Project Summary

Evaluation of a Paint Spray Booth Utilizing Air Recirculation

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The effectiveness of the recirculating air spray booth process at the Deere and Company facility in Davenport, Iowa, was evaluated. The effort involved a field measurement program and subsequent analysis of flow rates and emission data from the spray booth to define the degree of enhancement of the emissions stream and permit more efficient and economical control of spray booth emissions.

This Project Summary was developed by EPA’s Industrial Environmental 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

Energy conservation became a matter of concern for industrial operators during the late 1970s, when energy costs began to climb rapidly. Deere and Company engineers noted that if heated in-plant air, which passed through the spray booth to the outside air, could be recirculated and worker environments kept within safety standards, significant energy costs could be saved. An added benefit of this recirculation scheme would be the reduction in emission volumes. This reduction can result in significantly lower volatile organic compound (VOC) control costs, since only the quality of make-up air must be controlled under these circumstances.

System Description

Through rerouting the ductwork and modifying operator apparel to ensure worker safety, Deere and Company designed a recirculating air system that was patented in May 1981. Included in the design was a bleed stream which controls VOC buildup in the recirculating system by routing a portion of the air to a natural gas burner, where it serves as combustion air.

Test Plan Development

Based on a site survey conducted in July 1982, a test plan was developed to evaluate the system. The plan selected was designed to focus on operating parameters such as paint usage during test periods, parts handled, recirculation rate, bleed stream flow rate and VOC concentration, and burner efficiency. The amended test plan was approved on December 1, 1982 and the field effort scheduled for the week of December 13, 1982.

Color Changing

The Davenport system demonstrates a great deal of operational flexibility which should allow for its application to a number of alternative activities. Observations inside the spray booth over an extended time period indicated an ability to change colors rapidly (within one minute) without affecting product quality when electrostatic spray guns are used. This capability makes the process highly attractive in situations of frequent color changing, where it was previously thought that recirculating processes were at a distinct disadvantage to a once-through system.

Recirculation Rate

The circulation rate of the booth air was slightly over 89 percent, resulting in an actual emissions rate of 8850 scfm.
premodification emissions rate was 132,000 scfm. Although the exact economic benefit for a given operation is dependent upon the reduction in emissions volume to the atmosphere, the energy savings achieved by the Deere prototype system was determined to be approximately $25,000 annually.

**Spray Booth**

A comparison between paint solvent quantities introduced into the spray booth and measured VOC concentrations in the various exhaust streams was made in order to determine where the solvent left the system. Calculations showed that about 10 percent of the solvent introduced into the spray booth was captured by the bleed stream system and routed to the natural gas burners for destruction. The remaining 90 percent was carried to the curing oven on the parts, in the exhaust air stream to the curing oven, or remained in the paint sludges.

**Burner Efficiency**

Deere and Company has chosen to control the VOCs in the bleed stream by combusting them in natural gas burners operating at an adjacent water wash treatment system. Early test results indicated a malfunction in the monitoring/alert system installed to insure efficient combustor operation. Deere and Company technicians quickly remedied the problem and achieved a demonstrated VOC destruction efficiency of over 99 percent. However, the nature of this effort did demonstrate the need for a reliable VOC monitoring and surveillance system to maintain system operating efficiency.

**Conclusions**

- The air flow rate exhausted from the booth was reduced by 89 percent, resulting in a significant energy savings. The total energy savings will vary with the flow reductions achieved. At the Davenport facility the calculated savings was $25,400 annually.
- The reduced system exhaust through the bleed stream resulted in higher VOC concentrations. The maximum concentration reached in the booth during the evaluation was .2% lower explosion limit (LEL).
- Paint application procedures including frequent color switching were not affected by installation of recirculation.
- Worker acceptance was good due to a concerted effort to provide the employee with protection. Deere and Company used an artificial environment system to give spray booth workers an outside breathing source.
- Air recirculation can modify the spray booth emissions stream and enhance its potential for efficient and economical VOC control by lowering the emissions volume.
- Routing of the VOC-laden air to serve as combustion make-up air for a gas fired water heater (parts washer) resulted in 99+% destruction of the VOCs.


Charles Darwin is the EPA Project Officer (see below). The complete report, entitled “Evaluation of a Paint Spray Booth Utilizing Air Recirculation,” (Order No. PB 84-245339; Cost: $11.50, subject to change) will be available only from:

- National Technical Information Service
- 5285 Port Royal Road
- Springfield, VA 22161
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