Maximizing the Payback for UV Curing of Cast-Iron Parts

By Greg Trojan

Introduction

Although ultraviolet 100% solid coatings have long held the promise of protecting our environment, the adaption of the technology in the metal industry has been slow.

The challenges faced by the industry are major capital expenditures, employee training and re-qualification of new coatings by their clients. The impetus needed to overcome those challenges may be found in the current energy crunch.

The challenges faced by the industry are major capital expenditures, employee training and re-qualification of new coatings by their clients.

As the price of natural gas soars, the cost of operating curing ovens is rising. For companies that outsource their coating operation, the rising cost of transportation might present an even greater challenge, particularly when the cost of transportation exceeds the cost of coating.

We are quickly coming to the point, as energy costs continue to rise with no end in sight, that the change to UV technology will become not only a more practical and attractive option but will be mandated by an ever cost-conscious global market.

This paper will examine and compare the total process cost associated with both the previously used solvent-based coating process and the currently used 100% solid UV-curable coating process to coat cast-iron gearbox housings as shown below.

Pre-treating of the cast housings is the same for both processes. Eliminating the need for masking the three flange faces was a result of the equipment design rather than the process change. Nevertheless, it constitutes a major cost-saving in the overall manufacturing cost.

The coating application equipment (electrostatic) and method are the same for both coating types.

Coating Cost Comparison

The price for conventional solvent based coatings for the coating the gearbox housing was $22/gallon and had a solid content of 20%. The price for the 100% solid UV coating is set at $95/gallon.

As the chart shows, the total square footage cost of UV coating is only $.11 compared to $.20 for the conventional coating. If no coating recovery would take place, the cost per square foot for UV would be $.17.

Figure 1

Coating cost comparison chart

DESCRIPTION	SOLVENT BASED	UV
Coating Cost	$22.00	$95.00
Solid by Volume	20%	100%
Theoretical Coverage @ 1mil	312sqf	1604sqf
Average Film Thickness	1.75mil	1.75mil
Actual Coverage	178sqf	916sqf
% Material Utilization (Electrostatic)	60%	60%
Actual Applied (square feet)	107sqf	549sqf
Coating Recovery of Collection	N/A	90%
Additional sqf through Recovery	N/A	330sqf
Total square feet	107sqf	879sqf
Coating Cost per Square foot	**0.20 $**	**0.11 $**

Based upon an annual 1.4 million- square-foot production, the annual coating cost-saving is in excess of $126,000.

The material utilization rate of 60% is based on this particular part shown. Since process elements (such as part density and geometry, weight, line speed, equipment and performance requirements) will differ from process to process, the economics presented in the above chart is only applicable to this product. Numbers shown in charts are based on actual coating usage for both coatings.

Coating Recovery

Coating recovery was not possible with the solvent-based coating. Sludge removal under the Environmental Protection Agency's Hazardous Waste Act has been previously calculated at $.012 per applied square foot.

Another cost related to solvent based coatings is the requirement in some jurisdictions to install an incinerator for VOC destruction, resulting in an additional operating cost of $.02 per square foot applied.

100% solid UV coatings do not change their characteristics until exposed to UV radiation. This allows the coating overspray to be recollected and re-used immediately. Filtering the coating prior to re-introduction is recommended.

The overspray system which works on a principle of centrifugal force recovers up to 95% of the overspray. This is accomplished by increasing the air speed through the coils according to the specific gravity of the coating. In this installation, the air speed through the coils was increased 11 fold or to 1,100 feet per minute.

Applied Cost vs. Unit Price

Often end-users incorrectly assume that the coating cost of UV-coated products is synonymous with the total cost of finishing. It isn't. When making a thorough economic comparison, there are a myriad of factors which contribute to the overall cost savings for UV application.

Floor Space

Floor space has become more valuable as energy costs are rising.

Each line operates at an average line speed of 6 feet per minute, or 6 parts per minute. Considering a thermal drying time of 30 minutes, the conveyor length through the curing oven was 180 feet long. The

Figure 2

Recovery coils

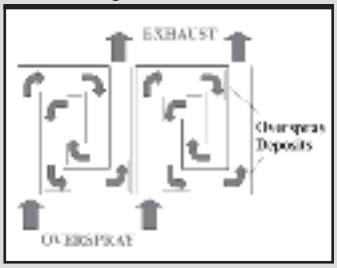

Figure 3

Recovery unit

Figure 4

3 lamp system

current UV chamber has a length of 32 inches, reducing the floor space requirement by more than 65%.

Although actual cost values can be allocated to the reduced floor space requirement, savings from the reduced amount of "work in process" are much harder to evaluate.

Curing Systems

Based on an average part size, the curing oven's natural gas consumption was 1.2 million BTU or 33.95 m3 per hour. With a current industrial price of $.46 per cubic meter, the natural gas cost to operate the oven was $15.61/hr.

The electrical connected load of the oven exhaust fans was 2.2 kW, or $.21 per hour, with an electric energy price of $.094/kWh.

The total operating cost of the oven was $15.82 per hour, resulting in an annual cost of $31,640.

In comparison, the current UV-curing chamber with three IST Minicure Lamps has a total connected load of 12.3 kW, resulting in an operating cost of $1.16 per hour. The annual operating cost for 2,000 operating hours is $2,320.

The resulting annual savings over the solvent-based coating is $29,320.

The overall production cost savings is over $200,200 annually.

Capital Expenditure

The coating application system was built for a total cost of $285,000 (not including tooling).

Summary

The operating cost chart clearly shows that a change to UV technology was a great benefit to the company. As one can see, the cost savings are substantial. In fact, the capital expenditure of $285,000 required to implement the UV process was recovered in less than 14 months.

Also, though it is difficult to place quantitative value on improved quality, reduced workplace toxicity and limited work-in-process, it is important to take these factors into consideration when making the decision to change the process.

Currently, other products coated on this line are brake drums and pulleys. A video of a similar process can be viewed on our Web site *www.uvtech.com/video/Sturm.*

—Greg Trojan is president and senior consultant at UV Research & Technology Inc., located in Ajax, Ontario Canada. He can be reached at uvtech@bellnet.ca.

Figure 5

Production cost comparison chart

DESCRIPTION	SOLVENT BASED	UV
Coating Cost per ft^2	$0.200	$0.110
Sludge Removal per ft^2	$0.012	N/A
Incineration per ft^2	$0.020	N/A
Energy Requirements per ft^2	$0.022	$0.001
Floor Space Cost	- $	- $
Others	- $	- $
Total Operating Cost per ft^2	**$0.254**	**0.111 $**
Annual Production Cost (1.4 mil sqf)	**$355,600**	**$155,400**