2. The Midget Impinger

The midget impinger is similar to the standard instrument except that it is usually hand-operated and draws a sample volume of 2.8 liters per minute through an orifice 1 mm. in diameter. Each impinger nozzle must be calibrated, as deviations in nozzle size of over 50 per cent are found. This instrument has been shown to be as satisfactory as the standard apparatus for sampling most dusts in the range of 0.7 to 10 μ, but it is not suited to the sampling of particles below 0.5 μ such as fumes. Its suitability for sampling asbestos fibers has been questioned. It can be operated by a hand crank and is therefore independent of a power supply and is suitable for use in flammable vapors or dusts. The entire impinger, complete with 9 flasks, is contained in a relatively light and easily portable case.

3. The Konimeter

The konimeter is a dust-sampling instrument introduced by R. M. Kotze in 1916, and later modified. In its present form (Zeiss Konimeter) it consists essentially of a small valveless spring-operated piston pump and a circular plate for impingement of the dust. When the piston is depressed it is held against the compression of the operating spring by a catch. Releasing the catch allows the piston to move rapidly to a stop and creates at the discretion of the operator a 2.5-ml. or a 5-ml. void, pulling atmospheric air through a round 0.5- to 0.6-mm. orifice and impinging it against a circular glass plate held 0.5 to 0.6 mm. distant from and perpendicular to the impinging orifice. The circular plate, held in a metal rim, is covered with an adhesive film to retain the dust particles, and has 30 numbered, equally spaced sample positions.

For use, the glass disk is cleaned, coated with an adhesive (glycerine jelly as recommended by the United States Bureau of Mines[39]), examined under a microscope, and, if satisfactory, inserted in the konimeter or a spare carrying case. Usually several samples are taken in the same work area in order to estimate average conditions. The instrument is not satisfactory for high dust concentrations: even a 2.5-ml. sample of visibly dusty air is likely to be too much to count. For very low dust concentrations more than one 5-ml. sample may be taken at the same position of the disk. In the technique used by the United States Bureau of Mines, the samples are estimated by counting sectors of the spots under a microscope with 200 magnification using light-field illumination. The counts cannot be directly compared to impinger counts, but are useful in estimating the effectiveness of dust-control methods, and for comparing dustiness in a situation where the type of dust remains more or less constant but its concentration varies with numerous conditions. The dust is counted without prior treatment. Ease and speed of sampling and counting are the chief advantages of the method. Techniques used in countries other than the United States vary from that described but will not be elaborated upon here.

[39] J. B. Littlefield, C. E. Brown, and H. H. Schrenk, *U. S. Bur. Mines Circ.* No. 6993, 1938.

4. Owen's Jet

The Owen's jet sampling device draws an air sample of 50 ml. or more through a moistening chamber and then at high velocity through a narrow slot, usually 1 cm. long and 0.1 cm. wide. The lowered temperature resulting from greatly reduced pressure on the air passing through the slot causes condensation of moisture on any dust particles, and the droplets are impinged against a cover glass where they adhere and later dry, leaving the dust on the cover glass. The ribbon of dust thus formed is not uniform and is therefore difficult to count. It has all the disadvantages of the konimeter and is, further, susceptible to different efficiencies depending upon the rate of pull on the pump plunger. The instrument has a value for comparisons, as does the konimeter. The Bausch and Lomb dust counter is a modification of this device.

B. ELECTROSTATIC PRECIPITATION

The electrostatic precipitator has a high efficiency for collecting all types of particulate matter. This device utilizes the principle of the Cottrell precipitator whereby air is drawn through a tube within which is a central conductor wire electrode, the other electrode being formed by the tube or its conductor lining or covering. For the purpose of air sampling the tube diameter is usually between $1^1/_2$ and 3 inches and the voltage used ranges from 8000 to 30,000. The relationship of tube diameter, air flow, and voltage must be within certain limits in order to approach the maximum efficiency of 100 per cent. A commercially available portable unit, similar to one described by Barnes and Penney[40] operates on a 110-volt 60-cycle current producing under favorable circumstances a secondary voltage of 8000 to 15,000. It is important that this voltage be checked, and maintained at not less than 10,000. The precipitator is equipped with a fan and a flowmeter calibrated to draw approximately 3 cu. ft. of air per minute. This volume, likewise, should be checked by a suitable meter. The dust content of the air is deposited upon the inside of the precipitator tube or, in some instances, on the inner electrode. Any deposit should be carefully preserved and transported to a laboratory for weighing, counting, or chemical analysis. This device is especially useful for sampling fumes, smokes, or other suspended matter with a particle size below 2 μ in diameter, in which range the impinger apparatus is not satisfactorily efficient. It is not suitable for use in flammable atmospheres.

As a comparison of efficiency between the standard impinger and the electrostatic precipitator for sampling fluoride fumes in a magnesium foundry, the following figures are of interest. With two impingers in series, from 62 to 87 per cent of the total amount collected was found in the first impinger and from 13 to 38 per cent in the second. On the average there was 74 per cent in the first and 26 per cent in the second. Samples collected simultaneously with a commercial electric precipitator (10,000 volts by spark-gap calibration) at the same location yielded from 80 to 106 per cent of the amount of fluorides found in the two impingers, the