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Project Summary

Evaluation of the Effectiveness of Chemical Dust Suppressants on Unpaved Roads

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The long-term effectiveness of five unpaved-road chemical dust suppressants was measured. Effectiveness at controlling total particulate emissions in three size fractions (< 15, < 10, and < 2.5 μm) was determined over several cycles of chemical application, control effectiveness decay, and chemical reapplication. All five chemicals were tested on the same road with each chemical used on separate, abutting road segments. The chemicals were applied in quantities that spanned the range of common practice in the steel industry. Traffic parameters were typical of the steel industry. Over a 30-day period, control effectiveness of each chemical decreased: in some cases by as much as 50%, and in others by as little as 10%. Control effectiveness for all chemicals was greater than 95% immediately after chemical application or reapplication. The rate of decay was approximately the same for all particle size ranges investigated. Road surface silt loading was found to be a reliable indicator of relative effectiveness for some chemicals.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, 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

Many studies of the iron and steel industry have shown that open dust sources (e.g., vehicular traffic on paved and unpaved roads, material handling, and wind erosion) merit prime consideration in the development of particulate emission control strategies. This conclusion has been based on (a) industry-wide comparisons between uncontrolled emissions from open dust sources, and (b) typically controlled fugitive emissions from major process sources such as steelmaking furnaces, blast furnaces, coke ovens, and sinter machines. In addition, preliminary cost-effectiveness (dollars expended per unit mass of reduced particulate emissions) analysis of promising control options for open dust sources has indicated that control of these sources might result in significantly improved air quality at a lower cost compared to the control of process sources.

Of open dust sources, vehicular traffic on paved and unpaved roads generally account for the vast majority of particulate emissions in the iron and steel industry. For the 1970s, unpaved surfaces were estimated to account for roughly 70% of open source particulate emissions in the industry. By the early 1980s, the contribution was considerably less. This reduction was due to implementation of dust control programs which, in addition to chemical treatment of unpaved roads, included paving many roads and using shuttle buses to reduce emissions from employees commuting to their work stations.

Some unpaved roads in the iron and steel industry are, by their nature, not suitable for paving. These roads are normally used by very heavy vehicles or may be subjected to considerable spil

lage. Because of the additional maintenance costs associated with a paved road under this type of service environment, emissions from these roads generally are controlled with regular reapplications of chemical treatments.

Besides water, petroleum resins (such as Coherex®) have historically been the products most widely used in the industry; however, considerable interest has been shown at both the plant and corporate level in alternative chemical dust suppressants. As a result of this continued interest, several new dust suppressants have been introduced recently, including asphalt emulsions, acrylics, salts, and adhesives. In addition, the generic petroleum resin formulations developed at the Mellon Institute with funding from the American Iron and Steel Institute (AISI), have gained considerable attention. These generic suppressants were designed to be produced on-site at iron and steel plants.

The overall objective of this study was to provide data that document the reduction of particulate emissions (in several particle size ranges) generated by vehicular traffic on representative unpaved roads in the iron and steel industry following control application. The data were used to provide average control efficiencies for common road dust suppressants, over ranges of averaging periods and application parameters that span typical values used in the iron and steel industry. Information of this type is valuable to both industry and regulatory personnel in developing and monitoring dust control programs.

Secondary objectives, which largely supported the primary objective stated above, included: (a) a survey of current and projected industry practices in unpaved road dust control; (b) characterization of traffic on unpaved roads in the industry; (c) collection of cost data to develop relative cost-effectiveness values for the suppressants evaluated; (d) examination of less expensive measures to monitor control performance; and (e) analysis of previous studies to develop a model to estimate control performance.

Summary and Conclusions

The purpose of this study was to obtain data characterizing the average control performance of dust suppressants commonly used by the iron and steel industry to mitigate particulate emissions from unpaved roads. Vehicular traffic on unpaved roads has been estimated to contribute more than half of the suspended particulate emissions from open sources in the industry.

Control efficiency values were determined not only for total particulate (TP), but also for particles < 15 μm in aerodynamic diameter (inhalable particulate, IP), < 10 μm in aerodynamic diameter (PM_{10}), and < 2.5 μm in aerodynamic diameter (fine particulate, FP). The study focused on PM_{10} control performance of dust suppressants in particular, because this size fraction is anticipated to form the basis of any revised National Ambient Air Quality Standard for particulate matter.

To make the control performance test results as useful as possible to the industry, unpaved road vehicular traffic characteristics and dust control techniques used in the industry were surveyed early in the study. Subsequently these results formed the basis for the design of the field testing program so that commonly used suppressants could be evaluated under service conditions representative of typical iron and steel industry unpaved roads.

The exposure profiling method developed by MRI was the technique utilized to measure uncontrolled and controlled emission factors for vehicular traffic on unpaved roads. Exposure profiling of roadway emissions involves direct isokinetic measurement of the total passage of open dust emissions about 5 m downwind of the edge of the road by means of simultaneous sampling at four points distributed vertically over the effective height of the dust plume. Downwind particle size distributions were measured using cyclone precollectors followed by parallel-slot cascade impactors. Upwind particle size distributions were also determined using impaction. A total of 64 tests of controlled and uncontrolled particulate emissions from vehicular traffic on unpaved roads were conducted at two iron and steel plants.

Five chemical dust suppressants were evaluated during the study: Petro Tac, an emulsified asphalt; Coherex®, a petroleum resin; Soil-Sement, an acrylic cement; Generic 2 (QS), a generic petroleum resin product developed at the Mellon Institute; and Liquidow, a salt (calcium chloride). All products, except Generic 2, have been used in iron and steel plants. In addition, industry personnel have expressed considerable interest in the use of Generic 2.

These suppressants were applied i quantities that generally span the rang of common practice in the industry manufacturers' recommendations, an previous field evaluations. Control effi ciency was measured over periods up t 70 days after application, although th main averaging period of interest wa about 1 month. The latter is represen tative of time periods between contrc applications in the industry.

All chemicals tested exhibited averag control efficiencies of about 50% or mor over the first 30 days after application These tests were conducted using appli cation and traffic parameters that ma be considered typical in the iron and stee industry. Note that, while the contro provided by some suppressants showe significant temporal decay, others exhi bited a relatively constant level of contro over the time period.

Statistical analyses of the data indicat that reapplication results in a signifi cantly higher level of control and tha only one suppressant exhibited signifi cant differences in control between th various particle size fractions. Compar isons between the control efficiencies fo different chemicals indicate that rela tively few suppressant/size fractio combinations could be considered signif icant at the 5% level.

Comparison of the relative cost effectiveness reveals only a slight vari ation between the suppressants othe than calcium chloride. In terms of cost effectiveness, the salt did not compar favorably with the other products; how ever, this is at least a partial result o the abnormally high precipitation durin the field exercise.

Several road surface material proper ties were discussed as possible indica tors of control performance. While reasonably strong relationships betwee silt loading and control were found fo some of the suppressants, the clustere nature of the entire data set precluded development of a reliable performanc indicator. However, the data suggest tha the industrial paved road emission facto equation may be used to conservatively overestimate emissions from controlle unpaved roads.

Finally, results of previous tests were combined with data from the presen study to develop an average contro performance model for petroleum resins The model was designed to meet typica needs in the iron and steel industry ir

terms of averaging periods and service environments.

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The complete report, entitled "Evaluation of the Effectiveness of Chemical Dust Suppressants on Unpaved Roads," (Order No. PB 88-139 936/AS; Cost: $14.95, subject to change) will be available only from:
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