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Pollution Prevention Case Study

Wood Furniture Finishing

High Solids Topcoats and HVLP Spray Guns

Ethan Allen of Beecher Falls, Vermont

Ethan Allen's furniture manufacturing facility in Beecher Falls, Vermont was one of the largest emitters of air pollutants in the state. Every year their reports under SARA Title III publicized their position as one of the state's "worst polluters". In an effort to improve their image within Vermont, to comply with Vermont's air toxic rule, and to stay ahead of the coming Clean Air Act standards for wood furniture, the Beecher Falls plant decided to make changes that would reduce their air emissions. This case study describes the main pollution prevention (P2) projects they implemented and provides details of the benefits and challenges associated with their efforts.

Background

The Beecher Falls plant is located in the northeastern-most point in Vermont, on the border with both New Hampshire and Canada. The plant has approximately 500 employees and is the main economic force in the area. The facility makes several styles of the high-quality bedroom and non-upholstered living room furniture that is sold in Ethan Allen's retail outlets.

Air emissions of hazardous air pollutants (HAPs) and volatile organic compounds (VOCs) from the Beecher Falls plant are almost exclusively from the finishing process. Prior to their recent P2 efforts, the production of Ethan Allen's furniture involved the application of 70 different finishing materials in a total of 9 separate applications. These were all low-solids solvent-based coatings. There are no automated finishing processes at the Beecher Falls plant. All finishing material is applied manually using a spray gun. In 1992, the plant reported total VOC emissions of 300 tons and total SARA-reportable HAP emissions of 95.6 tons to the U.S. Environmental Protection Agency. The Vermont Department of Environmental Conservation (DEC) regulates a state-specific list of approximately 300 hazardous air contaminants (HACs). All HAPs are on Vermont's list of HACs. Vermont DEC calculated 231 tons of HAC emissions for 1992.

In 1995, production at Beecher Falls was 18.5 percent higher than in 1992, yet total VOC emissions were 257 tons per year[1] and SARA-reportable HAP emissions were 50.5 tons per year.

[1] No portion of the emission reduction was achieved through reformulating any coatings with acetone. Some stains and basecoats have been reformulated with acetone as the primary solvent; however Ethan Allen has included acetone emissions in the 257 tons per year VOC figure. Acetone was removed from the U.S. EPA's VOC list on June 16, 1995 and is not a listed HAP, but it remains as a listed HAC under Vermont regulations.

In 1995, Vermont DEC calculated 225 tons of HAC emissions. Taking increased production into account, VOC and HAP reductions were 28 and 55 percent, respectively. In order to achieve these reductions, Beecher Falls implemented two main P2 projects: switching to high volume, low pressure (HVLP) spray guns and a high solids sealer and lacquer. In addition, they implemented several other P2 projects with more minor effects, including switching to aqueous-based color primer and spray booth coating, and reclaiming lacquer dust for reuse. All of these P2 projects are discussed in the following sections.

Primary P2 Project: High Solids Sealer and Topcoat

The Beecher Falls facility used traditional nitrocellulose sealer and lacquer that were 18 percent and 20 percent solids, respectively. With the traditional coatings, one sealer and two lacquer applications were needed to meet Ethan Allen's quality standards. In an effort to reduce VOC emissions, Beecher Falls switched to higher-solids sealer and lacquer, approximately 24 percent and 28 percent, respectively in the early 1990's. Although they had no problems with using these higher solids coatings, Beecher Falls wanted to reduce air emissions further.

In 1994, Beecher Falls decided to evaluate even higher solids sealers and lacquers. After careful evaluation, including pilot testing at the plant, they chose a 35 percent solids sealer and lacquer and the new system was fully operational by March of 1995. The 35 percent solids lacquer eliminated the need for a second lacquer application, saving on coating material and labor, and reducing air emissions. The new coatings contain 42 percent fewer VOCs and 83 percent fewer HAPs than the previously used "higher" solids coatings.

Beecher Falls worked closely with their coating supplier, Lilly Industries of High Point, North Carolina and their equipment supplier, Norris-Wiener of Billerica, Massachusetts, to develop a satisfactory system. The high solids material could not be applied at room temperature with the HVLP spray guns. Beecher Falls had a choice about whether to use high pressure guns (1,500-3,000 psi) or heat the coating material to lower its viscosity. They chose to electrically heat the material in-line so that it reaches the gun at approximately 90^{o} Fahrenheit. In addition, they modified the HVLP gun cap, nozzle, and tip to enable proper coating application. These modifications have not increased the pressure at the point of atomization beyond the 10 psi definition for HVLP.

There are several benefits to the new coatings, as well as several challenges as described in the following sections.

Benefits

- The primary benefit has been that only one lacquer application is needed to achieve adequate build. This eliminated the use of the second lacquer spray booth, and the two spray operators were transfered to other positions. At Beecher Falls, this newly available space was particularly valuable, and allowed for changes in the layout of the finishing department to make it more efficient. The elimination of one spray booth also reduced maintenance requirements, and subsequently the amount of solvent cleaner needed. The elimination of the second lacquer coat also eliminated the need to sand the surface between coats (scuff sanding), again eliminating the need for two employees to perform this operation.

- VOC and HAP emission reductions have been substantial because air emissions are directly related to the amount of coating used. Eliminating one lacquer application reduced material usage for lacquer coating by 46 percent. If the new coating formulations had the

same VOC and HAP content as the old coatings, VOC and HAP emissions from the lacquer application step would also be reduced by 46. However, the new coating formulations are not the same (42 percent fewer VOCs and 83 percent fewer HAPs), so reportable emissions from the lacquer application step have been reduced by more than 46 percent.

- Beecher Falls believes that the new coatings have improved worker health and safety conditions at their plant. There is less bounceback with the high solids coatings, reducing potential worker exposure. Lower bounceback also lowers overspray and reduces material use and air emissions further. After an initial period of adjustment, sealer and lacquer operators are happy with the new coatings and appreciate their improved work environment.

- The sealer coat now has a better build, so when it is sanded there are less cut throughs. This reduces the amount of touch-up required before lacquer application by approximately 30 percent over the previous sealer.

- The new lacquer covers defects better and reduces lacquer runs and sag, subsequently decreasing the need for final product repairs by approximately 50 percent.

- From a business perspective, perhaps the most important benefit of switching to the high solids sealer and lacquer is that Beecher Falls believes that their final product quality has a fuller feel and better build.

Challenges

- The high solids sealer requires more time to dry. Beecher Falls increased the air flow in the sealer flashoff area. The longer drying time and increased air flow increased the potential for dirt to contaminate the coating as it dried. Beecher Falls constructed a flashoff tunnel to help prevent this. Layout changes were required to construct the tunnel.

- Because the sealer coat has a higher build, it is more difficult to sand and requires an average of 30 percent more time per item. To maintain the same production level, two additional workers have been added to the sanding station. In addition, Beecher Falls replaced their block sanders with orbital sanders and now use a different grit paper.

- Eliminating the second lacquer application requires tighter quality control and operator care when the single lacquer topcoat is applied. There is no longer a margin for error with the first coat that can be made up for with the second coat. Initially, this increased repair requirements. However, operator retraining and adjustment have overcome this problem.

Savings/Costs

	Savings or (Cost)
Labor	$175,000 per year
Materials	($42,000) per year
Capital Costs	($42,000)
Payback Period	4 Months

- Labor: Elimination of two lacquer operators and two scuff sanders, reductions in pre- and post-lacquer touch up, and the addition of two sealer sanders, combine for an estimated annual labor savings of approximately $175,000.

- Material: The new high solids coatings are twice as expensive as the original low solids coatings on a per-gallon basis. However, because the solids content is higher, less material is needed to achieve the same dry mil thickness. In addition, one lacquer application was eliminated. Therefore, the total quantity of coating used is less. Beecher Falls estimated an increased material cost of approximately $42,000 per year. However, high solids coating prices are decreasing, reducing this cost differential in the future. Beecher Falls has not determined the effect on electricity costs resulting from the in-line heaters and the increased air flow in the sealer flashoff area. However, due to the elimination of the second lacquer spray booth and its ventilation requirements, they do not believe there is a substantial increase.

- Capital costs: The cost of adding the in-line electrical heating systems and the flashoff tunnel was approximately $42,000.

- Payback period: Four months

<u>Secondary P2 Project: High Volume, Low Pressure (HVLP) Spray Guns</u>

In the late 1980's Beecher Falls began using HVLP guns for some of their coating applications because they are lighter and therefore ergonomically preferable when compared to conventional spray guns. Early in 1993, plant personnel investigated the possible benefits of replacing all of the remaining conventional spray guns with HVLP guns. Thorough testing on the actual finishing line for basecoat and stain application revealed an average increased transfer efficiency (TE) from 30 percent with conventional guns to 60 percent with HVLP guns and a 39 percent reduction in the amount of finishing material used to coat the same item. Air emissions are directly related to the amount of finishing material used (sprayed from the gun), and therefore a 39 percent reduction in air emissions, from the stations that were using conventional spray guns, occured by switching to HVLP guns.

At the time of the test, Beecher Falls still had 25 conventional spray guns. Approximately 53,000 gallons of finishing material was being sprayed from these 25 guns each year. A 39 percent reduction in material use translated into not having to purchase over 20,000 gallons of finishing material each year. Beecher Falls estimated that over $145,000 in finishing material purchase costs would be avoided each year if HVLP spray guns were used throughout the plant. The cost of a new HVLP spray gun was approximately $325, translating into a one-time $8,125 capital cost to produce a savings of over $145,000 each year thereafter. This translates to a payback period of

less than three weeks. The conversion to HVLP spray guns was immediately approved and implemented.

The only additional cost was training the operators on how to properly use the new spray equipment. Beecher Falls has seen no drawbacks to their switch to HVLP guns. They continue to monitor spray gun equipment developments in a constant effort to improve material use efficiency and reduce air emissions.

Other P2 Efforts

Aqueous-based basecoat: Beecher Falls has reformulated their color primer to an aqueous-based material. The black enamel used over the aqueous primer is still nitrocellulose-based due to space constraints that cannot support the increased drying time that would be required if aqueous paint was also used. Only certain portions of some pieces are painted black, so the overall air emissions from the facility are not significantly affected by the switch to an aqueous-based primer. Aqueous-based basecoats meet Beecher Falls' quality specifications for opaque applications only.

Aqueous-based spray booth coating: The spray-on, strippable spray booth coating used at Beecher Falls is now all aqueous-based. With 23 spray booths in use, and stain booths coated every 6 weeks and the others coated 4 times each year on average, this also helps to reduce air emissions.

Lacquer dust reclamation: The sealer and topcoat spray booths use metal filters. These are brushed at the end of each day to remove as much lacquer dust as possible. This is collected along with dust that has accumulated on the floor and placed in a 55 gallon drum. The dust is hand sifted through filters to remove impurities and then mixed with solvent to make a topcoat material that is used to coat the interior of drawers and the backs of items. Beecher Falls uses approximately three 55 gallon drums of reclaimed lacquer dust each week, diverting them from disposal. Approximately one drum of unusable dust (the filter reject) requires disposal as a hazardous waste every month. Including the avoided cost of disposal and the 3-4 hours of labor spent on the reclamation effort each day, Beecher Falls estimates that it costs them approximately $4 per gallon to reclaim their lacquer dust; much less than the cost of purchasing new sealer or lacquer. The main drawback to the lacquer dust reclamation effort is that the nitrocellulose dust is highly explosive and extra care must be taken when handling and storing this material.

Summary

Through investing in pollution prevention, the Beecher Falls Division of Ethan Allen reduced VOC and HAP emissions by approximately 50 percent, improved the work environment for its employees, and improved the efficiency of its production process; all while saving money. None of the changes made by Beecher Falls required a substantial capital investment, and each had a short payback period making them economically attractive. The switch to high solids nitrocellulose coatings required an up-front investment in electrical in-line heating equipment and a flashoff tunnel, and had a payback period of 4.5 months due to labor and coating material use savings. Converting to all HVLP spray guns required a capital investment to purchase the guns, and had a payback period of less than three weeks due to decreased coating material use.

For more information about this case study, contact:

Jennifer L. Griffith, P.E.
NEWMOA
129 Portland Street, Suite 601
Boston, MA 02114

(617) 367-8558, Ext. 303
(617) 367-0449, FAX

Paul Ford, Environmental Manager
Ethan Allen, Inc.
Ethan Allen Drive, PO Box 1966
Danbury, CT 06813-1966

(203) 743-8540
(203) 743-8298, FAX

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