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Project Summary

ARMCO Special Study Report

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A particulate monitoring network was established by the U.S. Environmental Protection Agency in the vicinity of the ARMCO Integrated Steel Works in Middletown, Ohio, from March, 1980, to August, 1981. Particulate data collected included Total Suspended Particulate (TSP), 15-μm Inhaled Particulate (IP) Size Selective Inlet (SSI) high volume samples, and 15-μm IP dichotomous samples. The particulate data collected were used by the Office of Air Quality Planning and Standards (OAQPS) to test the overall effectiveness of the "bubble concept" as a method for reducing fugitive dust emissions. The 15-μm data were used by OAQPS to evaluate past and present ARMCO data with the proposed 15-μm particulate standard. Two of the "bubble concept" emission control strategies were implemented by ARMCO during the project. Pre- and post-control ambient particulate data were collected to examine their effectiveness in reducing plant fugitive emissions. Passive TSP samples were collected and an assessment made of how much particulate matter settled on the filter when the sampler was not operational.

When compared to pre-control data, the network data indicate a reduction in ARMCO fugitive dust emissions as a result of the "bubble concept" control strategies.

This Project Summary was developed by EPA's Environmental Monitoring Systems 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

Butler County, Ohio, was designated a TSP non-attainment area based on 1974-1979 TSP monitoring data collected in the proximity of the Middletown ARMCO plant. ARMCO responded by initiating a series of control measures aimed at lowering the plant's fugitive emissions. The first control measure, paving the slag haul road, was implemented in June, 1978. The last two control measures, paving the East-West Freeway and implementation of road cleaning and slag pile spraying programs, occurred during July, 1980, and August, 1980, respectively. These innovative control measures treat all plant emissions as though they were confined under a bubble and this was subsequently labeled the "bubble concept." Under this concept, the industry is provided maximum flexibility to reduce or eliminate pollution controls where costs are high, in exchange for compensating increased controls at emission sources where costs are low, in order to achieve a net reduction in overall plant emissions.

The Environmental Monitoring Systems Laboratory conducted a special study in the vicinity of the Middletown, Ohio, ARMCO Integrated Steel Works from March, 1980, to August, 1981. The U.S. Environmental Protection Agency (EPA) network operated prior to and after the implementation of the final two ARMCO "bubble concept" control strategies. Both pre- and post-control particulate data were collected. These data were used by the Office of Air Quality Planning and Standards (OAQPS) in support of their assessment of the overall effectiveness of the "bubble concept" control strategies in reducing fugitive emissions. OAQPS analyzed the network data to determine if post-control fugitive emissions fell within compliance of the National Ambient Air Quality Standards (NAAQS). A second assessment of the pre- versus post-control data would indicate whether the last two control measurements resulted in a significant reduction in fugitive emissions.

This report briefly describes the sampling operation and then discusses the results.

In addition to routine Total Suspended Particulate (TSP) high volume sampling, two types of 15-μm particulate samplers (high volume samplers fitted with a 15-μm size selective inlet (SSI) and 15-μm dichotomous sampler) were also operated. Collocated TSP samplers were operated at one site and collocated SSI samplers were operated at a second site to validate sampler operation. Because of the fugitive dust, passive high volume (hi-vol) samples were collected at five network sites. An estimate of off-mode particulate collection on the TSP hi-vol sample data was computed.

Procedure

Five particulate monitoring sites were established in the proximity of the Middletown ARMCO plant in March 1980. A sixth site, Standard Radio Electronic Parts Company (SREPCO), was added in September 1980. The SREPCO site was located approximately one-quarter mile from the old ARMCO East Works site, the site that generated the majority of noncompliance data during 1974-1979. TSP hi-vol samplers were set up at five sites. Since TSP samples included collection of some of the larger particle sizes associated with the fugitive emissions, the TSP data are used to describe the overall effectiveness of the "bubble concept." SSI hi-vol samplers were set up at all six sites while 15-μm dichotomous samplers were set up at two sites (Yankee Gate Road and ARMCO Research). Both fine (0-2.5 μm) particle size and coarse (2.5-15 μm) particle size fraction samples were collected with a dichotomous sampler. The sum of the coarse and fine fractions (total dichotomous sample) is comparable to the 15-μm SSI collection. The network 15-μm data allowed an interpretation of past and present ARMCO data in relation to the proposed 15-μm particulate standard. Passive TSP samplers (15 x 15 inch) were set up at five sites to investigate the effect of off-mode particle collection on TSP data as cited in earlier studies. An 11 ½ x 14 inch passive TSP shelter was collocated with the 15 x 15 inch TSP shelter at one site to directly compare the passive collection of a typical Inhaled Particulate Network (IPN) TSP shelter (11 ½ x 14 inch) versus the TSP shelter routinely used in other networks (15 x 15 inch).

From March through October, 1980, sampling was conducted every third day with every other sampling day matching the National Air Monitoring Station/State and Local Air Monitoring Station (NAMS/SLAMS) schedule on the sixth day. After November 1, 1980, network sampling was reduced to only every sixth day. Routine sampler operation, including sampler flow checks, calibrations, external flow audits, and administrative sampler documentation, followed prescribed EPA IPN procedures. Filter handling and laboratory weighing procedures followed published EPA or IPN guidelines. Routine sample validation procedures and standard statistical criteria were used to indicate outliers and to flag questionable data.

Results

Table 1 is a summary of the TSP data. Arithmetic and geometric means are reported for three time periods: the entire project period, the pre-control sampling period, and the post-control sampling period. A comparison of pre-control versus post-control data shows the effectiveness of the last two control strategies in reducing fugitive emissions. A comparison of the entire project data to pre-"bubble concept" data (1974-1979) shows the overall effectiveness of the "bubble concept" strategies in reducing the fugitive emissions in compliance of the NAAQS.

The TSP data indicate that the industrial sites were influenced more by fugitive emissions than were the commercial/residential sites, which were further away. Data from the three industrial sites cannot be directly compared to the NAAQS, as two sites (Coke Plant and Yankee Gate) did not meet ambient siting criteria ("fenceline") and the SREPCO site data summaries

Table 1. *TSP Mass Loading ($\mu g/m^3$) Summary Table*

Total Project	*Coke Plant Gate*	*Coke Plant Gate Collocated*	*Yankee Gate Road*	*ARMCO Research*	*Wilson School*	*SREPCO*
Arithmetric						
Mean	*100.3*	*102.1*	*87.0*	*64.5*	*59.2*	*88.7*
Std. Dev.	*39.7*	*41.8*	*30.0*	*21.0*	*22.9*	*43.5*
Geometric						
Mean	*92.9*	*94.3*	*81.9*	*61.0*	*55.0*	*79.8*
# Samples	*106*	*109*	*104*	*106*	*110*	*61*
MAX Value	*232.3*	*231.2*	*173.3*	*122.8*	*122.7*	*210.9*
2nd MAX Value	*195.2*	*224.1*	*156.2*	*122.4*	*117.5*	*187.7*
Pre-Control						
Arithmetric						
Mean	*104.5*	*108.9*	*92.8*	*69.7*	*62.1*	
Std. Dev.	*41.0*	*48.4*	*30.0*	*25.5*	*24.1*	
Geometric						
Mean	*96.4*	*98.5*	*87.7*	*64.6*	*57.4*	
# Samples	*40*	*42*	*40*	*39*	*38*	
Post-Control						
Arithmetric						
Mean	*97.7*	*97.9*	*83.4*	*61.4*	*57.6*	*88.7*
Std. Dev.	*39.0*	*36.8*	*29.8*	*17.4*	*22.3*	*43.5*
Geometric						
Mean	*90.8*	*91.7*	*78.6*	*59.1*	*53.8*	*79.8*
# Samples	*66*	*67*	*64*	*67*	*72*	*61*
	Industrial Site	*Industrial Site*	*Industrial Site*	*Commercial/ Residential Site*	*Commercial/ Residential Site*	*Industrial/ Residential Site*

are based on less than one complete year of data. Corresponding SSI and dichotomous sampler summaries were, as expected, lower in average concentration than the TSP values. The 15-μm sampler data also show that the industrial sites were more influenced by fugitive emissions. Overall, the TSP data collected by this special study were lower than the previous study TSP data. In addition, no single day TSP value exceeded the 260 $\mu g/m^3$ 24-hour standard. OAQPS evaluated the entire project data and concluded that there were significant reductions in TSP concentrations attributable to the "bubble concept" control measures.

Industrial site SSI/TSP ratios, which ranged from 0.69 to 0.74, indicated that approximately 30% of the particles collected at these sites exceeded 15-μm in diameter. The residential/commercial site SSI/TSP ratios, by comparison, ranged from 0.80 to 0.86 and indicated that only 10 to 20% of the particles collected at these sites exceed 15-μm in diameter. Dichotomous sampler Total IP loadings and the coarse/fine dichotomous ratio at the industrial site ($\bar{x}$ = 58.7 $\mu g/m^3$ with coarse/fine = 1.28) were larger than the comparable residential site dichotomous value ($\bar{x}$ = 40.9 $\mu g/m^3$ with coarse/ fine = 0.80). These differences were due to the differences in fugitive emissions at the industrial site versus the residential/commercial site.

A t-test for non-paired data was used to determine the effectiveness of the last two control strategies to reduce fugitive emissions. For each sampler, pre-control data was tested against post-control data, and a confidence interval calculated. With the exception of three marginally distinguishable cases, these tests indicated that implementation of the last two control strategies resulted in no statistically significant reduction in fugitive emissions. OAQPS had reported that the bulk of the reduction in fugitive emissions resulted from control measures implemented prior to this study.

An evaluation of the network 15 x 15 inch passive hi-vol samples[a] revealed that off-mode particle collection accounted for 10 to 12% of the TSP data. The comparison of the Coke Plant Gate 11 ½ x 14 inch passive hi-vol sampler[b] with the collocated 15 x 15 inch passive sampler yielded statistically indistinguishable results.

Using an external audit device, the mean percent difference calculated for 470 independent operator-performed sampler flow checks was an excellent 1.9%. Mean hi-vol sampler flow shifts resulting from 47 field recalibrations were 1.17% of the original sampler flow as determined prior to the project. The results of three independent external sampler audits averaged - 1.06% difference, with no sampler flow exceeding the ±10% audit flow limits. A comparison of collocated sampler mass loading data (TSP = mean 0.45% difference; SSI = mean 2.60% difference) indicates uniformity in sampler operations. These results indicate that the overall quality of the project data was acceptable.

Conclusions

The findings of the EPA Network are summarized below.

1. Based on the earlier OAQPS/EPA assessment, the ARMCO "bubble concept" control strategies have resulted in a total reduction of plant fugitive emissions. Although three network sites (Coke Plant, SREPCO, and Yankee Gate) yielded averaged TSP mass loadings in excess of the prescribed 75 $\mu g/m^3$ geometric mean standard, these site averaged loadings are lower than the pre-1975 ARMCO East Works data reported for TSP. Data collected from the two fenceline sites (Coke Plant and Yankee Gate) may not be appropriate for use in determining compliance with the NAAQS. SREPCO site summaries were calculated from less than one complete calendar year of data and therefore may not be directly compared with the NAAQS. Additionally, no single day TSP value exceeded the 260 $\mu g/m^3$ standard during the course of this study.
2. The monitoring data reported here, within consideration of the earlier data, do not indicate that the two control strategies implemented during the time period of this network yielded a statistically significant change in total plant emissions. An evaluation of pre- versus post-control mass loadings in the present study indicates the pre-control loadings are indistinguishable from post-control loadings.
3. The repeatability of mass loading collection for TSP and SSI samplers within this network was excellent (0.45% difference for TSP, 2.6% difference for SSI), as demonstrated by the collocated TSP and SSI sampler data.
4. Off-mode passive sampler collection, based on the 15 x 15 inch passive hi-vol samples resulted in a collection of about 10 to 12% of the total TSP collection for each site evaluated in this study. This size hi-vol sampler is almost exclusively used by agencies in the NAMS/SLAMS network.

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The complete report, entitled "ARMCO Special Study Report," (Order No. PB 83-209 759; Cost: $8.50, subject to change) will be available only from:
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Springfield, VA 22161
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[a] The size used by most local agencies.
[b] The size used in the IP Network.

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