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Environmental Protection
Agency

Hazardous Waste Engineering Research
Laboratory
Cincinnati OH 45268

Research and Development

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EPA

Project Summary

Environmental and Energy Benefits of Microprocessor Control of Oven Airflows from a Coil Coating Operation: A Case Study

In most industrial coating operations, the percentage of the lower explosive limit (LEL) of volatile organic compounds (VOC) emissions typically remain at below 5 to 10 percent LEL. Although monitors are available to determine solvent concentration in the oven, most existing ovens require manual corrective action when potentially explosive oven atmospheres are generated. In 1982, a project was completed that developed and demonstrated the viability of using microprocessor technology to make VOC control of paint curing ovens less expensive and safer than present operations. This would be accomplished by lowering oven ventilation air flow, safely increasing LEL concentration to a maximum 50 percent and providing automatic control of oven ventilation systems. The demonstration system, however, was not operated at maximum LEL concentration; thus, the versatility of the system to operate at high LEL concentration was not determined. This project evaluates the system at a commercial facility while operating at higher concentrations approaching 50 percent LEL.

Included in the report is a description of the oven modification at the Prior Coated Metals Coil Coating facility in Allentown, Pennsylvania, and the oven operating conditions before and after the modifications. Also included are the operating economics of the oven and VOC control system.

This Project Summary was developed by EPA's Hazardous Waste Engineering Research Laboratory, Cincinnati, OH, 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

Industrial paint curing ovens utilize significant volumes of ventilation or dilution air to keep the solvent concentration within the oven at below its LEL. This dilution, however, must be heated to curing temperature and finally to incineration temperature. The requirement to raise the oven exhaust temperature to the incineration temperature in order to meet VOC emissions regulations adds significantly to the cost of manufacturing coated products. By reducing the volume of VOC-laden gases emitted from the curing oven, environmental control costs can be reduced.

The full report presents an evaluation of a commercial installation utilizing microprocessor technology to reduce the volume of VOC-laden gases that are emitted from the curing oven. The site of this evaluation was the Prior Coated Metals Coil Coating facility at Allentown, Pennsylvania. The system represents an extension of the microprocessor technology concept demonstrated in early 1982 at the Mack Trucks, Inc. facility in Allentown, Pennsylvania, which is presented in another report, EPA-600/S7-83-037. The Mack Trucks program designed, developed, and demonstrated the basic concept of microprocessor control for oven applications; however, the system was not operated at its maximum solvent concentration potential of 50 percent LEL during that program due to limitations in the production schedule and the bake oven design. Therefore, demonstration of the system operating at high solvent evaporation rates, compositions, and LEL concentrations was required to totally prove the capability of the concept.

This report describes an installation that operates over a range of solvent evaporation rates and compositions that can reach the control set points of 50 percent LEL and demonstrates the versatility of the technology. It also presents the pollution reduction results of the modified oven and resulting operating economics of the system.

The Chemical Coaters Association, the Department of Energy, and the Environmental Protection Agency jointly sponsored the original technology development program conducted at Mack Trucks and this commercial evaluation program at Prior Coated Metals.

System Operation

Prior Coated Metals is a coil coating facility whose curing oven is typically operated over a range of solvent evaporation rates which result in variable oven solvent concentrations.

Typical oven operating conditions and fuel demands are presented in Table 1. As shown, the percent LEL within the oven is 5 to 6 percent with a flow rate of 5.75 to 7.3 std m^3/sec. With the installation of the microprocessor system, four conditions had to be met: (1) optimize the emissions control system operation; (2) reduce total energy demand; (3) reduce inplant VOC levels; and (4) provide safety and curing oven process control.

The oven modifications included the installation of a microprocessor, VOC analyzers, appropriate dampers, air seals, and duct modifications. Final installation and check-out was completed in December 1983, although the system had been operated successfully minus one air seal since May 1983.

Results

The microprocessor system modification to the oven resulted in a major reduction in VOC emissions, which significantly reduced pollution control and manufacturing costs. Table 2 summarizes operating conditions after the installation of the microprocessor system. The results of the evaluation indicated consistent achievement of greater than 95 percent VOC destruction efficiency based on 760°C (1400°F) incinerator operating temperature. The ventilation air flow rate was reduced approximately 60 percent and resulted in a total fuel demand reduction of approximately 60 percent.

Conclusions

The evaluation indicated that an oven utilizing microprocessor technology can be operated at high LEL concentration without adverse effects on system performance of product quality. With reduced air flow, capital expenditures for pollution control and operating costs are reduced because of the smaller volume of gas that must be processed by the oven and control system. The use of microprocessor technology is thus considered to be a versatile and important tool to assist in eliminating or reducing VOC pollution and associated control costs.

Table 1. *Typical Operating Conditions and Fuel Demand Before Retrofit**

Curing Oven Conditions	
Oven Air Flow Rates, std m^3/sec (std ft^3/min)	*5.76 to 7.27 (12,200 to 15,400)*
Solvent Evaporation Rates, m^3/s (gal/min)	*.00001 to .0001 (0.1 to 1.0)*
Oven Exhaust Temperature, °C (°F)	*249 to 382 (480 to 720)*
Average Fuel Demand, MW (Million BTU/h)	*2.43 to 3.31 (8.3 to 11.3)*
Percent LEL %	*5 to 6*
Incinerator Conditions	
Air Flow Rates, std m^3/sec (std ft^3/min)*	*6.53 to 8.04 (13,800 to 17,000)*
Incinerator Exhaust Temperature, °C (°F)	*538 to 649 (1,000 to 1,400)*
Average Fuel Demand, MW (Million BTU/h)	*1.76 to 3.16 (6.0 to 10.8)*

*Includes air flow from coater room and quench air.

Table 2. *Average Oven and Incineration After Retrofit*

Curing Oven Conditions	
Oven Air Flow Rates, std m^3/sec (std ft^3/min)	*3.1 (6500)*
Solvent Evaporation Rates, m^3/s (gal/min)	*.00005 (.5)*
Oven Exhaust Temperature, °C (°F)	*280 (535)*
Average Fuel Demand, MW (Million BTU/h)	*1.52 (5.2)*
Incinerator Conditions	
Air Flow Rates, std m^3/sec (std ft^3/min)	*3.1 (6500)*
Incinerator Exhaust Temperature, °C (°F)	*760 (1400)*
Average Fuel Demand, MW (Million BTU/h)	*1.21 (4.1)*
VOC Destruction Eff., %	*99.9*

The Project Summary was prepared by staff of Chemical Coaters Association, Wheaton, IL 60181.
***Charles Darvin** is the EPA Project Officer (see below).*
The complete report, entitled "Environmental and Energy Benefits of Microprocessor Control of Oven Airflows from a Coil Coating Operation: A Case Study," (Order No. PB 85-121 135; Cost: $8.50, subject to change) will be available only from:
National Technical Information Service
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