second, LED curing lamps are relatively expensive, so the upfront cost to implement them is a major hurdle. And third, printers are not as readily inclined to invest in screen-printing equipment due to the changes in the economy and more persuasive needs to invest in digital printing equipment. Despite these obstacles, screen-printers have begun to evaluate the benefits and payback period of adopting LED curing in screen-printing.

To justify the move into LED curing, a general method for calculating the ROI in purchasing an LED curing system is needed. This article outlines some of the aspects to consider in calculating the ROI and provide examples for different scenarios. The values included are estimations based on general usage conversations; however, this information is considered reasonable and a good source for initial review of implementing LED curing. Please note that only a ten year scenario has been considered; it is very likely that LED curing lamps last well past ten years of use.

CASE 1: 6-STATION IN-LINE PRESS WITH 2-LAMPS PER STATION USING 1.22M (48 INCH) BULBS

Diagram 1 shows the electrical supply for a 6-station in-line press using mercury vapour lamps

The electrical usage for an in-line press includes the requirement for the press beds and the UV lamps and is set-up as a standalone electrical source. Because it is separate from the building electrical, it should be relatively easy for a printer to isolate the electrical pull from this standalone station. For this case study, it is estimated that 80% of the energy goes to the UV light stations to power and cool the bulbs. The remaining 20% of the energy is used to run the press beds.

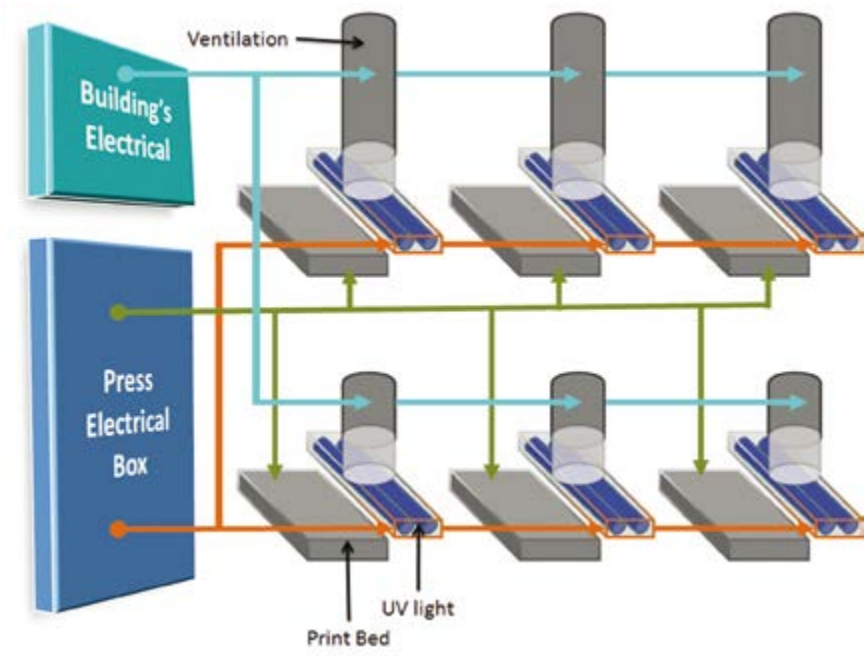

Diagram 1: the electrical supply for a 6-station in-line press using mercury vapour lamps

The following example shows the monthly bill to be $15,000 with 80% allocated for the UV lamps and 20% for the press beds.

PRESS'S ELECTRICAL: TOTAL MONTHLY BILL	$15,000
Estimated % for UV output stations	80%
Estimated % for press beds	20%

Each of the UV lamp stations requires ventilation. The electrical for the total building (minus the electrical for the press) is $5,000 monthly with an estimated 5% used for running the ventilation for six print stations. In addition, these ventilation stations displace a significant amount of air in the building, which affects the press electrical consumption. Air displacement costs in relation to the building's consumption are 15% in the winter and 25% in the summer. For this case study, winter is six months and summer is six months.

BUILDING'S ELECTRICAL: TOTAL MONTHLY BILL (MINUS PRESS)	$5,000
Estimated % for ventilation	5%
Estimated % for air displacement: winter (6 months)	15.0%
Estimated % for air displacement: summer (6 months)	25.0%

Typically, mercury vapour lamps have 2,000 hours of useable life. For an eight-hour shift running five days a week, the annual working hours are 2,080. For this case study, it is assumed the bulbs are changed out annually. For a six-station press with two lamps at each station, 12 bulbs would need to be replaced. This assumes the bulbs are changed within their normal 2000-hour life and are not prematurely changed due to damage or mis-use. The additional cost for the properly disposed mercury vapour lamps has been included; a fee is estimated for each.

BULB MAINTENANCE	
Number of bulbs per year	12
Cost per bulb + transportation	$550
Disposal fee per bulb + transportation	$100

Although the reflectors are not replaced as often as the bulbs, their cost can be significant and should be considered as part of the cost. We assume that the reflectors are replaced every two years due to damage and use.

REFLECTOR MAINTENANCE	
Number of reflectors	12
Reflector replacement	$1,500
Average number of years for reflector replacement	2.00

The total annual cost is $223,800 as outlined over:

Continued over

6-HEAD IN-LINE PRESS: CURRENT		MONTHLY COST	ANNUAL COST
Press electrical: total monthly bill	**$15,000**		
Estimated % for UV output stations	80%	$12,000	$144,000
Estimated % for press beds	20%	$3,000	$36,000
Building electrical: total monthly bill (minus press)	**$5,000**		
Estimated % for ventilation	5%	$250	$3,000
Estimated % for air displacement: winter (6 months)	15.0%	$750	$9,000
Estimated % for air displacement: summer (6 months)	25.0%	$1,250	$15,000
Bulb maintenance			
Number of bulbs per year	12		
Cost per bulb + transportation	$550		$6,600
Disposal fee per bulb + transportation	$100		$1,200
Reflector maintenance			
Number of reflectors	12		
Reflector replacement	$1,500		
Average number of years for reflector replacement	2.00		$9,000
TOTAL ANNUAL COST			**$223,800**

Replacing two mercury vapour lamps with one LED lamp is estimated to cost $7,000 for every 10cm (4 inches). The lamps can be chained together, so width is not an issue. The following outlines the estimated costs of $504,000 to retro-fit six 1.22m (48 inch) LED lamps. With additional costs for a water cooling system and installation, costs would be approximately $535,000.

COST PER UV CURING STATION			
Cost per 10cm/4" of LED lamp	$7,000		
Length of each bulb	1.22m/48"		
Total cost per head		$84,000	
Number of print heads		6	
Total for conversion of all print heads			$504,000
Water cooling system			$6,000
Installation costs			$25,000
TOTAL INITIAL COST			**$535,000**

An initial cost of $535,000 is significant for any company to invest in screen-printing. However, consider the diagram above paired with the savings outlined below.

Diagram 2 shows the electrical supply for a 6-station in-line press using LED lamps. The requirements from the dedicated electrical source would be reduced to only the press. The LED curing stations would run off the building electrical, and ventilation electrical would be eliminated. The additional electrical source would be for a water cooling system that could be run off the building electrical source.

SAVINGS IN CONVERTING TO LED CURING:

- The energy consumed by the LED lamps would be run off of the building supply rather than the press supply due to significant power reduction.
- Some side considerations, not factoring in the payback calculations:
  - The electrical consumption may drop enough to re-classify the business industrial consumption to a lower price bracket.
- Ventilation of the lamps would no longer be needed, along with the energy required for the air displacement of the building going through the press ventilation.
  - Stacks coming out of the top of the building would no longer be needed, positioning a printer potentially to be re-classified with respect to air-emitting regulations.
  - With the press no longer tied to ventilation and reduced electrical pull, the press location would be less limited. More effective use of space within a building would be possible.
- LED bulbs are currently rated for at least ten years before potential replacement. Bulbs are still in testing and it is very possible the life span is longer. For this case study, ten years has been used.
  - LED bulbs are instant on/off. The bulb life can easily exceed ten years if turned off when not in use. There is no start up or ramping up time for LED bulbs.
  - LED bulbs have consistent output over the life. Mercury vapour bulbs degrade slowly, so printers are constantly increasing UV output as the mercury vapour lamps age. Curing results would be more stable.
  - The cost and environmental concerns of disposal of mercury vapour lamps are not an issue with LED lamps.
- LED lamps have a fully contained reflector and lamp. There is no expected need to replace reflectors and, with low heat output, fires in the system are eliminated. There is a glass shield to protect the lamp from wet prints or misuse. These glass shields can be cleaned easily and replaced if damaged at a relatively low cost. It is estimated that the glass be replaced every three years.

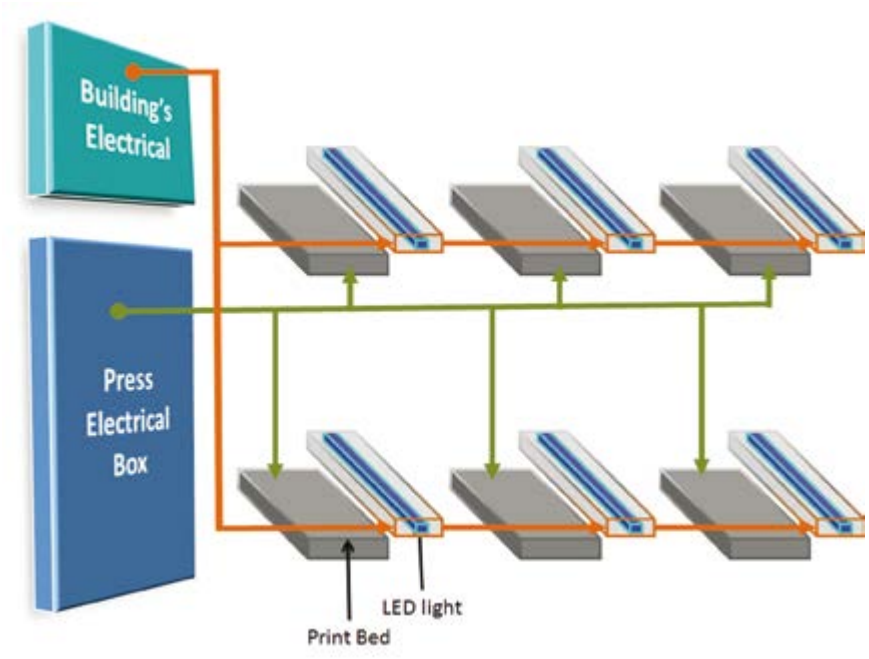

Diagram 2: the electrical supply for a 6-station in-line press using LED lamps

The total annual savings in moving to LED lamps is estimated at $184,700, as outlined below. Note that there is still energy consumption for running LED lamps; it has been assumed in this example that LED lamps would be about 5% of the total energy for the building. This may be an overestimation, but no real-world values are available.

6-HEAD IN-LINE PRESS: LED ALTERNATIVE		MONTHLY COST	ANNUAL COST
Press electrical: total monthly bill	**$15,000**		
Estimated % for UV output stations	0%	$0	$0
Estimated % for press beds	20%	$3,000	$36,000
Building electrical: total monthly bill (minus press)	**$5,000**		
Electrical for LED lamps	5%	$250	$3,000
Estimated % for ventilation	0%	$0	$0
Estimated % for air displacement: winter (6 months)	0%	$0	$0
Estimated % for air displacement: summer (6 months)	0%	$0	$0
Bulb maintenance			
Number of bulbs per year	0		
Cost per bulb + transportation	$0		$0
Disposal fee per bulb + transportation	$0		$0
LED glass maintenance			
Number of LED lamps	6		
Glass replacement	$50		
Average number of years for glass replacement	3.00		$100
TOTAL ANNUAL COST			**$39,100**
MERCURY VAPOUR LAMP ANNUAL COST			**$223,800**
LED LAMP ANNUAL SAVINGS			**$184,700**

The cost to retro-fit to LED lamps would be $535,000 with an annual savings of $184,700 providing a payback period of three years.

TOTAL ANNUAL SAVINGS	**$184,700**
TOTAL INITIAL COST	**$535,000**
PAYBACK PERIOD	**3 YEARS**
EST. SAVINGS OVER TEN YEARS ($184,700 X 10 YEARS)	**$1,312,000**

For most screen-printers, the up-front cost of $535,000 is out of reach, and implementing LED curing on an inline press without significant proof of savings is more than most can bite off. It is much more feasible for printers to adopt LED curing with their one-colour curing stations. Case Two outlines the payback period for a single head station.

CASE TWO: 1.22M (48 INCH) SINGLE UV LAMP STATION

Many printers have a single UV lamp (two bulbs) station that cures for one or more single colour presses. The same payback calculations were run and are outlined:

SINGLE COLOUR PRESS WITH INDEPENDENT LAMP: CURRENT		**MONTHLY COST**	**ANNUAL COST**
Press electrical: total monthly bill			
Estimated % for UV output stations		$2,500	$30,000
Building electrical: total monthly bill (minus press)			**$5,000**
Estimated % for ventilation	2.5%	$125	$1,500
Estimated % for air displacement: winter (6 months)	8.0%	$400	$4,800
Estimated % for air displacement: summer (6 months)	10.0%	$500	$6,000
Bulb maintenance			
Number of bulbs per year	2		
Cost per bulb + transportation	$550		$1,100
Disposal fee per bulb + transportation	$100		$200
Reflector maintenance			
Number of reflectors	2		
Reflector replacement	$1,500		
Average number of years for reflector replacement	2.00		$1,500
TOTAL ANNUAL COST: MERCURY VAPOUR			**$45,100**

SINGLE COLOUR PRESS WITH INDEPENDENT LAMP: LED ALTERNATIVE		**MONTHLY COST**	**ANNUAL COST**
Press electrical: total monthly bill			
Estimated % for UV output stations		$0	$0
Building electrical: total monthly bill (minus press)	**$5,000**		
Electrical for LED lamps	2%	$100	$1,200
Estimated % for ventilation	0%	$0	$0
Estimated % for air displacement: winter (6 months)	0%	$0	$0
Estimated % for air displacement: summer (6 months)	0%	$0	$0
Bulb maintenance			
Number of bulbs per year	0		
Cost per bulb + transportation	$0		$0
Disposal fee per bulb + transportation	$0		$0
LED glass maintenance			
Number of LED lamps	1		
Glass replacement	$50		
Average number of years for glass replacement	3.00		$17
TOTAL ANNUAL COST: LED ALTERNATIVE			**$1,217**
MERCURY VAPOUR LAMP ANNUAL COST			**$45,100**
LED LAMP ANNUAL SAVINGS			**$43,883**

COST PER UV CURING STATION	
Cost per 10cm (4") of LED lamp	$7,000
Length of each bulb	1.22m (48")
Total Cost per head	$84,000
Number of print heads	1
Total for conversion of all print heads	$84,000
Water cooling System	$2,000
Installation Costs	$6,000
TOTAL INITIAL COST	**$92,000**

The cost to retro-fit to LED lamps would be $92,000 with an annual savings of $43,883 provides a payback period of two years.

TOTAL ANNUAL SAVINGS	**$43,883**
TOTAL INITIAL COST	**$92,000**
PAYBACK PERIOD	**2 YEARS**
EST. SAVINGS OVER 10 YEARS ($43,883 X 10 YEARS)	**$438,830**

Implementing LED curing is a long-term investment that provides significant savings in energy costs, bulb replacement costs and reflector costs. But the other benefits related to the change can also have significant impact on costs associated with the overall business – possible reclassification for energy consumption, possible reclassification for emissions, more effective spacing of presses, safer working conditions, and lower environmental impact.

Currently, viable LED lamps are available, UV screen inks are available and press manufacturers are starting to build new machines and considering the retrofit to existing machines. Adapting LED curing for the screen-printing market is right around the corner. ■

For a copy of the first part of this article, contact subs@specialistprinting.com

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