Cleaner Technology Demonstration Site Case Study

Metallized Products, Inc., Winchester, MA

Electron Beam Curing

Summary

Metallized Products, Inc. (MPI) chose Electron Beam (EB) curing over more traditional coating/curing methods, a choice which has allowed them to develop new, unique products and to have a lower impact on the environment than if they had chosen a solvent-based system. The coatings used in EB curing are solvent free and do not require thermal drying, allowing the process to run at very high speeds. EB curing also allows MPI to avoid the regulatory reporting and permitting requirements associated with solvent- and aqueous-based coating processes. Though capital costs of these systems are high, the production time, space, and energy requirements are low, making EB an economically attractive coating method.

Background

MPI installed the first wide web electron beam processor in the United States in 1978 when they chose to diversify their vacuum evaporation business into coating and laminating. The coatings, which are specific to electron beam curing, use no solvents or volatile organic compounds. The EB process involves the coating of substrates with specially formulated, 100% reactive materials. As the coated substrates pass through the EB unit, they are bombarded with electrons.

The electrons ionize the materials, and the resulting free radicals instantaneously link to form long chains of atoms. In this polymerization process, the entire liquid coating converts to a solid with no mass loss.

Toxics Use Reduction Assessment

Because the EB process uses a 100% solids coating, no material is volatilized during the process. Though EB coatings contain no solvents or known carcinogens, they are not completely hazard free. Most EB coatings are allergens, and may be slightly toxic upon ingestion. In addition, the process uses radiation, though machine operators are protected by interlocked lead shielding which will not open if radiation is present. Although there are no fugitive emissions resulting from the coating process, solvents used to clean the equipment may contribute to emissions. MPI uses approximately 55 gallons of acetone per year to clean their coating equipment.

The EB process at MPI produces less hazardous waste than a typical solvent-based coating process and has less impact on air quality since there are no volatile emissions. They generate only two drums (110 gallons) of waste per year, which consist mostly of unusable or discontinued coatings and are sent off-site for incineration.

Economic Assessment

Because the EB process uses such small quantities of regulated toxics, there is a clear economic advantage when compared to other coating methods. For example, MPI pays a hazardous waste disposal facility approximately $160 per drum to incinerate their waste. Since they only produce two drums of hazardous waste per year, there are no other associated regulatory fees. In contrast, companies which use solvent-based (thermal) systems will pay significantly more per year in charges relating to their use of hazardous materials. These costs may include the salary of an employee to manage the hazardous waste, charges for disposal and storage documentation, increased insurance premiums for the storage of flammable materials, and in some cases, the purchase and operating costs of a thermal oxidizer to combust solvent emissions. The purchase and installation cost of a single EB unit ranges from $200,000 to $1,500,000, depending on the width and line speed of the equipment. A comparison between the capital equipment costs for electron beam and thermal processes is presented in Figure 1.

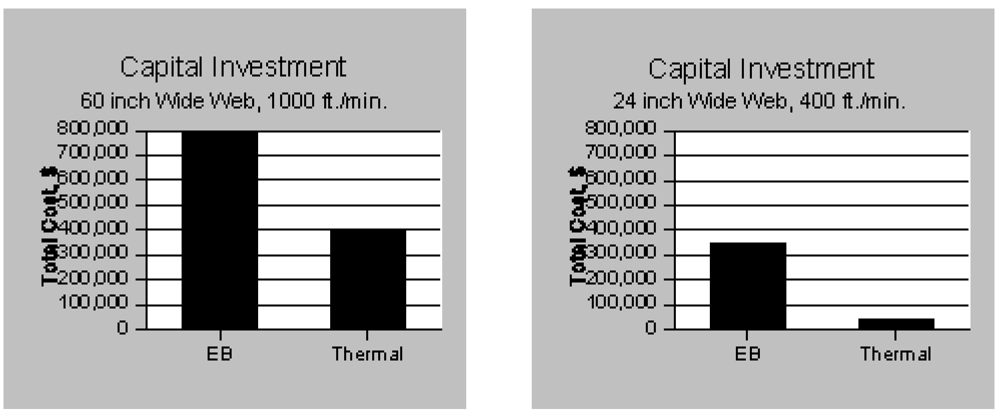

FIGURE - 1

The large capital investment in EB equipment may be overcome in several ways. A small company may choose to participate in toll manufacturing, by sending their goods to a company such as MPI to have materials coated for them. In the case of a company that has the need for high volume, high speed, in-house coating, the savings of production time, energy, space, and environmental regulation could pay for the EB unit in the long run. MPI was able to recover the investment made on their second, larger EB unit over the course of two years. The charts in Figure 2 show comparisons in space, speed, and operating costs between EB and thermal coating processes. Note that this model is simplified, since there are numerous factors which affect operating costs.

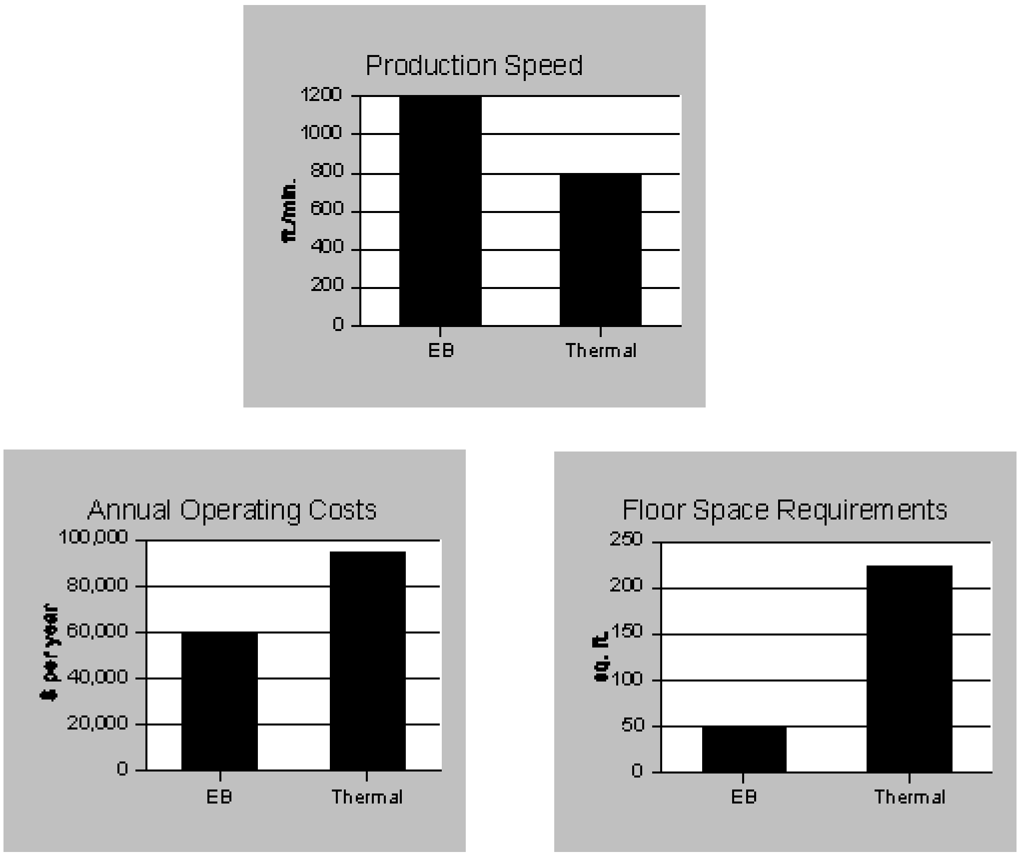

FIGURE - 2

Electron Beam curing can be used to meet a wide range of substrate and coating requirements, making it a high quality alternative to traditional coating, while offering features not available in thermal processes. Coatings can be varied by altering the coating chemistry or the penetration depth of the electrons. EB curing is unique because it uses chemistry, rather than heat, to polymerize the coating onto the substrate. Because no heat is used to dry or cure the coatings, it will not shrink or warp the product, making it ideal for heat sensitive substrates.

The list of products which have been successfully cured by the EB process is extensive. It includes such items as currency, consumer goods packaging, release liners, films, paper flyers, ready-to-assemble furniture, dry-erase marker boards, and laminates. EB can also be coupled with ultraviolet curing to produce a hybrid process to yield a more extensive range of properties.

This case study is part of the Toxics Use Reduction Institute's Cleaner Technology Demonstration Sites Program.