yet to be explored, largely because of the difficulty of generating, controlling, dispersing, and measuring the intensity of these waves.

2. Ultraviolet

Several organic solvents, especially in the aromatic series, have characteristic absorption patterns in the ultraviolet region of the spectrum.[85] The patterns can be used to identify very small amounts of solvents, while the opacity of the solvent at specific wave lengths can be used to measure the amounts. As in the case of infrared analysis, a sample must be collected from the air by condensations, by collection on silica gel (page 182), or by scrubbing air through a tenacious nonvolatile solvent that has no interfering absorption pattern. It is frequently necessary to refrigerate the scrubber in order to obtain high collection efficiency.

3. Light Absorption

Visible light spectrometry[86] is similar to infrared and ultraviolet spectrometry except that there are fewer compounds having distinctive absorption patterns. In spectrometry accurate results require a source of radiant energy confined to a narrow band of known (calibrated and checked) wave length, recognition and consideration of interfering absorption, and reliable measurement of transmitted energy.

G. THERMAL CONDUCTIVITY

The thermal conductivity of gases and vapors can be used to measure or monitor vapor-air mixtures. Commercial instrumentation to fractionate vapors and measure their thermal conductivity is now available. Gas chromatography, a technique combining fractionation and thermal conductivity, requires quantities of only a few milligrams for identification and measurement of paint and lacquer thinners and other volatile solvents of interest to industrial hygienists.

DUSTS, FUMES, AND SMOKES

I. Sampling

The instrument to be employed for sampling and evaluating particulate matter in the atmosphere will depend upon the availability of instruments, place to be sampled, nature of the contaminant, and purpose of the investigation.

A. IMPINGEMENT

There are several dust-sampling instruments that employ the principle of

[85] M. E. Maclean, P. J. Jencks, and S. F. Acree, *J. Research Natl. Bur. Standards*, **34**, 27 (1945).

[86] M. G. Mellon, *Ind. Eng. Chem., Anal. Ed.*, **17**, 81 (1945).

impingement. Dust carried by air at high velocity is impinged against a plate, wherein it is arrested by an agent, such as a film of water or other liquid, gelatin, or grease.

1. Greenburg-Smith Apparatus

In the United States the Greenburg-Smith[87] standard impinger and its midget counterpart are the most widely used instruments for obtaining dust samples for evaluation by counting. In the standard instrument air is drawn through an impinger nozzle or orifice 2.3 mm. in diameter at the rate of 1 cu. ft. per minute and impinged against a glass plate set perpendicular to, and 5 mm. distant from, the orifice. Each orifice must be calibrated and, if necessary, adjusted to this size and type. The plate may be the bottom of the sample flask itself. The plate is covered to a depth of at least 1 inch with dust-free water or other suitable liquid, which serves to trap and retain the dust particles after they strike the plate. The device is usually equipped with an electrically driven air pump, but may be obtained for hand operation, or with an ejector utilizing compressed air as the means of aspiration.

This device is suitable for sampling all air-borne dusts greater than 0.7 μ in diameter (dust within the range of definition by light-field technique), but at the standard rate of flow its efficiency for dusts of smaller size falls off rapidly. When set up with two impinger flasks in series, however, it can be used for particles somewhat smaller in size, such as lead fumes and fluoride fumes, the greater part of which are below 0.5 μ in diameter. Frequently the greater portion of freshly formed fumes is caught in the second impinger flask, perhaps because the particles have become moistened in passing through the first flask and so are more easily trapped in the second. Another possible explanation is that condensation of water upon the individual particles takes place as a result of the cooling of the saturated air as it suddenly expands upon emerging from the orifice into the second flask.

With freshly generated lead fume,[88] the efficiency has been found to range from 55 to 60 per cent, 34 to 37 per cent in the second flask; while with fumes 1 to 2 hours after generation 60 to 65 per cent was collected in the first impinger and 30 to 32 per cent in the second, for a total collection efficiency of 78 to 92 per cent. With fluoride fume collected in a magnesium foundry the second impinger contained 13 to 38 per cent of the total collected (see page 193), and the collection efficiency, compared with a commercial electrostatic precipitator was 94 to 120 per cent. A small and undetermined portion of the fluoride contamination was doubtless gaseous.

[87] L. Greenburg and G. W. Smith, *U. S. Bur. Mines Rept. Invest.*, No. **2392**, 1922; C. E. Imhoff and H. H. Schrenk, *U. S. Bur. Mines Circ.* No. **7026**, 1938.

[88] J. B. Littlefield, Florence Feicht, and H. H. Schrenk, *U. S. Bur. Mines Rept. Invest.*, No. 3401, 1938.