APPARATUS FOR SAMPLING AND CHARACTERIZING AEROSOLS

CONTRACTUAL ORIGIN OF THE INVENTION

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BACKGROUND OF THE INVENTION

This invention relates generally to apparatus for sampling and characterizing aerosols. An aerosol is a colloidal system in which a gas, frequently air, is the continuous medium, and particles of solids or liquids are dispersed in it. Aerosols are commonly studied in connection with air pollution control and environmental safety. There are numerous industrial applications requiring aerosol sampling and characterization. In a nuclear reactor, for example, failure of a water-cooled fuel pin would produce fission-product aerosols under conditions of high pressure (0.35–17.5 MPa) and temperatures (700–1900 K) in the presence of steam, hydrogen, noble-gases and fission-product vapors travelling at relatively low velocities (0.1–30 cm/s). Such aerosols (in both liquid and solid states) would include particles in the 0.01–100 μm range, number densities of 10^3–10^8 particles/cm^3, and mass loadings up to approximately 1 g/s.

The basic methods of aerosol sampling (by particle separation) are represented by four classes of instruments: impactors, impingers, centrifugal units, and gravitational units. Commercially available devices generally fall into one of these categories using only a single collection scheme. The relative efficiency of the device depends primarily on the size of particles present and the velocity of the air stream. Each collection scheme is primarily directed to a particular range of conditions. For example, impaction is effective for particles greater than one micron, whereas diffusion is effective for particles approximately 0.1 micron and below. Inertial and centrifugal samplers may have a high power demand. High efficiency in such devices is generally associated with a marked pressure drop, requiring increased power to move the air through the sampler. Gravitational units require low velocities because the number of particles removed increases with falling speed.

Therefore, it is an object of the present invention to provide an apparatus for sampling and characterizing aerosols over a wide particle size range.

It is another object of the present invention to provide an apparatus for sampling aerosols at relatively low velocities.

It is also an object of the present invention to provide an apparatus for sampling and characterizing fission-product aerosols.

Additional objects, advantages, and novel features of the invention will be set forth in part in the description which follows, and in part will become apparent to those skilled in the art upon examination of the following or may be learned by practice of the invention.

SUMMARY OF THE INVENTION

To achieve the foregoing and other objects and in accordance with the purposes of the present invention, an apparatus for sampling aerosols may comprise: a chamber having an inlet at one end and an outlet at the other end, said chamber including: a plurality of vertically stacked, successive particle collection stages located within said chamber between said chamber inlet and chamber outlet and together with said chamber, defining a flow path from said chamber inlet, through successive collection stages, to said chamber outlet, each of said collection stages including: a separator plate located within and extending across said chamber for separating that stage from the previous stage, said separator plate having an inlet opening extending therethrough, a channel guide, mounted transverse to said separator plate, defining a labyrinthine flow path from said inlet opening to the inlet opening of the next stage, and one or more particle collection means located within said labyrinthine flow path. Preferably more than one particle collection means are used, such as collector plates for gravitational settling, fine-wire impactors, and diffusion battery screens.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated in the accompanying drawings wherein:

FIG. 1 is a schematic of an aerosol sampling device having three separate chambers, each chamber having fourteen collection stages.

FIG. 2 is a detail of a collection stage from **FIG. 1**.

FIGS. 3A–3C are various particle collection means for use in the collection stages.

FIG. 4 is a schematic of an experiment to sample aerosols from a fuel pin failure using two of the sampling devices shown in **FIG. 1**.

DETAILED DESCRIPTION OF THE INVENTION

An aerosol sampling device **10** which is actually three separate devices is shown schematically in FIG. **1**. Aerosol sampling device **10** includes three chambers, **11**, **13**, and **17**, which are stacked vertically. Each chamber contains fourteen collection stages, **12**. A manifold tube (**20**, shown in FIG. **2**) extends vertically through all three chambers transverse to and through the collection sections and is connected to inlet **14** which is connected to the aerosol source for sampling and characterization. The manifold tube has three openings (not shown), one to each chamber's initial stage to provide inlet flow to each chamber. Gas containing particles to be collected enters each chamber at the inlet, located at the bottom of the chamber, and flows upward through each collection stage, finally leaving the chamber at the outlet (outlets **16**, **18**, and **20** for chambers **11**, **13**, and **17** respectively). Although this embodiment provides for each chamber inlet at the bottom of the chamber and the aerosols to flow vertically upwards, it is clear that inlet **14** could be located at the top of device **10** and that each chamber inlet could also be located at the top of its chamber with aerosols flowing vertically downward.

In FIG. **4** sampling device **10** is shown schematically in an experimental set-up to sample aerosols from test fuel pins in a primary vessel. Input **14** receives the aerosols produced in the primary vessel. Outlets **16**, **18**, and **20** are connected through aerosol filters **50** to sequencing valves **60**. The downstream end (outlets **16**, **18**, and