Lawrence Berkeley National Laboratory

Title
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Publication Date
1979-06-01

Peer reviewed

LBL-9323

CONF-790673--2

Lawrence Berkeley Laboratory
UNIVERSITY OF CALIFORNIA

ENERGY & ENVIRONMENT DIVISION

Presented at the Trace Substances and Environmental Health Conference, Columbia, MO, June 4-7, 1979

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MASTER

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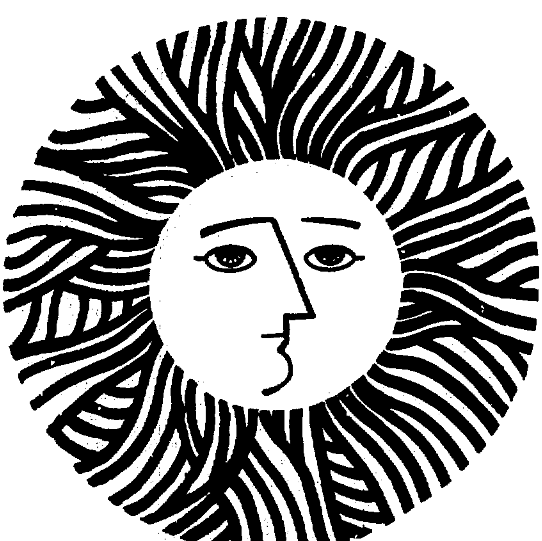
June 1979



Prepared for the U. S. Department of Energy under Contract W-7405-ENG-48

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ABSTRACT

In the last few years a much greater emphasis has been placed upon understanding, controlling and monitoring the environmental effects of the advancing technologies. This has resulted in rapid advances in techniques for environmental monitoring. To aid the concerned scientist in keeping abreast of these developments, the Lawrence Berkeley Laboratory publishes a collection of volumes entitled "Instrumentation for Environmental Monitoring."

Separated into four volumes covering four media, AIR, WATER, RADIATION, and BIOMEDICAL, they provide a source book for three types of material:

1) Monitoring Rationale. They describe the characteristics, forms, and effects of a wide variety of pollutants and the means of controlling them. Federal regulations are explained and summarized.

2) Analytical Techniques. Methods of determining specific pollutants are described with special emphasis on the principles that form the basis of instrumental methods.

3) Commercial Instrumentation. The features of most commercially available instrumentation used for the determination and monitoring of each pollutant are presented in a manner that facilitates instrumental comparisons.

A description of the publication and ways in which the contents can be used in the selection of analytical instrumentation will be presented in what follows.

DISCUSSION

This presentation is made from a different perspective than most of the papers presented at this conference. Here the concern is not so much with the physiological effects of pollutants but rather with methods for determining and limiting the levels.

The stretegy to limit the levels involves extensive monitoring. which has resulted in the rapid development of expensive, sophisticated instrumentation. Development in this field involves many disciplines and is greatly influenced by government regulations. Instrument manufacturers are producing many instruments, all of which have certain strengths and weaknesses. For these reasons a single source of information was needed to aid in the understanding and selection of analytical instrumentation. In addition, this publication should provide an up-to-date description of government regulations (and the rationale behind them) that dictate monitoring requirements.

A set of volumes entitled "Instrumentation for Environmental Monitoring" provides this information. This presentation gives examples of the type of material that will soon be (or already has been) incorporated into this work.

<u>Air</u>

Figure 1 illustrates the effect of a recent Environmental Protection Agency (EPA) decision to establish standards for particulates of <15 μm diameter rather than continue to use standards for <100 μm diameter. This decision results from recent health effects studies carried out by the EPA which indicated that particulates of greater than 15 μm diameter rarely reached the lower portions of the lung and hence were not an important factor in health effects. The study further indicated that information on the concentration and composition of particulates <2.5 μm diameter was also necessary. In order to provide the needed information, the traditional high-vol sampler has been retrofited with an inertial impaction device as shown in the first figure. A new, more sophisticated sampler which is now commercially available is also illustrated in this figure. This instrument is able to separate out particulates of <2.5 μm diameter and is microprocessor controlled so that sampling periods and sampling times can be pre-set.

Figure 2 illustrates the reference method for the determination of ozone levels in the ambient environment. This is a chemiluminescent technique that depends on the emission of light when ethylene and the sample are mixed. This mixing occurs in a chamber that is optically coupled to a photomultiplier tube which measures the intensity of the emitted light. The EPA has recently renamed the parameter used to indicate the oxidizing level of air from photochemical oxidant to ozone. This means the chemiluminescent result is now a direct measure of air quality. (In addition, the permissible level was changed from 0.08 ppm to 0.12 ppm).

The establishment of a lead standard is also indicated in this figure. A convenient method of lead determination would be by x-ray fluorescence. The particulate sample could be placed in front of the x-ray tube and results obtained directly with a minimum of sample handling. Prototype microprocessor controlled instruments to perform this type of analysis have been built at the Lawrence Berkeley Laboratory. This figure also calls attention to controls that are being considered for the atmospheric emission of vinyl chloride, benzene and asbestos.

Water

Figure 3 is concerned with levels of pollutants in water. This list of "toxic substances" resulted from the settlement of a court case between the National Resources Defense Council (NRDC) and the EPA. The settlement resulted in the EPA agreeing to establish effluent guidelines for 50 organics and 15 inorganic substances. This meant that the EPA has to develop reliable monitoring methods and then determine present levels in a very short period of time. Although no method has been officially designated as the reference method, GC/MS (gas chromatography/mass spectroscopy) has the capability to determine the organics. GC/MS instruments now used are interfaced with computers with large memories that store the many MS peaks that result from the analysis of the GC peaks which brings the cost to over $100,000. However, this may represent the most economical way to do the job.

The reference method for the metals listed in this figure is atomic absorption analysis. If many samples are to be run, it may pay to use plasma emission spectroscopy rather than AA analysis. Present day plasma instruments are computer interfaced and can obtain concentration levels of most of the 12 elements required in one run. Some laboratories have had plasma methods approved as alternates to AA analysis. The cost of this instrument is also in the $100,000 range. Of all the priority pollutants listed, only CN will likely be determined by traditional wet chemical techniques.

Figure 4 illustrates the approach used for monitoring asbestos. This sketch of a fiber of chrysotile, which is the type of asbestos used in 95% of commercial applications, was drawn from an electron micrograph having a magnification of ~150,000. Asbestos features displayed in this figure illustrate the many different techniques that are used to monitor this material. The characteristic shape is used for both electron and light microscopic determinations. The regular spacing of the crystal lattice is used for x-ray diffraction determinations. The vibration of the OH group, attached to the silicate structure, when infrared light of 2.72 μ is absorbed, has also been used. When heated to 640°C, water is driven off in an endothermic reaction. The differential thermal analysis spectrum resulting from this process has been used as a detection method. Finally, not very successful attempts have been made to attach dyes to the outside of fibers or absorb indicators into the inside.

It appears that the reference method for exposure to the general population (i.e., asbestos in buildings, water supplies, wines, beer, etc.) will be the electron microscope method. The recommended method for occupational exposures is the light microscope method.

Radiation

Figure 5 illustrates the need for monitoring even low levels of radiation. Approximate values of radiation levels are listed that are associated with various sources. (The 3 Mile Island accident has not yet had a measurable effect on the nuclear power number). The point I am trying to make with this figure is that man-made radioactivity is here to stay—even if we stop all the reactors tomorrow. As a result, we must monitor. A more complete description of sources of radiation, along with biological effects, government regulations, monitoring methods, and commercial equipment is contained in the RAD volume of the Survey.

Instrumentation

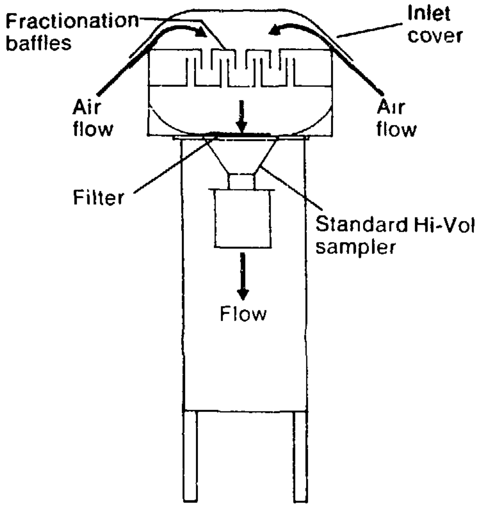
Figure 6 is a partial listing of the factors that must be considered in deciding upon analytical techniques and analytical instrumentation. Of course a most important part of the decision process is discussion with others in the field who are already using the instrumentation under consideration. At the risk of stating the obvious, one must always try to find ways of confirming statements made by the salesperson as it applies to your particular situation, including running your type of sample on the equipment before purchase.

The Instrumentation for Environmental Monitoring Survey can make an important contribution to the instrument selection process by 1) providing feature by feature comparisons of analytical instrumentation, 2) describing inherent strengths and weaknesses of the techniques involved, and 3) providing a ready source of EPA requirements for levels that must be detected.

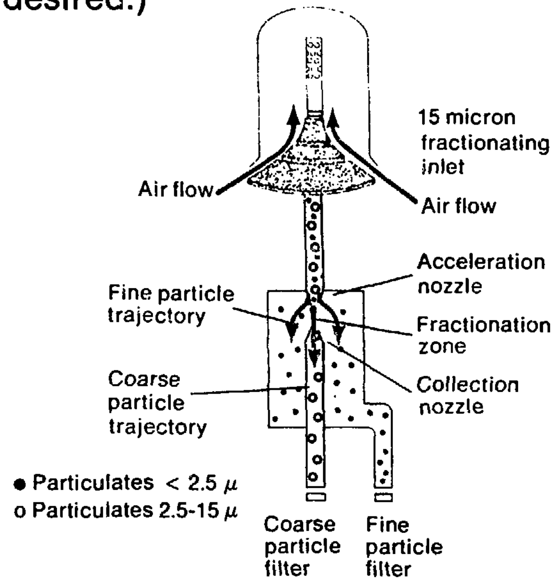
In summary I have tried to describe present developments in the program to lessen deleterious effects of pollutants on the population involves monitoring the levels so that corrective action can be taken if levels become unsafe. This approach is interwoven with the recent and continuing development of analytical techniques and instrumentation. It is also largely determined by government regulations.

A continuously updated information source is available that serves to introduce the newcomer to this field, to offer a ready reference to the long term researcher in environmental science, and to provide special assistance in the instrument selection process.

AIR: The EPA has determined that particulates of < 15 μm diameter cause the most detrimental health effects. Monitoring is required to establish standards. (Information on < 2.5 μm particles is desired.)



Traditional Hi-Vol sampler retrofited for < 15μm particles.



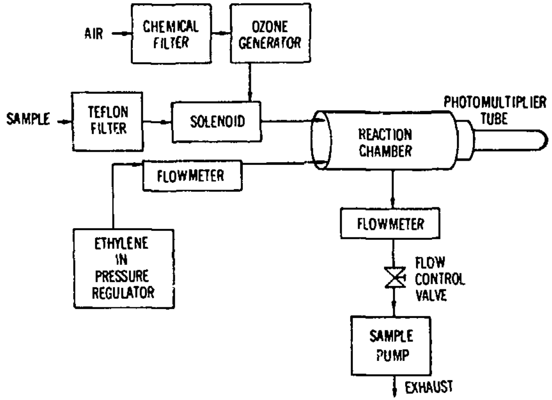
Dichotomus sampler (can be microprocessor controlled).

Figure 1

Figures courtesy of *Envir. Sci. and Tech.*

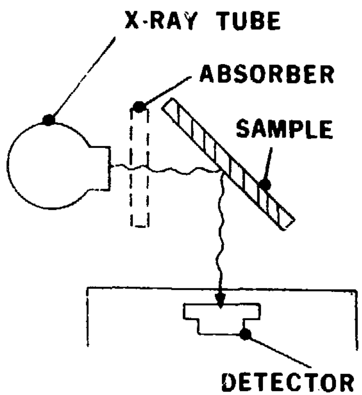
1) Change EPA standard from photochemical oxidant to ozone.

chemiluminescence for ozone



2) Establish lead standard of 1.3 μ gm/m^3.

x-ray fluorescence for lead

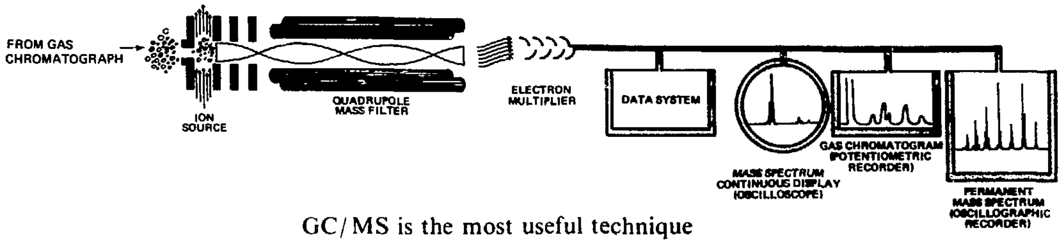


3) Develop emission standards for the hazardous substances; arsenic, asbestos, benzene and vinyl chloride.

Figure 2

WATER: A 1978 court decision ("EPA Consent Decree") requires the EPA to establish effluent guidelines for:

- 50 families of organics



GC/MS is the most useful technique

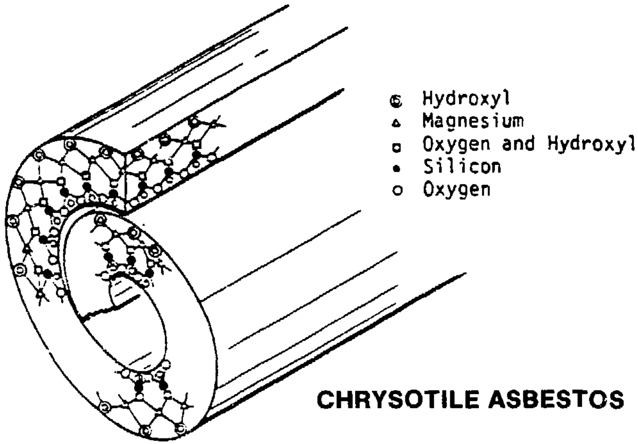
- 13 metals (Ag, As, Be, Cd, Cu, Cr, Pb, Hg, Ni, Sb, Se, Tl, Zn)

- CN and asbestos

  CN is determined by a colorimetric method; asbestos by electron microscopy

Figure 3

ASBESTOS: The unique pollutant. Detection depends on shape recognition.



CHRYSOTILE ASBESTOS

Methods:

1) light microscopy
2) electron microscopy
3) x-ray diffraction
4) infra-red spectroscopy
5) differential thermoanalysis
6) fiber loading

RADIATION: The "Nuclear Genie" is out of the bottle and will not get back in. Even low levels are detrimental.

Sources of Radiation:

Natural Background	U.Th cosmic rays	100 mrem
Medical Exposure	Diagnostic x-rays (medical, dental)	70 mrem
Nuclear Weapons	U.S., Russian tests (1946-62)	3-4 mrem
Advancing Technology	Ore mining & milling, coal-fired plants, industrial diagnostic x-rays	~3 mrem
Nuclear Power	Water cooled reactors	0.003 mrem

Figure 5

INSTRUMENTATION: Too often analytical chemistry is taken for granted. The fact that an instrument produces a number does not mean that it is a meaningful number. Many factors must be considered in selecting an instrument.

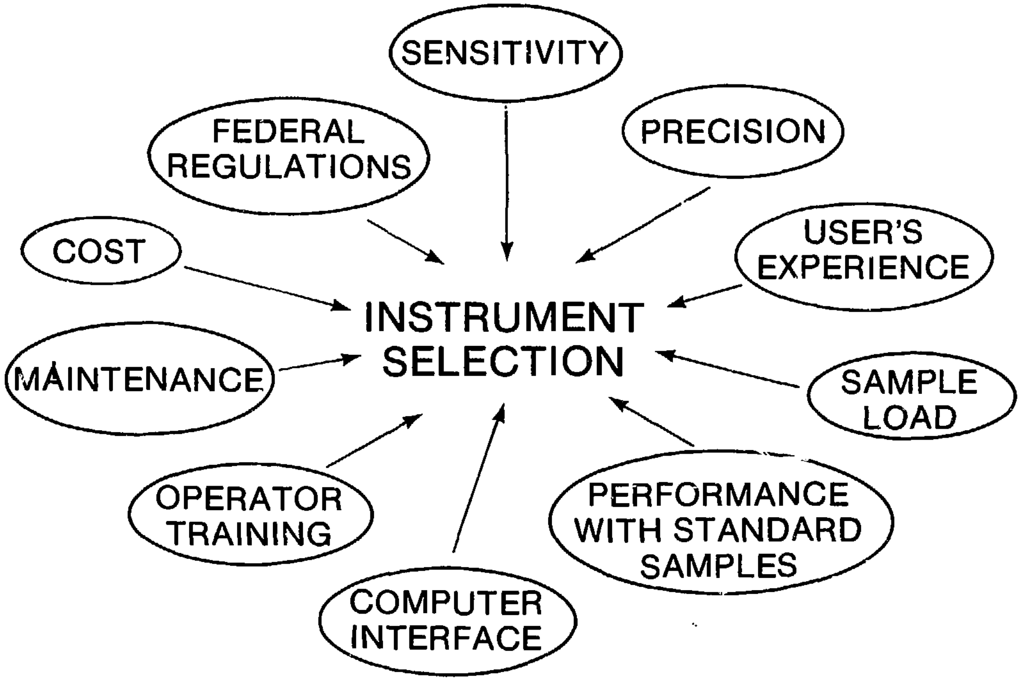


Figure 6