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POLLUTION PREVENTION OPPORTUNITIES IN THE MANUFACTURE OF PAINT AND COATINGS

BY

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Abstract

The paints and coatings industry is rapidly changing to meet environmental and economic pressures. Some of the changes include new coating formulations, higher performance finishes with improved properties, continued development of new technologies, and new application methods with improved transfer efficiencies. In order to control costs, improve productivity and quality, and protect the environment, more paint companies are turning to pollution prevention as the cornerstone of their waste management programs. Paint pollution prevention has been incorporated into many corporate total quality management (TQM) strategies.

There are many pollution prevention methods for the paint manufacturing industry which vary from very simple, inexpensive measures to new, expensive plant/equipment. The methods, techniques or programs can generally be classified as either recycling or source reduction and may involve material substitution, process or equipment modification, revised operating practices, operating procedures (such as waste stream segregation), personnel practices (such as operator training), loss prevention practices, or accounting practices. This paper will provide an overview of these practices in-place at particular manufacturing facilities to reduce wastes and associated costs, to be a more competitive industry that must still maintain quality and performance of its products.

The information in this article has not been subjected to Agency review. Therefore, it does not necessarily reflect the views of the Agency.

Introduction

The role of the paint and coatings industry in the U.S. economy is pervasive. Paint and coatings are essential not only for the decoration and protection of the surfaces of many new industrial products but also for the maintenance of existing structures and products, such as homes, vehicles, machinery and equipment, buildings and factories. Without these paint and coatings, many of our durable and non-durable goods would have a decreased life-span.

The manufacture of paints and coatings is big business with shipments exceeding $11.5 billion (1989) in the U.S. alone. Americans consume approximately 1 billion gallons annually, of which, approximately 50 percent is represented by architectural coatings. The annual growth rate for the industry is expected to be 1 percent (1991-1996). The product coatings area accounts for about 36% of (1991) shipments and special purpose coatings with 16% of 1991 shipments. The nine industries that are major consumers of paint and coatings include: (1) automotive; (2) trucks/buses; (3) metal cans; (4) farm machinery/equipment; (5) construction machinery; (6) coil coating; (7) wood furniture/fixtures; (8) metal furniture/fixtures and; (9) household appliances.

The driving forces behind the changes in paints and coatings continue to be product performance improvements and environmental regulations associated with new materials.

Paint and coating formulators as well as upstream raw material and resin suppliers are evaluating the components in their products and processes, changing the constituents to achieve desired performance of their coatings while also meeting new environmental rules. Paint producers undertake their own product research and development but also look to technological leaders to meet reformulation needs.

In addition to addressing product reformulation impacts, paint and coatings manufacturers are also examining their production methods to look for ways to control costs. To achieve improved productivity and quality, as well as protect the environment, more paint companies are turning to pollution prevention as the cornerstone of their waste management programs. Pollution prevention methods generally involve material substitution, process or equipment modification, modified operating practices and procedures (such as waste stream segregation), personnel practices (such as operator training), loss prevention practices or accounting practices. This paper will provide an overview of the paint industry's efforts to reduce wastes and reduce costs, while at the same time provide quality paint and coatings products which meet the performance requirements of a diverse customer base.

Review of Raw Materials

The primary raw materials used by the paint and coatings industry include resins, pigments, solvents and additives. In the production of liquid paints (latex and solvent-based), production methods are primarily physical, that is, there are no chemical reactions or conversions of raw materials to other products and byproducts. Paint is typically a dispersion of a finely divided pigment in a liquid composed of a resin or binder and a liquid vehicle.

There is a wide variety of synthetic resins used in coatings (i.e. acrylic, alkyd, vinyl, epoxy, polyester, urethane, etc). The synthetic resins are long chain polymers that may be linear, branched, or cross-linked or some combination of these forms depending on the functionality and reactivity of the monomers from thick they are formed. Resins are selected based on many factors but primarily on application and performance.

The liquid portion varies depending on whether the paint is solvent based or water-based. Typical organic solvents include methyl ethyl ketone, methyl isobutyl ketone, toluene, and xylene. Water based, water dispersed, or water soluble coating systems substitute water for some or all of the volatile organic solvent.

Manufacturing Process Wastes

In the manufacture of paint and coatings, paint manufacturing facilities generate different waste streams. Typical wastes include:

- Raw material packages, bags, containers from unloading materials into mixing vessels.
- Pigment dusts from unloading of pigments into mixing vessels

- Solvent emissions from storage tanks, leaks, and open process equipment
- Off-spec paints
- Spills
- Rinsewater from equipment cleaning using water or caustic solutions
- Paint sludge from equipment cleaning operations
- Filter cartridges with undispersed pigment, paint and/or resins.

Paint industries handle this waste by either on-site recycling, off-site recycling or treatment/disposal. On-site recycling involves the selected reuse of raw materials or wash materials in new batches of paints and coatings. Recycling of usable materials within the plant reduces the amount of new virgin raw materials needed per batch, resulting in significant reductions in operating aw well as waste management costs. On-site recycling of solvents may include distillations. Many companies send their wastes to an off-site recycler, though more and more of these companies are recycling their own wastes to reduce costs and improve operating efficiencies. Treatment/disposal operations available to paint manufacturers include incineration or land disposal. Typically, many paint manufacturers send solvent-containing wastes off-site to a cement kiln for inclusion in a fuels-blending program (for thermal destruction).

Of the wastes generated in a typical paint manufacturing facility, equipment cleaning wastes are by far the largest in volume, collectively accounting for some 80% of the industry's wastes. Process equipment and tanks are routinely cleaned to prevent product contamination and/or restore operation efficiency. Equipment that may need cleaning include high speed dispersion mixers, sand mills, colloid mills, rotary batch mixers and blenders, drum mixers and roller, grinding equipment, mixing vessels, pumps & motors, filters and strainers, filling and capping equipment and packaging equipment. Many paint manufacturers are finding pollution prevention provides significant opportunities for reducing wastes.

Pollution Prevention Methods for the Paint Manufacturing Industry

Pollution prevention, or the method of preventing polluting through source reduction and recycling, is becoming a cornerstone of most progressive waste management programs. Reducing wastes to remain competitive has been an important ingredient for successful business in the past and it will be absolutely essential in the future. So controlling and optimizing all parts of the manufacturing process is critical to reduce costs, improve processes and continue to be competitive and profitable.

Pollution prevention approaches can be broken down into the following categories:

- Source reduction - Good manufacturing practices, production process changes, and input material changes.

- Recycling - use and reuse of wastes, reclamation (on-site, off-site recovery).

Good manufacturing practices generally means better procedural or institutional policies and practices and can include waste segregation, personnel/employee practices, procedural measures, loss prevention practices, and accounting practices. Personnel practices can include upper management initiatives, employee training, and/or employee incentives. Careful attention to production and maintenance operations is important to reduce spills and minimize off-spec products. Making employees more aware of the impact of waste on the company's costs as well as the impact on the environment.

Procedural measures can include better documentation, better material and handling storage, material tracking and inventory control and better production scheduling techniques. For example, since thousands of different paint formulations require special production runs, more effective planning and production scheduling may be needed. Paint production, although a vital phase, must intermesh smoothly with purchasing, formulation sales, accounting, inventory, personnel management etc. to make it profitable. Production planning and scheduling may consist of a scheduling board listing the batches to be run on each piece of equipment and the expected starting and finishing times. It aids maintaining adequate inventory of active raw materials without overstocking and permits attainment of delivery of commitments to customers. Also, if practiced effectively, it helps level peaks and slumps in production during surges of short delivery orders or establish "downtime" of each piece of equipment while keeping check of overall efficiency and ensuring maximum equipment utilization.

In loss prevention practices, better awareness of spill prevention and in house preventive maintenance programs may be required. Accounting practices should incorporated better apportionment of waste management costs to the departments that generate wastes.

Most off-spec paint is generated by small shops that produce specialty paints. Since the production costs for specialty paints are typically high, most off-spec paints are reworked into marketable products. However, the cost of reworking off-spec paints are avoided if better trained and supervised operators as well as quality control are reinforced so that generation of off-spec paints are avoided.

Obsolete paint products and customer returns can be blended into new batches of paint. Obsolete products result from changes in customer demands, new superior products, and expired shelf life. Careful production planning and inventory control can reduce obsolescence resulting from expired shelf life. Also marketing policies such as discounting older paints can help reduce the amount of obsolete products.

There are many other ways of applying good manufacturing and operating practices.

For example, soliciting employee suggestions may uncover methods to make changes especially since the operators understand the process operations. Quality improvement teams make significant improvements to the quality of the product, optimize the process, improve efficiency and productivity, and reduce the wastes in the process. Furthermore, incentives, rewards, and bonuses can be used to support pollution prevention programs and reduce wastes.

Improving the efficiency of a process can significantly reduce waste generation. Available techniques range from eliminating leaks from process equipment to installing state of the art production equipment. This pollution prevention category includes improved operation and maintenance, procedural changes, and equipment modifications.

Equipment cleaning wastes represents the largest source of waste in a typcial paint plant. A method that reduces the need or frequency of tank cleaning or allow for reuse of the cleaning solutions is the most effective way to reduce wastes.

The use of mechanical techniques, such as rubber wipers, reduces the amount of paint left on the tank walls of a mix tank. Wipers are used to scrape the sides of a cylindrical mix tank (flat or conical). Equipment cleaning is usually a manual operation so this process may be justified based on rescued labor costs as well as reduced usage of cleaning solution (another savings). High pressure spray heads and limiting wash/rinse time systems can be used in place of regular hoses to clean water-based paint tanks. Studies show that high pressure wash systems can reduce water use by as much as 80 to 90 percent.

Teflon line tanks are sometimes used to reduce wall adhesion and improve drainage. This method is usually applicable to small batch tanks. A plastic or foam "pig" is used to clean pipes. This pig device is forced through the pipe from the mixing tanks to the filling locations, using nitrogen or some other inert gas to propel the pig.

Manufacturing procedures may be improved. For example, a paint facility's wash solvent from each solvent-based paint batch may-be separately collected and stored. When the same type of paint is to be made, waste solvent from the previous batch is recycled and used in place of virgin solvent.

Countercurrent rinsing processes can be applied to those plants with sufficient tanks space. This technique is used to recycle "dirty" solution initially to clean tanks and then is followed by a "clean" solution to complete the rinse cycle. The level of contamination builds up more slowly with the clean solution than the dirty reused solution thus extending cleaning solution life.

Spills due to accidental or inadvertent discharges usually occur during transfer operations or as a result of equipment failure. For example, during a loading operation, a spill may occur from a leaking fill hose or fill line connection or leaking valves, piping, and pumps. Sometimes spills occur from overfilling of tanks or due to improper or

malfunctioning overflow alarms. Improving regular equipment inspections and training programs prevent these spills from occurring as well as improved instrumentation and automation and efficient cleanup methods if spills do occur.

Small amount of dry materials used in paint may remain in bags. Capturing the pigments for reuse through vapor traps helps reduce waste problems. The availability of these materials in slurry or paste form eliminate problems of disposing of waste bags or packages. Empty containers of liquid raw materials that contain hazardous compounds are typically cleaned or recycled back to the original raw materials manufacturers or to a local drum recycler. This avoids the costs of disposing of the containers.

There are two major types of air emissions in paint manufacturing plants: VOCs and particulates. VOCs may be emitted from the conservation vents on top of the bulk storage tanks of resins and solvents and from the use of open processing equipment such as mix tanks. Since most process equipment is of open design, reducing VOCs from equipment could require substantial capital expenditure in retrofit costs. Closed vessels with overhead refrigerated condensers will require considerable capital requirements which most paint manufacturers cannot afford. In fixed roof design, maintained conservation vents, conversion to floating roof, use of nitrogen blanketing to suppress emissions or the use of refrigerated condensers. Implementing these options can result in cost savings to the paint and reduced raw material losses.

Dusts generated during handling, grinding, and mixing of pigments may be hazardous and therefore dust collection equipment such as hoods, exhaust fans, and bag houses are used. Use of pigments in paste form instead of dry will reduce or eliminate dust generated from pigments. The drums can be recycled.

Also, a major advance in paint manufacturing is the growing use of electronic control devices and batch automation. The intent is to avoid operational accidents, improve quality, and production efficiency, and the overall accuracy of the batch. The effect should be less waste generated. Computer use is increasingly being used for materials allocation and inventory control as well as preventive maintenance scheduling. As the costs associated with plant automation equipment decreases, the use of automation in paint manufacturing facilities will increase.

Case Studies

Four companies that have received special recognition for their pollution prevention programs by industry are Moline Paint Manufacturing co. in Moline, IL, Vanex Color, Inc. in Mt. Vernon, IL, Red Spot Paint & Varnish Co. in Evansville, IN, and Jamestown Paint Company in Jamestown, PA. Moline reported a 50% reduction of hazardous wastes in less than five years and reported savings of over $140,000/yr in disposal and raw materials costs. Moline's program included on site recovery for reuse, process modifications, statistical process control techniques of waste generation, improved housekeeping, employee

participation, and reuse of hazardous wastes off-site in a waste-to-energy recovery program.

Vanex Co. used source reduction and recycling methods. Ethylene glycol, a free-thaw stabilizer in latex paints, has been replaced with propylene glycol which exhibits less health concerns. Wash solvents generated from the production of solvent-based paints is recycled, when possible, into subsequent solvent-based paint batches. Unusable wash solvent was sent to a cement kiln. Approximately 80% of all wash solvent was recycled in-house resulting in savings of $15,000/yr.

Red Spot Paint & Varnish Co. initiated a full waste-tracking system to identify the exact point of origin of each unit process waste, which was then sampled and analyzed to determine its potential for recycling and reuse. The program concentrated on motivating employees to become more waste conscious and to train them in waste reduction methods and procedures. Through their program, the company saved more than $1 million by incorporating a number of seemingly insignificant equipment additions and a few equipment and tool modifications, which represented over 60% savings.

Jamestown Paint Company incorporated pollution prevention into their total quality management (TQM) program by focusing on waste minimization, quality control, customer satisfaction and increased profitability. Employees drawn from various operational and administrative areas formed process improvement teams, and each team was given specific objectives and charged with clearly defined improvement goals. Results a year after implementation of the program showed a reduction in hazardous waste by more than 75% and savings in excess of $100,000.

Pollution Prevention Techniques Applicable to Paint Manufacturing

The following summarizes some of the pollution prevention techniques paint manufacturers are using:

Source Reduction

- Schedule compatible solvents in sequence to reduce truck loading and drum flushing need.
- Schedule like colors through equipment.
- Install dedicated lines where feasible to reduce flushing.
- Segregate line and pump flushings to produce low-grade thinners suitable for cleaning purposes.
- Equip bulk storage tanks with vapor return lines.

- Install collector to remove pigment dust from manufacturing area.

- Increase drum inventories of high volume products to reduce changing of products in the drumming line.

- Replace wastewater treatment lagoons with new system incorporating concrete cells covered by fiberglass dome, equipped with venting of off-gases to destruction by burning.

- Eliminate dry bags by converting to titanium dioxide slurry system pumped directly to mixer.

- Install closed filtration systems to reduce VOC emissions (losses); also closed filter systems can eliminate residues once left in filter bags.

- Install odor/vapor capture systems on bulk solvent storage tanks, resin tanks and manufacturing tanks.

- Eliminate all obsolete materials for possible rework.

Reuse/Recycling in manufacturing process

- Recycle wash solvent whenever possible; to facilitate recycling, setup holding tanks for recovered washwater and wash solvent, segregate by color and/or product line; reuse wash solvents from one batch in the grind state of the next batch of the same formula.

- Collect pigment dust and recycle into batches.

- Reuse in batch production solvents used for cleaning sand mills, manufacturing tanks, and tankwagons.

- Reuse obsolete materials in present production.

- Use virgin solvent for tankwagon cleaning and reuse in subsequent production.

- Pass vapors generated during filling and manufacturing through filters to remove as much VOCs as possible; collect solvent that would otherwise have gone to atmosphere and use as wash solvent.

- Where possible, mix obsolete colors and sell as undercoat or primer.

- Accumulate all skids not usable at plant and give to skid vendor.

- Recycle used motor oil from company vehicles.

- Reuse cardboard shipping cartons and plastic pails; return corner boards on can shipments to supplier.

- Unrecyclable wash solvents can be used as supplemental fuel in cement kilns for energy recovery; establish contracts with cement kilns for recycling of unusable wastes with high BTU value.

- Inspect, repair, and reuse shipping pallets received with the purchase of raw materials or return to vendor.

- Rinse and crush metal containers and ship to scrap metal recycler.

- Recondition and recycle drums and five-gallon pails for use.

Conclusions

The paints and coatings industry will continue to seek new technologies to meet the growing needs and demands of our society. While there has been significant progress in the industry to reduce or eliminate waste, manufacturers of all coatings recognize that new environmental regulations may seek to significantly reduce their wastes even further. As a result, paint manufacturers will increasingly turn to pollution prevention techniques and methods to eliminate waste generation. Already, pollution prevention methods are making significant contributions to reduce paint wastes/sludges through source reduction, process/production techniques, good manufacturing practices, and material substitutions. The coatings industry's efforts will be important towards improving environmental quality. Many of the pollution prevention techniques developed by the paint industry are relatively simple and inexpensive and may only require a conscious change in operating procedures. Some changes such as new plant/equipment require greater monetary expenditures up front, but in the long run, may provide the company with significant cost savings and improved environmental quality.

Conclusions in this article are those of the author. No official support for these conclusions by the U.S. EPA is intended or should be inferred.

For Further information

There are many pollution prevention methods which have been published in various literature or can be obtained through industry contacts. For further information, please contact:

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16. ABSTRACT

The paints and coatings industry is rapidly changing to meet environmental and economic pressures. Some of the changes include new coating formulations, higher performance finishes with improved properties, continued development of new technologies, and new application methods with improved transfer efficiencies. In order to control costs, improve productivity and quality, and protect the environment, more paint companies are turning to pollution prevention as the cornerstone of their waste management programs. Paint pollution prevention has been incorporated into many corporate total quality management (TQM) strategies.

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