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Project Summary

Demonstration of the Use of Charged Fog in Controlling Fugitive Dust from Large-Scale Industrial Sources

Edward T. Brookman and Kevin J. Kelley

Although charged fogging has been widely applied to industrial sources of fugitive dust, little data are available regarding fogger control effectiveness on particulate matter. To obtain such data, a full-scale demonstration of a charged fogger was conducted on several industrial fugitive emission sources. The sources tested included a primary rock crushing operation, a secondary rock crushing operation, a molten iron spout hole at a blast furnace cast house, and a coke screening operation. The fogger evaluated was the "Fogger IV" manufactured by the Ritten Corporation. The report presents and discusses the results of these four source tests.

The report also presents and discusses the results of three other source tests. The same charged foggers were used, along with a charged fogger developed by AeroVironment, Inc., Pasadena, CA. The sources for field testing the two foggers were a stainless steel slab torch cutting operation, a conveyor transfer operation at a recycle (sinter) plant, and a limestone crusher/conveyor operation.

In general, the tests showed that (1) the control of emissions by the two foggers are generally comparable, (2) fogger efficiency depends on the positions of the foggers in relation to the source, and (3) charging a water spray appears to increase its effectiveness in controlling particulate matter emissions by up to 40 percent.

This Project Summary was developed by EPA's Industrial Environmental 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

A spray of fine water droplets is a well known means of airborne dust removal. Various types of scrubbers rely on water droplets to remove entrained particles from streams, and direct water sprays are often used in mining and material handling for dust suppression. Unfortunately, water sprays are not very effective in removing dust from ambient air.

One way to improve the effectiveness of water sprays is to apply an electrical charge to the spray that is opposite in polarity to the charge on the dust to be suppressed. Most industrial pollutants and naturally occurring fugitive dusts acquire an electrostatic charge as they are dispersed into the air. Exposing this charged airborne material to an oppositely charged water spray enhances contact between the particulate matter and the water droplets. After contact is made, the wetted particulate matter agglomerates rapidly and falls out of the atmosphere.

The effectiveness of these charged sprays can be improved by atomizing the water droplets, producing a fog. The fineness of the fog droplets enhances the charge-carrying capability of the spray. Previous work has shown greatest effectiveness when water droplet size is similar to that of the dust particles to be controlled. There is also the benefit of reduced operating costs since less water is required when fog is used.

A device that produces such a fine spray and applies an electrostatic charge to it is known as a charged fogger. The charged fogger is intended primarily for fugitive dust sources that cannot reasonably be controlled conventionally, such as by hooding. Such sources include material-handling (transfer points and conveyors), truck and railroad car loading and unloading, front-end loaders, ship loading, grain silos, and mining.

Although charged fog has been widely applied to industrial sources of fugitive dust, little quantitative data are available on fogger control effectiveness on particulate matter. To obtain such data, a full-scale demonstration of a charged fogger was conducted on several appropriate industrial fugitive emission sources. Particular interest was in testing the largest fogger, designated "Fogger IV," manufactured by the Ritten Corporation of Ardmore, PA, on several sources in the iron and steel industry and the sand and gravel industry.

After many visits to iron and steel plants and sand and gravel companies, several sources were selected for Phase I field-testing the charged fogger:

- Sand and gravel company: primary rock crushing.
- Sand and gravel company: secondary rock crushing.
- Iron and steel plant: molten iron spout hole at a cast house.
- Iron and steel plant: coke screening.

Coincidentally with the EPA fogger test program, Armco, Inc., agreed with EPA Region 5 to set aside funds to demonstrate the use of electrostatically charged fog on several fugitive dust sources at Armco's plants.

To provide Armco with state-of-the-art information on charged fog technology, two types of charged foggers were to be field tested under Armco's agreement: the Ritten Corporation's Fogger IV, and a fogger developed by AeroVironment, Inc. (AV) of Pasadena, CA. Compared with the Ritten fogger, the AV fogger uses a different method of charging the fog and a different method of fog dispersal. Testing both foggers side-by-side would give a basis for comparison for future decisions to select a charged fogger.

The sources selected for Phase-II field-testing the two foggers were at Armco plants and included:

- A stainless steel slab torch cutting operation.
- A conveyor transfer operation at a recycle plant.
- A limestone crusher/conveyor transfer operation.

The report gives results of both Phase I and II charged fogger tests.

Summary and Conclusions

Results of the seven field tests led to several conclusions regarding the performance, operation, and field installation of the foggers tested.

Performance

- Charging a water spray appears to increase its effectiveness in controlling particulate matter emissions by up to 40 percent.
- The two Ritten foggers, operating at a combined water flow rate of approximately 160 l/hr, were capable of 60 percent effectiveness in controlling particulate matter emissions. For control efficiencies greater than 90 percent, water flow rates of 300 - 400 l/hr would most likely be required for the sources tested.
- The Ritten and AeroVironment charged foggers were essentially comparable in terms of baseline emissions reduction and increase in effectiveness due to charging.
- The foggers tested did not visually improve plume opacity because
  - The fog itself has an opacity associated with it.
  - The fogger water flow rates were insufficient to completely control the quantity of emissions generated.
  - Several of the sources were hot, causing the fog to turn to steam and thus add to the visible plume.

Operation

- Both foggers are extremely difficult to operate in subfreezing ambient temperatures. This problem might be alleviated either by adding glycerin to the water or using steam instead of water. Both solutions have been successfully demonstrated in the laboratory.
- Both foggers, as designed, are not rugged enough to withstand the harsh environments often associated with industrial dust sources (e.g., molten metal, heavy dust plumes, caustic materials).
- The nose cone and control panel of the Ritten fogger should be redesigned to allow for easier access to the inner workings. As designed, Fogger IV is extremely difficult to work on in the field.

Field Installation

- The foggers should be run with as low a fan speed as possible to avoid dust reentrainment. The fan speed should be no greater than that necessary to carry the fog to the source.
- Foggers should be placed above a dust source and aimed down upon it. This should help to isolate the agglomerated particles at the source.

In general, both foggers, as designed, show promise, but have design and operational problems. The problems include dust reentrainment from the fan-forced air used to carry the fog to the source, freeze-ups in cold weather, frequent shorting of electronics, lack of mobility, and water flow limitations. Both foggers were prototypes, and the tests focused primarily on evaluating the two different concepts. However, neither fogger is ready for use in industry and neither performed much better than the other.

Future development of the Ritten foggers is no longer with the Ritten Corporation, which terminated their business after the study began. Ritten foggers are now being manufactured and sold by the Sonic Development Corporation. Sonic is incorporating their sonic dry-fog nozzles into the Ritten induction ring foggers. To date, Sonic is developing a prototype Fogger I (the original, small Ritten fogger) using a 15 l/hr (4 gph) water flow nozzle that produces droplets in the 1 - 40 μm range. They are also planning a Fogger IV with a Sonic nozzle. Some of the inherent problems of the Ritten foggers have been addressed by Sonic personnel. They have eliminated waterlines to the gauges and heat-traced those leading to the nozzles, which should eliminate freeze-ups. They are also using a nozzle that produces finer droplets which should increase the charge/droplet ratio and thus capture efficiency. Sonic has also put the controls in a separate industrial-strength box to reduce maintenance. The product line offered should be a significant improvement over the prototypes tested during the study.

Edward T. Brookman and Kevin J. Kelley are with TRC Environmental Consultants, Inc., East Hartford, CT 06108.
Robert C. McCrillis *is the EPA Project Officer (see below).*
The complete report, entitled "Demonstration of the Use of Charged Fog in Controlling Fugitive Dust from Large-Scale Industrial Sources," (Order No. PB 83-217 828; Cost: $14.50, 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:
Industrial Environmental Research Laboratory
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