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Project Summary

Evaluation of Pollution Prevention Opportunities for Mold Release Agents

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EPA's Air Pollution Prevention and Control Division (APPCD) has assessed the processes, materials, installation practices, and emission characteristics associated with the application of mold release agents (MRAs). Emissions were estimated based on available information on MRA composition and consumption. Volatile organic compound (VOC) emissions of MRAs were estimated to be 126,000 tons (114,000 tonnes) per year. The study also found that polyurethane molding operations accounted for a significant portion of the total MRA emissions (about 25%) and that automobile seat and other foam molding operations accounted for most of the emissions associated with the polyurethane category. Thus, the polyurethane foam manufacturing industry was selected for a pollution prevention technology demonstration.

Several pollution prevention alternatives were identified for conventional MRA usage in the polyurethane foaming industry. An initial assessment of each of the identified technologies was performed. APPCD selected the Solvent Emission Reduction Technology™ (SERT™) process for further evaluation. A detailed assessment of SERT was made through a demonstration at the Integram-St. Louis Seating polyurethane molding facility in Pacific, Missouri. The demonstration evaluated the applicability and technical barriers associated with the penetration of the SERT process into the current MRA-using infrastructure, the overall emission reduction potential, and the costs associated with switching to the SERT process. The demonstration showed that a 60% reduction in VOC emissions is readily attainable with this process and that pollution prevention, e.g., the SERT process) is a much more cost effective way to reduce VOC emissions than conventional treatment methods.

This Project Summary was developed by EPA's National Risk Management Research Laboratory's Air Pollution Prevention and Control Division, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction and Background

Over the past several years, a new and innovative approach to reducing hazardous waste and emissions has been rapidly developing in the U.S. This new approach, called "pollution prevention," has been defined by the U.S. Environmental Protection Agency (EPA) as "the use of materials, processes, or practices that reduce or eliminate the creation of pollutants or wastes at the sources. It includes practices that protect natural resources through conservation or more efficient use."

In the Pollution Prevention Act of 1990 (PPA), the U.S. Congress passed legislation to make pollution prevention a major part of national environmental policy and required the EPA to facilitate the adoption of source reduction techniques by industries. Following the PPA, the U.S. Congress passed the Clean Air Act Amendments of 1990 (CAAA), which require the EPA to establish a basic engineering research and technology program to develop, evaluate, and demonstrate nonregulatory strategies and technologies for air pollution. In response to this legislation, the EPA published the Pollution Prevention Strategy (56 FR 7849), which outlines EPA's pollution prevention goals and sets forth a program to achieve specific objectives. A key component of the program outlined in the strategy is the establishment of a pollution prevention research program to assist in the development, evaluation, and demonstration of clean products and clean technologies. One such research program required the assessment of emissions and pollution prevention options for several consumer categories, including mold release agents.

The EPA's Air Pollution Prevention and Control Division (APPCD) completed an assessment of the processes, materials, installation practices, and emission characteristics associated with the application of mold release agents (MRAs). Eleven categories of industrial processes were identified as consumers of MRAs. Emissions estimates were developed based on available information on MRA composition and consumption for these 11 categories. While the available data were limited, total emissions from industrial mold release agent use were found to be significant. Volatile organic compound (VOC) emissions for the 11 categories of MRA processes were estimated to be 126,000 tons (114,000 tonnes) per year (tpy). The study also found that polyurethane molding operations accounted for a significant portion of the total MRA emissions (about 25%) and that automobile seat and other foam molding operations accounted for most of the emissions associated with the polyurethane category.

The study concluded that automotive and furniture seat cushion molding operations had the greatest opportunity for pollution prevention. These operations were identified because (1) their activity represents a significant fraction of the total national emissions associated with MRA usage, (2) processes related to MRA usage do not vary significantly in the automotive and furniture seat molding industries, making it likely that a single pollution prevention approach could be demonstrated that would be broadly applicable, and (3) several pollution prevention technologies at various stages of development are applicable.

Several pollution prevention alternatives were identified for conventional MRA usage in the polyurethane foaming industry. An initial assessment of each identified technology was performed. This initial assessment included potential to reduce emissions of VOCs, technical feasibility, and cost. Based on this preliminary evaluation, the Solvent Emission Reduction Technology™ (SERT™) process was selected for further evaluation. A detailed assessment of SERT was made through a demonstration at the Integram-St. Louis Seating polyurethane molding facility in Pacific, Missouri. The demonstration evaluated the applicability and technical barriers associated with the penetration of the SERT process into the current MRA- using infrastructure, the overall emission reduction potential, and the costs associated with switching to the SERT process.

Project Objectives and Scope

The purpose of this project was to identify pollution prevention options for the polyurethane foam molding industry. In addition, a demonstration of a best candidate technology was planned. The demonstration was to show that an alternative mold release system could be implemented into a current manufacturing facility. The system was to be evaluated on several key issues, including technical feasibility, VOC reduction, cost, worker acceptance, and effects on production rate and quality. The SERT process was compared to the conventional MRA system in place at the Integram facility. This system includes the use of high-volume, low-pressure (HVLP) spray guns. A detailed Quality Assurance Project Plan was prepared, reviewed, and approved in advance of the demonstration. This plan served as a guide throughout the demonstration and data analysis.

Summary of Results

VOC Emissions and MRA Usage

The SERT process proved to be effective at reducing MRA usage and thus VOC emissions. Table 1 shows the amount of MRA used and VOC released for each of the 20 lots. MRA usage was reduced from 5 lb/100 parts (2.27kg/100 parts) to 2 lb/100 parts (0.91 kg/100 parts). This corresponds to a decrease in VOC emissions of 3 lb/100 parts (1.36 kg/100 parts), representing a 63% reduction in VOC emissions. For a plant producing 2.1 million parts per year, the VOC reduction would be 35 tpy.

Optimization of the system and training of the sprayers would lead to even greater reductions in VOC emissions. During the study, it was determined that workers using the SERT system were spraying 30% more solids than the workers using the conventional MRA. Experience using this system will help the workers determine the proper amount of MRA to use, thus reducing the amount of overspray. The two spraying stations used in the study of the conventional process were combined into one for testing the SERT system. One section of the mold was being sprayed from beyond the optimum distance. This may have led to additional overspray in an attempt to compensate for the MRA that was not reaching the mold. If the system were optimized to equal the amount of solids sprayed by the conventional system, emissions reductions could exceed 70%. This would correspond to a 40 tpy reduction in VOC emissions from a plant such as the one in the demonstration.

Production Rate

The use of an alternative MRA can affect the production rate in two ways. First, production rate can be negatively impacted if the alternative MRA has a longer application time than the current MRA. Second, the production rate can be impacted if the alternative MRA has either a greater or lesser amount of downtime due to malfunctions or maintenance. Both the SERT and conventional MRA were spray-applied taking only a few seconds per part. The MRA application step was not a limiting factor with either technology. Downtime was also monitored during the demonstration. The cause for each downtime was determined to identify if the MRA were at fault. During the tests, downtime averaged less than 5 minutes per hour for both the conventional and SERT processes. No MRA related downtime was observed during the demonstration for either technology. Additionally, the number of parts molded per hour per number of active molds was determined for each lot. The difference in the values for the SERT and conventional processes was insignificant (less than 2%). Based on these observations, it can be concluded that the SERT process would not result in a significant impact on production rate.

Product Quality

As in most industries, molded polyurethane foam must meet specific surface qualities to ensure that the foam will be adequate for its intended use. Poor surface quality foams are often shredded for other uses, such as carpet backing, thus lowering the value to the manufacturer. During the demonstration, surface quality was evaluated by Integram's trained inspectors. Each molded part was initially inspected following demolding. The foam was allowed to finish curing and was then

***Table 1**. Summary of MRA Usage and VOC Emissions Measured During SERT Demonstration*

MRA Type	*Run No.*	*MRA Usage (lb/100 parts)*	*VOC Emissions* (lb/100 parts)*
Conventional	*1*	*6.1*	*5.9*
	2	*6.0*	*5.7*
	3	*4.0*	*3.8*
	4	*8.3*	*8.0*
	5	*6.8*	*6.5*
	6	*4.9*	*4.7*
	7	*2.9*	*2.7*
	8	*4.4*	*4.2*
	9	*3.5*	*3.4*
	10	*3.4*	*3.2*
	Average	*5.0*	*4.8*
SERT High Solids	*1*	*1.9*	*1.7*
	2	*2.3*	*2.0*
	3	*1.6*	*1.3*
	4	*2.1*	*1.8*
	5	*1.6*	*1.4*
	6	*1.6*	*1.4*
	7	*2.5*	*2.2*
	8	*2.0*	*1.7*
	9	*2.2*	*1.9*
	10	*2.3*	*2.0*
	Average	*2.0*	*1.8*
Average Percent Reduction (%)		*60*	*63*

**MRA usage estimates do not include all three spray stations. Based on historical information supplied by the test facility, the excluded station is estim*ated to contribute an additional 10% to the *total MRA usage.*

evaluated by a final inspector. The inspectors examined the foam for defects (i.e., tears, surface bubbles, and pore structure defects) and rated the pieces of foam on a pass/fail basis. There were no MRA related defects for parts made by either process. Based on the results of the demonstration, it is concluded that the SERT process would have no negative impacts on the quality of the molded foam.

Worker Acceptance

A key issue in implementing any new process is worker acceptance. If the workers are uncomfortable with a process or piece of equipment, overall performance and quality may suffer. During the test, the operators were asked for their opinion of the SERT system. Half of the operators were completely satisfied with the system in its present state. The others recommended minor changes to the system. The most common recommendation was the use of lighter, more flexible hoses and a swivel at the base of the spray gun. This would allow the operator more maneuverability and could potentially reduce overspray by giving the worker better access to the part that needs to be sprayed. The only other complaint voiced by the workers was the “cloud” the system produced. This was simply the vaporization of the carbon dioxide. By increasing the maneuverability of the worker, worker exposure to this “nuisance cloud” could be avoided. From these interviews, the workers appeared receptive to the SERT process.

Cost Details

The costs associated with implementing the new system were broken into two groups, capital and annual. The total capital investment for four SERT stations including freight, engineering, electrical improvements, and installation would be $290,000. The total annual cost is $164,000 (including operating costs of $117,000 and capital recovery costs of $47,000). The total annual cost for the conventional MRA is $98,600 ($96,700 operating costs and $1,900 capital recovery costs). From the total annual costs for the new and conventional systems and the VOC reduction, a cost effectiveness value can be calculated. The cost effectiveness for the SERT system is $1,870 per ton of VOC reduced. Several scenarios were generated by manipulating conventional MRA price, number of SERT stations required, and SERT MRA use rate. The results of this sensitivity analysis are presented in Table 2. The cost effectiveness for scenarios involving four SERT stations ranged from $1,090 to $2,390, while it ranged from $440 to $1,110 if only two stations were required.

Conclusions

The SERT process was found to be effective at reducing VOC emissions during the demonstration. On average VOC emissions were reduced 63%. Industry-wide, it was determined that 77% of the VOC emissions are due to plants with production greater than 4,000 tpy. If SERT was installed at large polyurethane plants using solvent-based MRA and the same VOC reductions were seen, VOC emissions from the use of mold release agents would decrease by 10,700 tpy. Additionally, these VOC reductions were obtained without loss of production or product quality.

The cost effectiveness value obtained for the SERT process with four stations was compared to standard add-on VOC control measures. Thermal and catalytic incinerators were chosen as the control methods, since many polyurethane facilities may not have the steam necessary to regenerate carbon adsorbers. The incinerators were designed and costs determined by the methods described in the OAQPS Control Cost Manual. The cost effectiveness value for a thermal incinerator was estimated at $8,040 per ton of VOC not released, while the cost effectiveness for the fixed bed catalytic incinerator was estimated at $6,440 per ton of VOC not released. From these values, it is clear that pollution prevention, (e.g., the SERT process) is a much more cost effective way to reduce VOC emissions than conventional treatment methods.

Table 2. *Sensitivity Analysis Results*

	Base	Scenario 1	Scenario 2a	Scenario 2b	Scenario 3	Scenario 4
Number of SERT Units	4	4	4	4	2	2
MRA Usage	Measured	Optimized	Measured	Measured	Measured	Optimized
Conventional MRA Cost	$5/gal [a]	$5/gal	$4/gal	$6/gal	$5/gal	$5/gal
TCI [b] (SERT)	$290,000	$290,000	$290,000	$290,000	$161,000	$161,000
Operating Costs (SERT)	$117,000	$95,000	$117,000	$117,000	$111,000	$89,000
TAC [c] (SERT)	$164,000	$142,000	$164,000	$164,000	$136,900	$115,300
TAC (Conv.)	$98,600	$98,600	$80,400	$116,700	$97,900	$97,900
VOC Decrease	35 tons [d]	40 tons	35 tons	35 tons	35 tons	40 tons
Cost Effectiveness	$1,870/ton	$1,090/ton	$2,390/ton	$1,350/ton	$1,110/ton	$440/ton

[a] 1 gal. = 3.79 L.
[b] TCI = Total capital investment.
[c] TAC = Total annual cost.
[d] 1 ton = 907 kg.

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The complete report, entitled "Evaluation of Pollution Prevention Opportunities for Mold Release Agents," (Order No. PB96-187745; Cost: $21.50, subject to change) will be available only from:
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