



# *metal finishing*

SPECIAL SUPPLEMENT  
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## **UV Curing for Metal Finishing**

*Shedding light on technology advances and new uses*

# Shedding New Light on Radiation Curing

*Seven reasons why surface finishers switch to UV-curable coatings and the benefits they experience.*

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Volumes have been written about UV technology, how it works, and the chemistry behind it. There is an abundance of information about molecular structures, photoinitiators, and chemical reactions. At times, it feels like you need a Ph.D. in chemical engineering to understand it all.

This article will solve some of the mystery behind UV technology, provide key insight into why finishers switch to UV-curable coatings, and detail the benefits they experience.

The reasons most finishers switch to UV curable coatings can be grouped into seven major categories.

## REDUCED ENERGY CONSUMPTION

Figure 1, from the U.S. Department of Energy, illustrates how natural gas prices have skyrocketed in recent months.

This is probably old news for many of you who recently opened your own gas bill to find a monthly charge that caused you to do a double take and immediately lower your thermostat. As with most manufacturers, cutting energy expenses in the finishing industry is not as easy as lowering the thermostat and putting plastic over the windows. Most finishers cannot just pass the additional costs to their customers so they just have to deal with the increasing costs and tumbling margins. Typically, this means putting off investing in new technologies. However, investment in new technology may just be the answer to the problem.

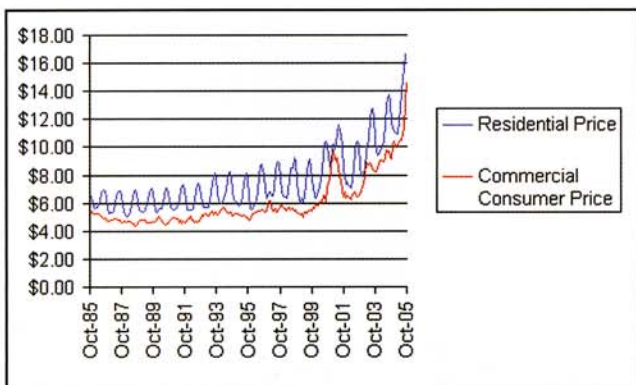


Figure 1: U.S. natural gas prices (\$ per 1,000 cu. ft.). Source: U.S. Department of Energy.

A major advantage of a liquid UV coat and cure operation over a conventional system is the elimination of a costly thermal dryer or oven. In a liquid UV system, the oven is replaced with a small cluster of UV-curing lamps. The cost of installing UV-curing lamps is typically about half the cost of installing a large-capacity thermal dryer or oven, and yearly operating costs are dramatically less.

For example, a large gas oven consumes 1 MBTU/hr. and requires large blowers to achieve a given production capacity. This same production capacity can be achieved with UV lamps requiring a total energy consumption of only 72 kW/hr. This can lead to a cost savings of more than \$60,000. You get the benefit of this savings every year the system is in operation.

Table I assumes a 24-hour operation in which the oven remains on continuously. If, however, production is confined to one or two shifts per day, the thermal oven will be shut down and then restarted for the next shift, which consumes an enormous amount of energy without producing any product. The oven might also be left running between shifts, which consumes energy without adding any value. With a UV-curing lamp system, the lamps can be turned on and off nearly instantaneously. So if they are not curing parts, the lamps are not consuming energy, resulting in even greater savings.

## REDUCED CYCLE TIME PER PART

As often happens, a rush order comes in from a customer who needs the product yesterday. UV coating materials typically cure in seconds versus up to an hour with a conventional coating in a thermal oven, so

	Energy Consumption	Cost per Energy Unit	Cost Per Hour	Cost per Year (350 Days per year x 24 hours a day)
Thermal Dryer or Oven	1 MTBU/hr	\$8.50/MBTU	\$8.50	—
	Blowers: 60 kW/hr	\$0.07/(kW/hr)	\$4.20	—
			<b>\$12.70</b>	<b>\$106,680</b>
UV Curing Lamp System	72 kW/hr	\$0.07/(kW/hr)	<b>\$5.04</b>	<b>\$42,336</b>

THERMAL CURE			
Painting	Thermal Cure	Cooling	Packing
2 min.	15-30 min.	10-25 min.	

UV CURING		
Painting	UV Curing	Packing
2 min.	2 min.	

**Figure 2: Comparison of steps and time involved in thermal cure vs. UV curing.**

cycle time is cut dramatically (see Figure 2). Since the UV process typically raises the temperature of the part less than 10°F, cooling time can be eliminated. The order can be packed and shipped immediately, meeting the customer deadline. (How much you charge for this premium service is up to you.)

The UV process also helps you move closer to a lean manufacturing environment. Faster cycle time reduces two significant wastes of lean: work in progress and waiting time.

A serious consideration of lean should include an investigation of UV processing.

**REDUCED SCRAP AND REWORK**

Dust, dirt, and other contaminants often found in a finishing environment routinely land on wet coatings during curing, ruining the finish. In fact, this is one of the primary causes of defects for most finishers. However, the UV process eliminates flash off time and reduces cure time to just seconds, minimizing the time the wet coating is exposed to the environment. This practically eliminates particulates contaminating the coating after painting, decreasing rejects and scrap.

Additionally, some defects in the coating cannot be found until the coating has completely cured. With the speed of UV curing, defects are identified immediately and corrective action can be taken much faster, reducing the number of bad parts that are created. It is common for finishers that switch to UV to reduce rejects by 75%.

**SMALLER SYSTEM FOOTPRINT**

A UV-curing lamp system typically consumes one-tenth the floor space of a conventional thermal oven. A conventional oven can easily be 100 feet long and consume more than 1,000 sq. ft. of floor space. Assuming a conservative \$1/sq. ft./mon., the costs to house a 100-ft. thermal oven is \$12,000 per year compared to only \$1,200 per year to house a UV lamp system (see Table II).

And with all the extra space from replacing their thermal oven with a compact UV system, customers

	<i>Space Required (square feet)</i>	<i>Cost per square foot per month</i>	<i>Cost per Year</i>
Thermal dryer or oven	1,000	\$1.00	<b>\$12,000</b>
UV curing lamp system	100	\$1.00	<b>\$1,200</b>

can increase their production capacity without adding any more square footage.

**REDUCED ENVIRONMENTAL IMPACT**

Many UV formulations are considered 100% solids, meaning they contain no VOCs. UV coating materials can be an alternative to costly VOC abatement equipment, or the need to switch to powder coating. If you are already spraying with liquid coating materials, you can eliminate VOCs without investing in new powder processing equipment. The UV system can have all of the environmental and performance benefits of powder, and still allows the fast color changes of liquid.

Using 100%-solids UV coatings also benefits employees by eliminating their exposure to solvents. Many manufacturers use this fact alone to justify switching to UV materials.

Finally, liquid hazardous waste is typically mixed with absorbers, sealed in 55-gal. drums, and hauled off by a licensed contractor for incineration. Direct disposal costs can be hundreds of dollars per drum. UV-curable materials contain no solvents so they can easily be disposed of as ordinary solid waste in most jurisdictions.

**MORE COATED PARTS PER GALLON**

When learning about UV-curable coatings, you will find the cost of one gallon of UV coating can be substantially higher than conventional materials. However, you need to look beyond the per gallon price tag before you make your final decision.

Since UV materials can be 100%-solids formulations, they can cover up to four times more surface area per gallon than conventional coatings. Solvent-based or waterborne coatings cure with heat from a traditional thermal oven. The heat evaporates the solvent, which reduces the dry film thickness to as little as 25% of the wet film thickness (see Figure 3).

Most UV coating materials do not use solvents. They are instantly cured by UV energy. The UV energy initiates a chemical reaction within the coating (that's where the oligomers, monomers, and photoinitiators come into play). Since there are no sol-

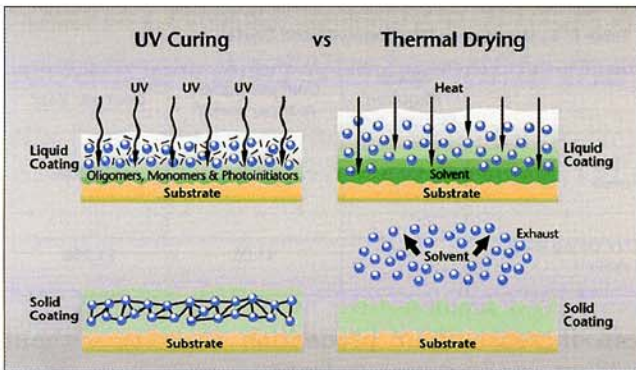


Figure 3: UV curing vs. thermal drying.

vents to flash off, 1 mil of wet coating actually gives you 1 mil of dry film build.

While the price of a gallon of UV coating may be higher, comparing the cost per unit of dry film build is a more accurate measure of the value of that gallon of material. So for every one gallon of 100%- solids UV material, you will need as many as four gallons of a low-solids conventional material.

The mathematical calculation for finding the coating value is as follows:

$$\text{Material cost} \div \text{mil of film thickness} = (\text{cost per gallon}) \times (1,604 \text{ sq. ft.}) \times (\% \text{ solids}) \times (\text{application efficiency})$$

UV coatings will not dry until they are exposed to high-intensity UV light, making reclaiming of over-spray much easier. You don't need to add additional solvents to reclaim material, since there is no flash off with UV materials.

**BETTER PERFORMANCE CHARACTERISTICS**

Along with all the cost saving benefits, UV-curable materials exhibit superior performance characteristics, including:

- Improved hardness and gloss;
- better scratch and abrasion resistance;
- superior chemical resistance;
- and increased bond strength.

In fact, due to their durability in all types of envi-

Table III: Projects Currently in Testing

Metal	Wood	Plastic	Glass
Aircraft components	MDF doors	Plastics mirrors	Bottles
Brake shoes	Milled products	Graphite golf club shafts	Window glass
Hydraulic cylinders	Cabinets	Hardware components	—
Steel doors	Flooring	Frames	—
Steel strapping	—	Fiberglass doors	—

ronments, UV materials have been called “liquid powder.”

**CONCLUSION**

Now that some of the mystery has been taken out of UV technology, hopefully, you are starting to think about how UV coat and cure can fit into your finishing line. Customers in a variety of industries, spraying all types of surfaces, are switching to UV coat and cure materials. Table III lists projects currently in testing. Do you see your product on this list?

In tough economic times, the tendency is to cut costs and avoid reinvesting until the economy starts to stabilize. However, now may be the best time to take action and invest in the right finishing process.

If you would like to see how you could become more competitive by converting your process to UV technology, visit [www.nordson.com/uvcalculator](http://www.nordson.com/uvcalculator). This extensive ROI calculator will be a vital tool in helping you make your finishing line decision.

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