A Tale of Two Coil Coaters

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This is a case study in implementing paint temperature control to improve process stability and reduce cost.

It was the best of times…

In April of 2007 new process temperature control systems were implemented on the Continuous Paint Lines at Steelscape's Kalama, WA and Rancho Cucamonga, CA facilities. The goals of these implementations included:

1) Ensuring that paint temperature could be controlled at a targeted value on each coater to reduce viscosity variation.

2) Reducing the quantity of petroleum solvents added to our paints by a minimum of 50%.

3) Improving the consistency and repeatability of the painting process to increase the finish quality and first-pass yield of painted products.

Description of Problems

It was the worst of times…

"Stability, or existence of a system, is seldom a natural state. It is an achievement, the result of eliminating special causes one by one."

- W. Edwards Deming[1]

Paint is a fluid and like all fluids its viscosity (the measure of resistance to flow) is different at different temperatures. For example, paint at 90°F flows very easily while paint at 40°F flows slowly (think honey coming out of the refrigerator!) Steelscape's paint vendors specify and formulate paints to perform optimally at temperatures in the 70°F to 80°F range. But in the winter months, incoming paint temperatures at Kalama could approach 45°F which resulted in coater setups being different than those of the summer time when the incoming paint temperatures could well exceed 80°F. Though shifted upward, similar seasonal variations were being experienced by the Rancho Cucamonga facility.

As with most coating operations, petroleum based solvents were routinely added to get these paints down to their targeted viscosity. Historically, these additions were four to five gallons per 50 gallon drum of paint with additions sometimes exceeding 8 gallons. In addition to the environmental implications, solvent pricing has increased significantly over the past few years due to increasing petroleum costs. Solvent prices, some of which now exceed $11 per gallon, were having a significant impact on the cost of running the paint operation. To make matters worse, every ounce of solvent added to the paint is being "baked out" during the curing process and adds nothing to the final product.

Differences in paint formulation (created by adding solvent) and the constantly changing coater setups can have a significant impact on finish quality. Recurring problems with solvent pop, color match, gloss, film build, and edge-to-edge variation all could be traced to these process deviations. Rejects and reworks associated with these quality issues were also pushing up the cost of the coating operation. It was clear that steps had to be taken to both stabilize the coating process and to significantly reduce the cost of the painting operation. It seemed obvious that this could be best achieved by stabilizing the paint temperature and reducing the amount of solvent added. As Kent Hatch of Valspar stated:

"At Valspar, we formulate our paints to run under a variety of different conditions and process variables. One of the primary variables is the paint temperature, which can vary from 40°F to 100°F based on the conditions at the coil coating facility. This wide swing in temperature can play havoc with both paint viscosity and application setup. Having consistent and targeted paint temperature removes this process variable and its effects from the equation. Additionally, having consistent paint temperature ensures optimal (minimal) usage of expensive reducing solvents to attain the desired viscosity and applied paint film thickness."[2]

System Requirements

A cross-functional team comprised of operations and maintenance associates from the Kalama and Rancho facilities was formed to examine these issues. As it was clear that temperature variation was the root cause of many of these issues, it became their task to both determine the appropriate paint temperature control system to be purchased and devise an acceptable implementation plan.

Notice that this was defined as "paint temperature control" and not just paint heating. As described previously, Steelscape would need a system which could provide

heating in the winter and cooling in the summer. This also would need to be a closed loop system, continuously monitoring paint temperature and making the appropriate adjustments whenever the paint does not meet the targeted temperature. Further, the team concluded that the paint temperature control system must:
• Get paint to the target temperature quickly
• Prevent damage to delicate paint formulations
• Provide a minimum of 50% reduction in solvent additions
• Clean up quickly and easily at color change
• Be operator friendly and easy to use
• Interface readily with the existing line control system
• Require minimal maintenance

In addition to installation of the paint temperature control system, the team determined that the RDS (Recipe Data System) would have to be updated to make it useable for maintaining line setups and data crucial to optimizing the painting process.

Choosing A Solution

The paint temperature control team reviewed many potential equipment vendors and options to determine the best system for this application. One of these was conventional in-line electric paint heaters. In addition to the obvious fact that these could not provide the required cooling capability, testing at the Rancho facility showed that though comparatively inexpensive, their disadvantages outweighed their benefits. These disadvantages included:
• Manually intensive to use
• Excessive paint temperature fluctuations
• Frequent fouling and difficulty cleaning
• Dirt and other paint application problems

Also examined was a system utilizing paint drum heating jackets. Again, these systems could not provide the required cooling capability and they exhibited other critical disadvantages including:
• Large number required to keep up with number of drums to be brought to temperature
• Excessive manual labor required to apply jackets to and remove from drums
• No paint temperature monitoring to control whether the drum is at temperature
• Potential fire and safety hazards

After much research, the paint temperature control team eventually selected St. Clair Systems' paint temperature control equipment. In addition to the fact that it provides the required heating and cooling capability, it also provides the following financial and process control advantages:
• Ability to quickly change temperature
• Integrated systems to protect delicate paints from excessive temperature swings
• Closed loop control monitors paint temperature directly
• Easy to use and maintain for the operations team
• Quick and easy clean-up at color change without excess solvent
• Intrinsically safe components in coating area occupy a very small footprint
• Fully integratable with line control system

System Installation

The SCS Paint Temperature Control Systems were installed and commissioned at both the Rancho and Kalama Paint Lines in April of 2007. The Kalama facility equipment is shown in Figure 1. Simultaneous implementation at both facilities with the same style equipment brought some unforeseen benefits. There were many synergies developed by the cross functional teams (operations, maintenance, and business improvement groups) during the install process and the lessons learned were shared almost daily. This allowed improvements to be made much more quickly than if each plant had done the implementation individually – the sum of the whole outweighed the sum of the individual parts! This is important as it had long been believed that the different climates (Northwest Mountain vs. Southwest Desert) separated the process rules for the two facilities. In fact, when the ambient temperature differences were removed from the equation, the systems performed almost identically.

As a part of the equipment installation and commis-

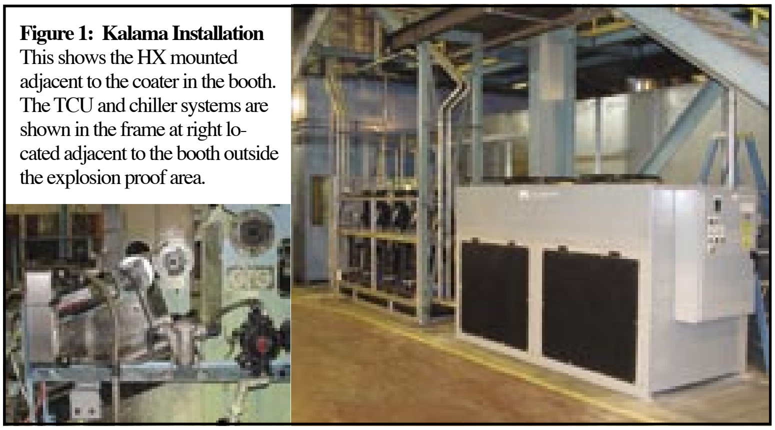

Figure 1: Kalama Installation
This shows the HX mounted adjacent to the coater in the booth. The TCU and chiller systems are shown in the frame at right located adjacent to the booth outside the explosion proof area.

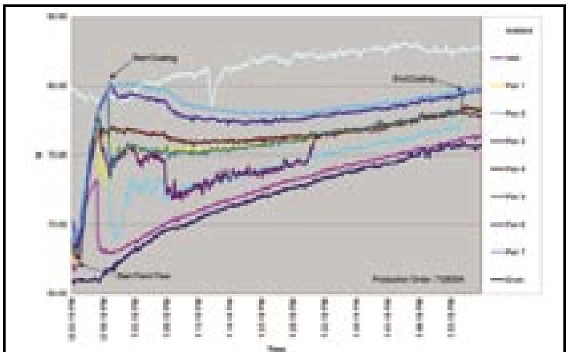

Figure 2

sioning, the coaters were submitted to SCS' P.A.A.C. (Profile Analysis and Correction) system. Utilizing this proprietary measurement system it was possible for us to measure deviations in the existing thermal profile of the coater from edge to edge on the strip. Figure 2 shows the uncorrected profile measured at the beginning of the commissioning process.

This graph shows not only an increase in temperature over the course of the run but also significant variation in temperature at different points across the pan. As discussed above, these different temperatures represent different viscosities. This clearly shows the root cause of the edge to edge film build variations that had been observed. From this data we were able to utilize the P.A.A.C. tools to analyze the paint pan and delivery system and make changes to both the pan design and the paint delivery system to eliminate this variation.

Figures 3 and 4 show the results of these changes. Figure 3 shows the coater head after correction but without the temperature control equipment operating. This data proves that the changes to the design of the pan and delivery system have virtually eliminated the variation across the width of the strip, but the increase in temperature over the duration of the run remains unchecked.

Figure 4 shows the same coater head with paint temperature control equipment in operation. It is evident that the variation across the pan remains negligible but the increase in temperature during the course of the run has been eliminated. The energy being added to the paint by the friction of the rollers is being removed by the temperature control system at the same rate resulting in a very stable paint temperature (and therefore a stable viscosity) at all points across the width of the strip.

Project Results

As noted above, the simultaneous implementation at both facilities by the cross functional team and the synergies developed produced outstanding results. Some of the more notable include:

• Project completed on time and on budget
• St. Clair Temperature Control System is easy to use and requires a minimum of maintenance

The nine months since the installation of the paint temperature control equipment have seen significant changes in the coating processes at Steelscape. Process improvements thus far as a result of this project include:

• Paint temperature is now easily controlled and target temperatures are consistently achieved at each coater resulting in better paint viscosity control both during a run and from run-to-run
• A drum of paint can be quickly heated from 65°F to

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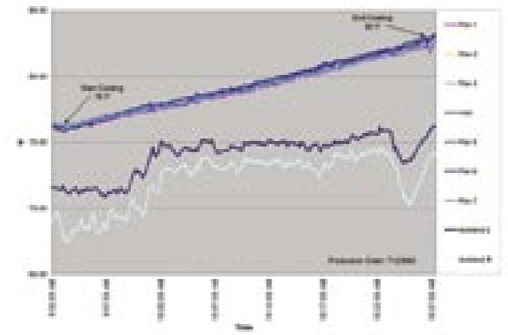

Figure 3

90°F in less than four minutes
• Paint film thickness variation across the strip has been virtually eliminated
• Finish quality of the painted strip surface (gloss, appearance, etc.) has shown significant improvement
• Improved paint application control has resulted in a direct decrease in paint consumption
• Reduced paint consumption has eliminated paint shortages caused by exceeding estimated usage
• Reductions in solvent additions in excess of 60% has resulted in significant cost savings for 2007 over 2006.
• Paint defects such as solvent pop have been reduced by 75% from previous levels due to lower solvent levels in the paint
• Environmental compliance has improved due to reductions of naphthalene and paint volatile organic compounds (VOC's) produced during the paint curing process

The stability of the process allows for continued exploration into other coating related operating improvements that have the potential to further extend the reductions in operating costs already realized.

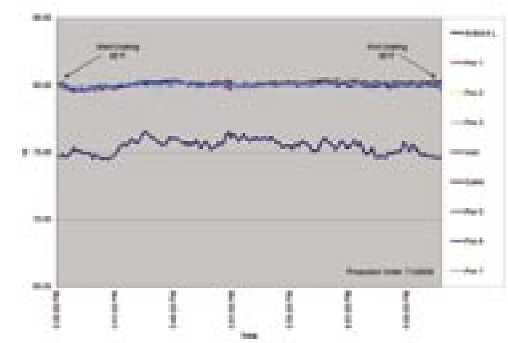

Figure 4

Requirements Revisited

As described under "System Requirements" above, in addition to ease of use and protection of delicate paint formulations, a major justification for this system hinged on "providing a minimum of 50% reduction in solvent adds". In fact, process improvements enabled by the implementation of the temperature control system resulted in solvent addition reductions in excess of 60% as shown here in Figure 5.

Conclusion

"In the state of statistical control, all special causes so far detected have been removed. The remaining variation must be left to chance – that is, to common causes- unless any new special cause turns up and is removed. The next step is to improve the process, with never-ending effort."

- W. Edwards Deming[3]

Implementing the St. Clair Paint Temperature controller system was a perfect case of removing both special cause variations such as temperature fluctuation from ever changing ambient temperature changes, as well as common causes such as the process of applying paint to metallic coated steel strip. It has been a great success and shows that a project involving cross functional teams and two Steelscape plants can be implemented successfully with many gains and job satisfaction along the way. Financial and quality benefits are being realized daily

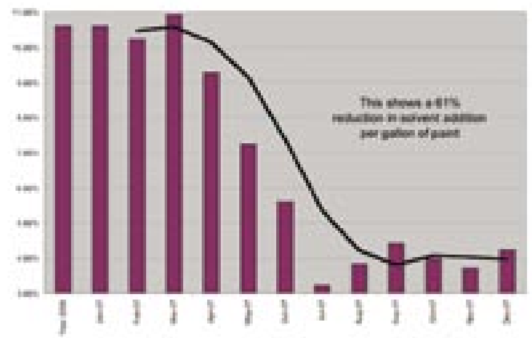

Figure 5

while we continue working on improving the gains from the paint temperature control system, always looking for the next process and product quality improvement opportunity.

Bibliography

1 – Deming, W. Edwards. Out of the Crisis. Massachusetts: The MIT Press, 2000. (Pg. 322)
2 – Hatch, Kent. Valspar Corporation. E-mail to Eric Slind, Steelscape, Inc. December 13, 2007. Reprinted by permission.
3 – Deming, W. Edwards. Out of the Crisis. Massachusetts: The MIT Press, 2000. (Pg. 321)

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