Air Pollutant Emissions from Power Plants

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An examination of the issue of pollution resulting from fireworks displays in contrast to power plant emissions was chosen as a seminar topic during a pyrotechnic chemistry workshop, sponsored by the Partnership for the Advancement of Chemical Technology (PACT) at Miami University, Middletown, Ohio, July 2001.

This brief article presents some of the information found while preparing that seminar. The following are some of the statements found in the literature regarding pyrotechnic pollution: The presence of heavy metals in harbor sediments has been attributed, in part, to frequent fireworks displays over these bodies of water.[1] A study of the accumulation of heavy metals on the bottom of the World Showcase Lagoon at Walt Disney World's EPCOT Center, Florida, included sampling done before the start of nightly pyrotechnic displays as well as continued sampling during the succeeding decade.[2] Special effects during theatrical productions present potential health hazards to the audience.[3] The presence and persistence of pyrotechnically produced aerosols has provided the means to test instrumentation developed for monitoring air quality in real-time, or for on-line analysis of aerosols.[4,5] The abundance of air-born particulates, attributed to fireworks by mass spectrometry or by laser-induced breakdown spectroscopy analysis, increased around July 4, when fireworks are more frequently used.[4,5]

In an attempt to put the above concerns into perspective, US Environmental Protection Agency (EPA) data on emissions from fossil-fueled power plants were examined.[6] This EPA publication listed estimates of hazardous air pollutant (HAP) emissions from fossil fuel electric utility steam generating units. The results of

emissions test data from 52 units provided the basis for projecting average annual emissions for each of the 684 power plants. The data was obtained from extensive emission tests performed by Electric Power Research Institute (EPRI), Department of Energy (DOE), the Northern States Power Company, and EPA. Tables 21, 22, and 23 of the EPA publication listed the total inorganic HAP emissions from coal-fired, oil-fired, and gas-fired utility steam generating units, respectively. Tables 24, 25, and 26 of the EPA publication presented the total organic HAP emissions. The quantity of each type of fossil-fuel facility could not be found in the publication, so a listing of the 1990 total emissions for each HAP for the three different fuels burned is reported in Table 1 on the next page. The sum of these three fuels would be the estimated annual total for 1990 from all 684 power plants. Since a typical pyrotechnic fireworks display lasts 20 minutes, the total pounds of each HAP that would be emitted during 20 minutes were calculated and are tabulated in Table 1 beside the annual average tonnage per plant.

It is hoped that the information about US power plant emissions will aid in assessing the relative contribution produced by fireworks.

References

1) Doris Gnauck White , "Pollution Caused by Fireworks" *American Laboratory*, (October 1996) pp 24–26.

2) Thomas A. DeBusk, Jeffrey J. Keaffaber, Benedict R. Schwegler, Jr., and John Repoff, "Environmental Effects on Bodies of Water" *Proceedings of the 1st International Symposium on Fireworks*, Montreal Canada (1992) pp 92–102.

3) Monona Rossol, "Health Effects from Theatrical Pyrotechnics" *Journal of Pyrotechnics*, No. 3, (1996) pp 14–21.

4) J. E. Carranza, B.T. Fischer, G.D. Yoder, D.W. Hahn, "On-line Analysis of Ambient Air Aerosols Using Laser-Induced Breakdown Spectroscopy"; *Spectrochimica Acta Part B—Atomic Spectroscopy*, Vol. 56, No. 6 (2001) pp 851–864.

5) Don-Yuan Liu, Don Rutherford, Matt Kinsey, Kimberly A. Prather, "Real-Time Monitoring of Pyrotechnically Derived Aerosol Particles in the Troposphere", *Journal of Analytical Chemistry*, Vol. 69 (1997) pp 1808–1814.

6) EPA Office of Compliance Sector Notebook Project, *Profile of the Fossil Fuel Electric Power Generation Industry*, September, 1997 EPA/310/R-97-007; www.epa.gov/tio/download/toolkit/fossilsn.pdf

Table 1. Emissions from Fossil-Fueled Electric Generation Plants.[6]

Inorganic HAPs	Coal-Fired tons	Oil-Fired tons	Gas-Fired tons	Total of all 684 Plants	
				tons/yr	lbs/20 min
Antimony	11			11	0.84
Arsenic	54	5	0.16	59.16	4.50
Beryllium	6.6	0.45		7.05	0.54
Cadmium	1.9	1.7	0.054	3.654	0.28
Chromium	70	4.7	1.2	75.9	5.78
Cobalt	21	20.3	0.14	41.44	3.15
Hydrogen chloride (HCl)	137000	2870		139870	10644.60
Hydrogen cyanide (HCN)	240			240	18.26
Hydrogen fluoride (HF)	19500	144		19644	1494.98
Lead	72	10.6	0.44	83.04	6.32
Manganese	180	9.5	0.37	189.87	14.45
Mercury	51	0.25	0.0016	51.2516	3.90
Nickel	48	389	2.3	439.3	33.43
Phosphorous	270	68	1.3	339.3	25.82
Selenium	190	1.7		191.7	14.59
Organic HAPs					
Acrolein	28			28	2.13
Benzene	21	0.88	1.8	23.68	1.80
Carbon disulfide	37			37	2.82
Carbon tetrachloride	28			28	2.13
Chloroform	28			28	2.13
Isophorone	200			200	15.22
Methylene chloride	110			110	8.37