United States
Environmental Protection
Agency

National Risk Management
Research Laboratory
Research Triangle Park, NC 27711

Research and Development

EPA/600/SR-97/011 April 1997

EPA

Project Summary

Fractional Penetration of Paint Overspray Arrestors

Charles H. Darvin

The report describes the development of fractional penetration curves for liquid droplet penetration of overspray arrestors for discrete droplet diameters from 0.3 μm to 10 μm. (NOTE: fine particulate are particles with diameters of 10 μm or less.) These data points were obtained for two conditions: 1) for a clean arrestor and 2) for an arrestor coated with paint. The paint was applied to the arrestor by spraying high solids baking enamel from a spray gun directed at the paint overspray arrestor with the air flowing a face velocity of 120 fpm (0.61 m/s).

Paint overspray arrestors tested can be grouped into three generic designs. This work demonstrated that, for the conditions of the tests, the behavior of the paint overspray arrestor is peculiar to the design of the arrestor. The program also defined the efficiency of the test method used to define the fractional penetration.

The results indicated that, with the five different arrestor systems tested, the 50% cutoff diameter (where at least 50% of the particles will be captured by the arrestor) ranged from 3 to 7 μm. The two-stage polyester bag system showed the smallest cutoff diameter at approximately 3 μm. The inertial separator system designs exhibited the greatest cutoff level at approximately 7 μm.

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

A request for technical assistance was received by EPA's Control Technology Center (CTC) from the City of Philadelphia, PA, to evaluate the relative emissions from various dry paint arrestors. A study was initiated by the CTC to develop the requested data. The results of the initial study indicated that most dry arrestors operate at 90 to 99+ % arrestance - based on a total weight capture basis. However, it was also determined from these studies that the capture of particles less than 10 μm in diameter (PM10) varied significantly for different designs. This suggested that, although the efficiency in terms of total weight captured is high, the capture efficiency for fine particulates could be vastly different. This is because fine particulates comprise only a small percentage of the total mass of paint overspray, and thus their capture is not significant in the total weight method.

Based on these findings, additional study was commissioned by the CTC to evaluate the fine particulate emissions (fractional penetrations) of the various dry paint overspray arrestor designs.

Fractional Penetration

A test protocol was developed to measure the fractional penetration of aerosol droplets emitted (penetrating) through paint overspray arrestors. Fractional penetration is defined as the fraction of particles or

droplets of a given size that avoid capture when challenging an air cleaning device; e.g., a filter or separator. Fractional penetration is equal to 1 minus the capture efficiency of the arrestor. Capture efficiency and fractional penetration are both functions of the particle or droplet diameter.

The droplet diameter at which 50% of the droplets penetrate the device (the remaining 50% are captured) is termed the "cutoff diameter." The "cutoff diameter" is only one of many descriptive criteria for separation devices and is deemed appropriate to define paint overspray arrestor efficiency in the fine particulate PM10 range.

Research Test

The research was performed in a specially outfitted single pass wind tunnel that allowed for spraying paint onto the paint overspray arrestors. The air flow was controlled to provide a 120 fpm (0.61 m/s) face velocity at the filter. The procedure measured the droplets in discrete size ranges both upstream and downstream of the paint arrestor. The ratio of downstream concentration to upstream concentration for each size range was determined as the fractional penetration for that specific range of particle or droplet diameter. The fractional penetration of each paint overspray arrestor design tested for this program was initially measured in a clean condition, and then measured again after being coated with a high solids baking enamel.

The data quality objective (DQO) of the project was quantification of fractional penetration to within 0.1 at the 90% confidence level over the particle size range from 0.3 μm to 10 μm, and to resolve the particle or droplet diameter plus or minus 20%, in an air flow velocity of 120 fpm at the filter face. This DQO was met for 98.5% of the data.

The test procedure used during this program was developed to permit an assessment of the fine particulate capture capability of paint overspray arrestors. It was specifically developed to avoid the measurement interference presented by a weight efficiency method. This report gives the procedure for performing the tests and the results of testing five types of paint overspray arrestors.

Results

The five different paint overspray arrestors that were tested exhibited a range of cutoff diameters from 3 μm to 7 μm.

The measurement of fractional penetration indicated that the PM10 penetration varied widely between designs. The two-stage polyester bag paint arrestor showed the smallest cutoff diameter of all systems tested. This system achieved a 50% fractional penetration at the 3 μm droplet diameter.

Fiber-filter-based designs tended to maintain their fractional penetration after loading with paint. The inertial-separator-based designs maintained their fractional penetration after loading with paint, resulting in cutoff diameters of greater than 6 μm.

Charles H. Darvin *(also the EPA Project Officer) is with the Air Pollution Prevention and Control Division, National Risk Management Research Laboratory, Research Triangle Park, NC 27711 (see below).*

The complete report, entitled "Fractional Penetration of Paint Overspray Arrestors," (Order No. PB97-147 953; Cost: $28.00, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officer can be contacted at:

Air Pollution Prevention and Control Division
National Risk Management Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park, NC 27711

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Center for Environmental Research Information
Cincinnati, OH 45268

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