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TECHNICAL REPORT

 # 082811-0808

DATE: September 26, 2011

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TITLE: Mitigating Coating Cost Increases by Reducing Coating Usage

INTRODUCTION

If you listen at all to the government "experts" and news media, you're bound to hear talk that inflation is under control. These same pundits cite extreme price pressure resulting from intense competition as the reason. If you're a coil coater, you're already well aware of the price pressures you are receiving from your customer and at the same time, seeing your cost to manufacture exploding. The purpose of this paper is to explore ways to mitigate those costs and manage this seemingly impossible dilemma.

THE INCREASING COSTS OF COATING

Disregarding G&A expenses, the primary cost structure for pre-coated coil metal is comprised of (in decreasing order):

- Metal
- Coating(s)
- Energy (electricity and natural gas)
- Pre-treat chemicals
- Labor

Let's examine the two primary cost drivers: metal and coatings. By February 2011, the sharp rise in steel prices was already garnering attention. The Wall Street Journal observed:

> *"Steelmakers have increased prices six times, for a total increase of 20% to 30%, since November [2010] on basic flat-rolled steel, used in everything from cars to toasters, to offset higher input costs of raw materials, such as iron ore and coal."* [1]

And coating cost increases have also been making the news. The major players have all announced price increases this year:

Manufacturer	Increase	Effective
PPG	5 - 8%	1-Sep-11
Akzo-Nobel	up to 12%	1-Feb-11
Akzo-Nobel	2 - 6%	1-Jul-11
Beckers	7 - 12%	1-Jun-11
Valspar	8%	1-Aug-11

Unfortunately, process changes have no impact on metal prices so our next best opportunity is to focus on how we can optimize the coating process to reduce coating usage.

THE OPPORTUNITY

Variations in film build from edge-to-edge and from head-to-tail result in excess coating material usage. To demonstrate the magnitude of the edge-to-edge variation, four full-width samples were obtained from a Midwest coater and the film build measured in 12 locations evenly spaced across the width of the strip using DJH Designs' Crater DFT Measurement System which provides thickness measurements in accordance with ASTM D5796-95 [2]. The results of these measurements on the four samples supplied were graphed and are shown here in Figure 1:

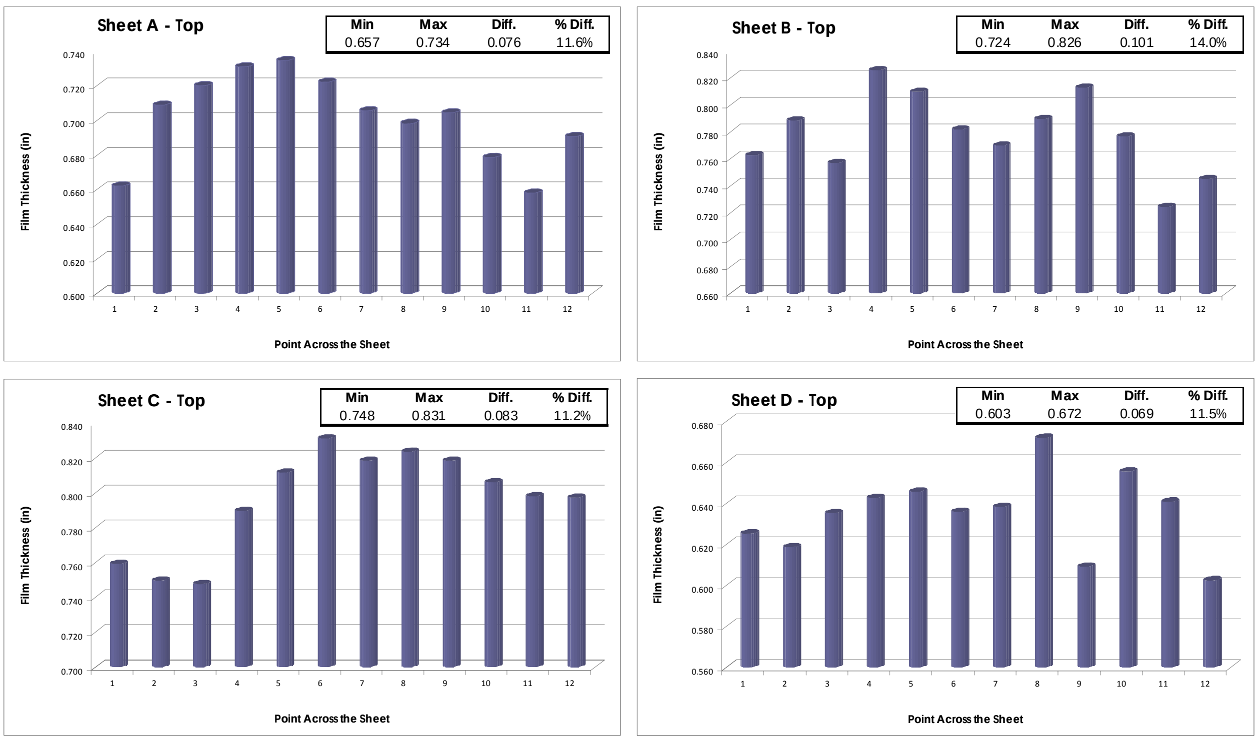

Figure 1: Examples of Uneven Edge-to-Edge Coating

Upon initial observation of the raw numbers, most coaters would see these as a demonstration of pretty good control. But by graphing and analyzing them as shown, the first thing that becomes clear is that all of these top-coats have an edge-to-edge variability in excess of 11%. By analyzing the source of this variation and devising a means to cut it in half, a minimum of 5% reduction in coating usage should be readily achievable – representing a significant cost savings to the coater.

The second observation from this analysis is that these variations in coating thickness are not due to maladjustments of the nip pressure at each end, which would have produced a "ramp" from one edge to the other. The uneven changes observed across the width of the strip are likely the result of viscosity variations in the coating at the point of application and so we will start our investigation there.

VISCOSITY BASED COATING VARIATIONS

Virtually all coil coaters understand the impact that viscosity has on the coating process. The more viscous the coating, the greater the film build. As the viscosity falls, so does film build. In fact, the first step in most coater setups is to measure and adjust the viscosity of the coating – usually by adding solvent – but that's the subject for another paper.

In most cases, coating viscosity variations can be directly related to changes in coating temperature. Virtually all liquids show some change in viscosity as a function of temperature. Figure 2 shows the viscosity vs. temperature curves for a selection of common polyester paints used in the coil coating industry. This shows the typical non-linear relationship associated with these materials over the normal ambient temperature range and how that varies by color formulation even within the same resin base. It is worthwhile to note that this characteristic is shared with virtually all viscous liquids and is a physical material property not a defect. As we will see, it is this parameter that is responsible for the edge-to-edge film variations shown in Figure 1 above.

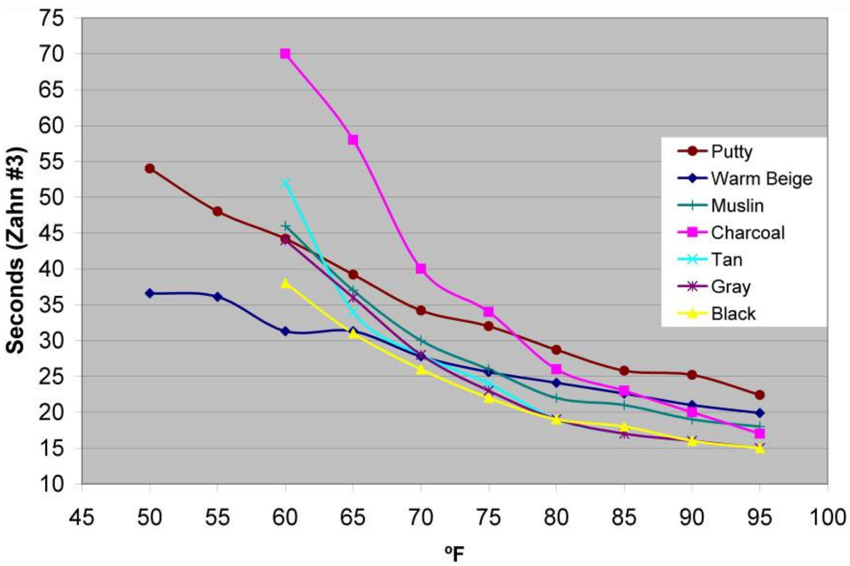

Figure 2: Paint Viscosity vs. Temperature by Color[3]

When the thermal profile across the face of the pickup roller in a normal coil coating system is measured using SCS' Profile Analysis System, as shown here in Figure 3, we can see significant differences in the temperature of the paint being applied at various points across the width of the strip. Based on the typical curves shown in Figure 2, each of these temperatures represents a different viscosity. In fact,

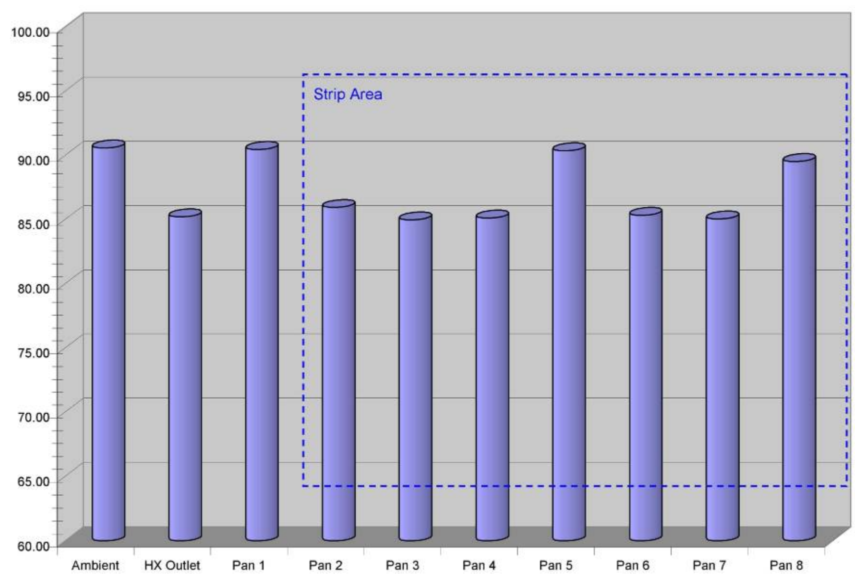

Figure 3: Temperature Profile of a Typical Coil Coater

if this was the Charcoal color in Figure 2 above, the paint would vary from 20 – 23 seconds. This 13% variation is very similar to the film results measured in Figure 1. Where the paint is warmer the viscosity will be lower. Where the paint is cooler the viscosity will be higher. An approximation of the resulting film build is laid over the thermal profile in Figure 4. Note how this closely represents the film measurements for Sheet B and Sheet D in Figure 1.

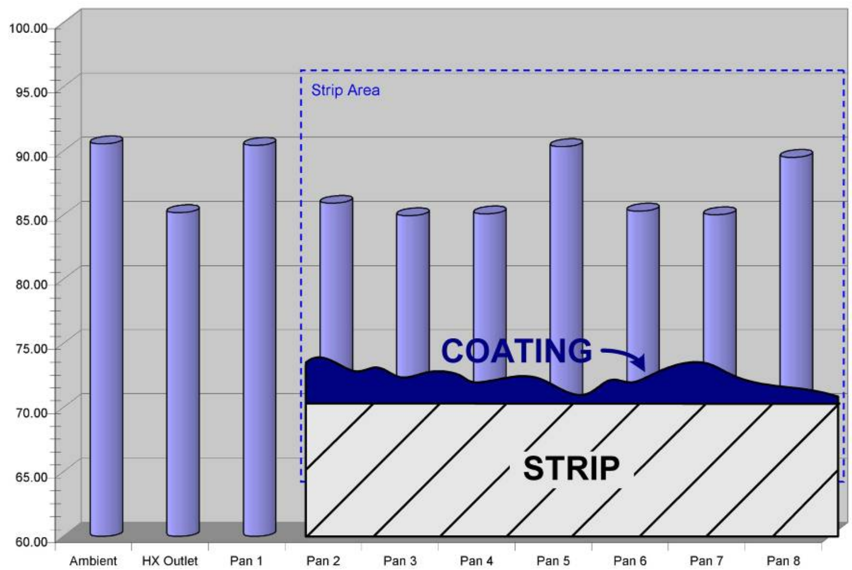

Figure 4: Temperature Profile and Film Build Relationship

The "enabler" of this variation is the urethane applicator roll. Where the viscosity is higher, the hydrostatic pressure at the nip (between the pickup roll and the applicator roll) will be greater, resulting in a larger displacement between them and therefore a heavier film transfer. The opposite occurs where the viscosity of the paint is lower. Because of the compressibility of the urethane, these variations in deformation can occur at infinite points along the nip, thus explaining the range of edge-to-edge film build variation patterns observed in Figure 1. While the durometer of the urethane will have some influence on the magnitude of the variations, increasing the hardness of the roll will not eliminate the variations and produces other tradeoffs.

The only way to eliminate these variations is to stabilize the temperature of the paint all along the face of the pickup roll to assure a consistent viscosity is presented to the nip at all points across the width of the strip.

STABILIZING THE THERMAL PROFILE – EDGE-TO-EDGE

Identifying and correcting the factors that create temperature variation at the point of use (pick-up) can be complex and must be treated on a case by case basis. To facilitate this process, SCS developed the PAAC (Profile Analysis and Correction) System. This combination of measurement tools and software allow thermal variations to be located and displayed graphically as shown in Figure 3 above. Once these temperature variations have been identified, changes can be made to the pan and coating delivery system to eliminate them, resulting in a flat, smooth coating from edge-to-edge.

Figure 5 shows the thermal profile of the system above after completion of the PAAC process. Here we can see that the temperature spikes identified at locations 5 and 8 have been eliminated and the total variation across the width of the strip has been reduced from greater than 5°F to less than 1°F – an improvement of more than 80%.

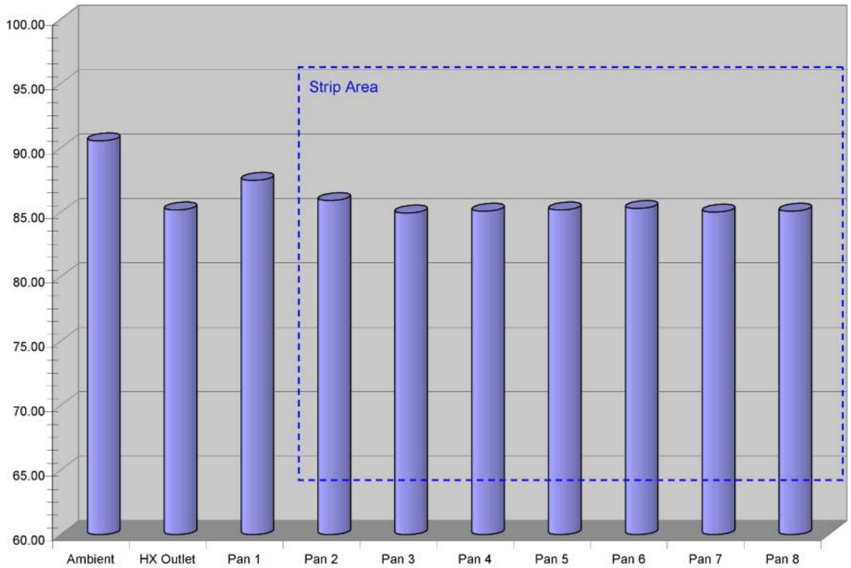

Figure 5: Temperature Profile after the PAAC Process

As we have already demonstrated, this will have a corresponding effect on the film build, shown in Figure 6 below. Here we can see that the "low spots" in the film build have been eliminated (corresponding to the elimination of the temperature spikes) and the coating is now smooth and flat across the width of the strip.

With this setup, it is possible to reduce the overall film being applied, which correlates directly to a savings in paint usage with no degradation in quality – in fact, the quality factors related to cure will also improve as an even coating will result in an even cure rate across the strip as shown in Figure 7.

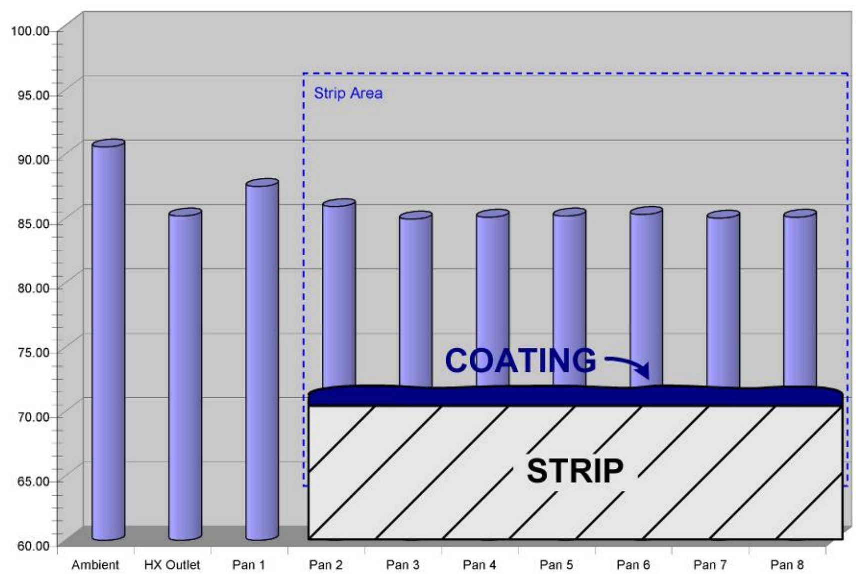

Figure 6: Temperature Profile and Film Build after PAAC

Though intuitively obvious, this demonstrates how the thicker areas of the paint will cure more slowly than the thinner areas. The even cure resulting from profile correction improves such factors as gloss, adhesion and blistering.

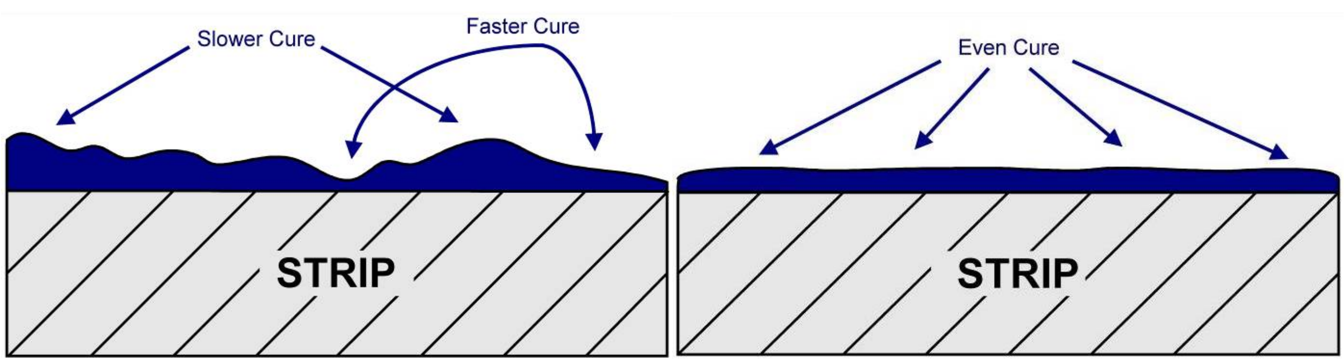

Figure 7: Impact of the Corrected Thermal Profile on Curing

STABILIZING THE THERMAL PROFILE – HEAD-TO-TAIL

Solving the edge-to-edge variation is only half the battle. The same factors that apply to edge-to-edge variation also apply to head-to-tail variations. The Temperature vs. Time Line Chart output of the PAAC System provides the means to analyze this situation. Figure 8 shows the variation of the coating system over time.

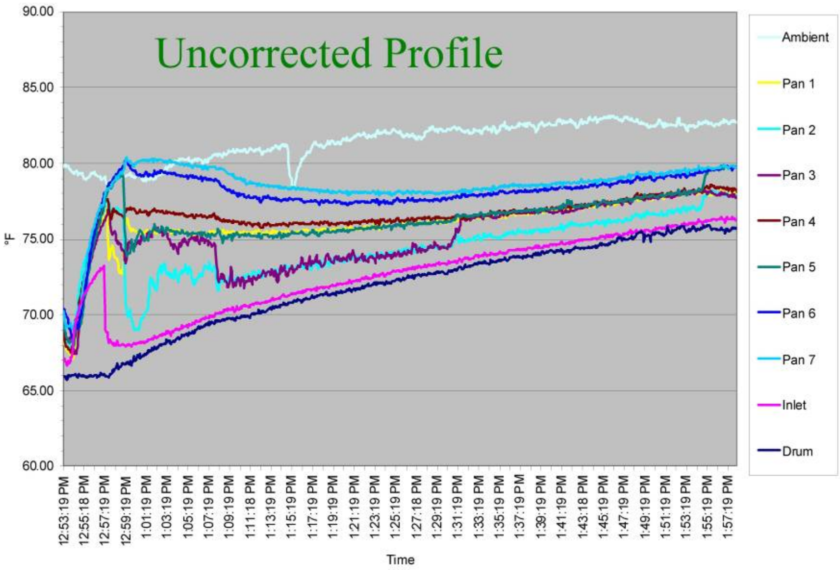

Figure 8: Uncorrected Temperature Profile over Time

Here we can see all of the variations associated with the uncorrected profile. The edge-to-edge profile is reflected in the vertical distance between the traces. The head-to-tail variation is reflected in the overall rise in temperature across all traces over time. This drift is caused by the heat generated by the process, primarily due to the friction at the nip and in this instance was on the order of 5°F/hour.

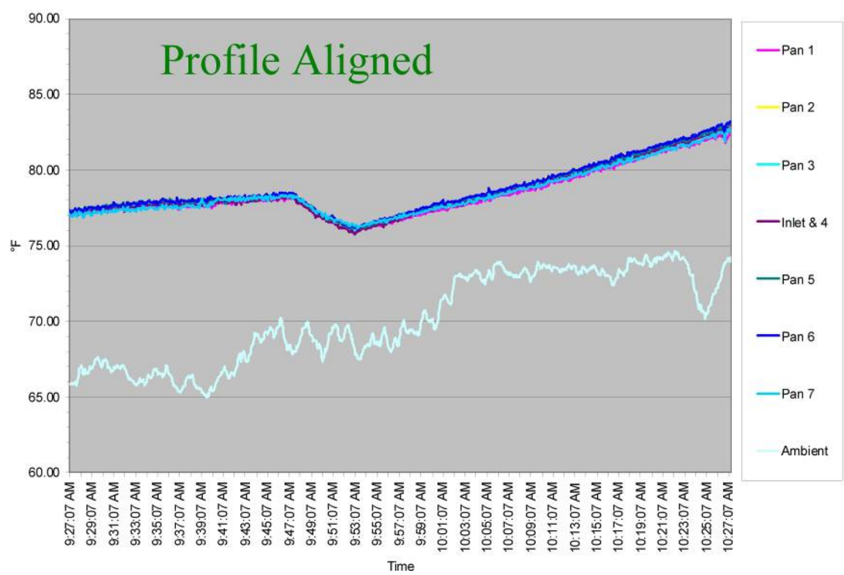

Figure 9: Aligned Temperature Profile over Time

As we have already discussed, fixing the edge-to-edge profile only addresses half the problem as shown in Figure 9. In this graph we see the system from Figure 8 after profile correction but without temperature control. The vertical space between the traces has been eliminated, but the drift over time remains. In this situation, the film would be even from edge-to-edge but would be expected to fall over time, requiring repeated nip adjustments by the operator in order to keep the film up throughout the course of the run. Without these adjustments, the reduction in film build would result in a quality failure not only due to insufficient film but also likely due to color match issues. With the adjustments, it is likely that excess coating will again be applied throughout the run and color variation is also likely.

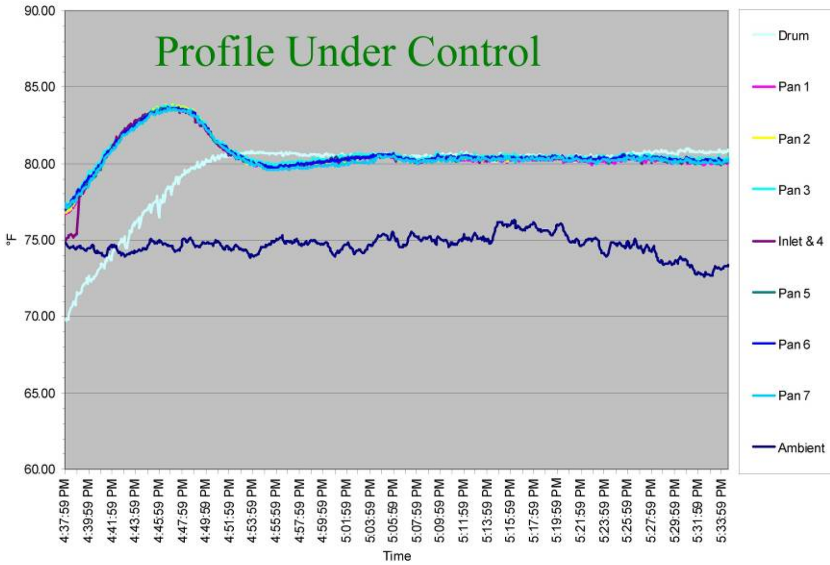

Figure 10: Corrected Temperature Profile over Time

The adding of temperature control solves this problem by assuring that the paint being delivered to the process remains at a consistent temperature over time. Figure 10 shows the system after profile alignment and with temperature control in operation resulting in a truly controlled profile. Because this temperature stability is repeatable it is possible to use the same settings in January and in July which makes the creation of "recipes" for each product (coating/substrate combination) feasible. In this situation, the final coated product will be consistent and repeatable not just from edge-to-edge but also from head-to-tail, coil-to-coil and season-to-season representing a process truly under control.

MITIGATING THE COATING COST INCREASES TO STAY COMPETITIVE

So, how can we use this knowledge to mitigate the increase in coating cost? Let's assume that the coater whose samples are shown in Figure 1 was using $15M/year in coating as of the beginning of the year. For convenience, let's also assume that they experience an average coating cost increase of 10% across all of their paints. Their total annual cost increase would then be:

$$\frac{\$15{,}000{,}000}{year} * 10\% = \frac{\$1{,}500{,}000}{year}$$

For a total anticipated annual coating cost of:

$$\frac{\$15{,}000{,}000}{year} + \frac{\$1{,}500{,}000}{year} = \frac{\$16{,}500{,}000}{year}$$

To determine the anticipated savings, let's assume a conservative 5% reduction in coating usage. The savings would then be:

$$\frac{\$16{,}500{,}000}{year} * 5\% = \frac{\$825{,}000}{year}$$

And therefore, 55% of the $1.5M coating cost increase is offset due to material savings alone. As discussed above, other cost savings due to quality improvements will also be realized which will offset even more of this increase.

THE CONCLUSION

The pre-coated metal marketplace is highly competitive and all players are experiencing similar increases in raw material costs. With regard to coating, if you can reduce the impact of those increases by greater than 50% you can significantly improve your competitive position. This can mean the difference between failing, simply surviving, and thriving.

BIBLIOGRAPHY

1 – Matthews, Robert Guy. "Steel-Price Increases Creep Into Supply Chain." Wall Street Journal. 3 February 2011: Business Section.

2 – Film build data provided courtesy of DJH Designs, Inc. – Oakville, ON.

3 – Paint Viscosity vs. Temperature data provided courtesy of Sherwin-Williams Corp.

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