AUTOMATED PROPORTIONAL INTEGRATED SAMPLING SYSTEM

BACKGROUND OF INVENTION

This invention relates generally to chemical analysis and sampling, and more specifically relates to sampling and analytical procedures for use with source and process streams.

Because of an ever increasing awareness of the environmental dangers posed by discharge of toxic chemical compounds and compositions into bodies of water such as rivers, streams, ponds and the like, an increasing need has arisen for sophisticated apparatus for use in monitoring the undesired species of contaminants which may be present in an aqueous environment of interest. In many instances, the contaminants monitoring sought to be achieved is a consequence of voluntary efforts by industry or citizen groups. More frequently, however, it is found that municipal, state and/or federal agencies are involved in such procedures or promulgate standards which require the monitoring activity. For example, the Environmental Protection Agency (EPA) has been involved in the promulgation of emissions standards, the objective of which is to control various emission sources of volatile organic compounds (VOC's) listed therein as hazardous wastes. Under the Resource Conservation and Recovery Act (RCRA), non-point sources such as ponds, land treatment areas, and waste water treatment systems, are the focus of considerable research activities designed to access VOC emission characteristics.

The problem of adequately and accurately sampling process steams is a particularly acute one. Current grab sampling techniques for volatile and semi-volatile organic emissions sampling, commonly do not adequately address integration of the cyclic variation of flow or concentrations in liquid process systems. Grab sampling data pertaining to volatile organics must also be manually corrected for changes in flow rate of the stream under survey. Manual correction of data is labor intensive and subject to calculation error. The grab sampling and analysis methods are also labor intensive for cyclic process sampling, due to the large number of samples that must be taken and analyzed to account for flow and concentration variation in process streams over time.

For the foregoing reasons, automatic sampling apparatus of various types are increasingly being sought and used to sample liquid streams. Such devices can in principle be cost effective, versatile, and reliable, and can include capabilities for greater sampling frequency and the ability to integrate emissions over time. A number of different automated samplers are indeed commercially available, which vary in sophistication, performance, mechanical reliability and cost. However, to the present time, no single automatic sampling device has found to be ideally suited for most situations. Among other things, certain criteria are sought after in such a device. Among the variables which must be effectively compensated for or processed in such apparatus, are these:

1. the variation of water or waste water characteristics with time;

2. the variation of flow rate with time;

3. the specific gravity of liquid and concentrations of suspended solids;

4. the presence of large debris and floating materials in the source or process stream; and

5. the type of channel containing the stream, i.e. whether a duct, sluice or weir.

A further very significant problem arising in the prior art is generated by the mentioned need to measure volatile organics in the samples obtained from the stream or other aqueous source. In order to adequately and properly measure the VOC components, the sample containing same must be withdrawn and treated in such a manner as to avoid loss of the very volatile component the concentration of which is sought to be established. Prior apparatus has not adequately dealt with this very serious problem.

The prior art applicable to this invention is well shown in a number of United States patents. These include the following:

U.S. Pat. No. 3,985,028 to Yoshida, relates broadly to the concept of sampling a waste stream at a rate proportional to the flow of the stream being analyzed and providing an integration of the sample readouts. The apparatus described therein utilizes a flow meter to determine the rate of flow in the stream which is being sampled, and preferably converts the signal from the flow meter into a pulse signal which operates a driving circuit for a pulse motor. The pulse motor in turn operates at a rate determined by the output of the flow meter, a cylinder and piston arrangement which draws the sample at a rate proportional to the flow in the stream. One or more of such piston cylinder arrangements can be utilized. Yoshida also utilizes a predetermined fill period in operating each of its syringes; i.e. withdrawal of the sample is taken for a predetermined period. Yoshida also storing container is separate from the container in which the samples are initially collected.

In U.S. Pat. No. 4,091,675 to Jennison, the head of a liquid is sensed by capacitor probes, and a voltage is generated for driving a stepping motor, which in turn is used to operate a pump controlling the sampling.

Lapidot, U.S. Pat. No. 3,940,933 discloses apparatus for obtaining from a fluid stream a sample having a volume that is proportional to the flow rate of the fluid stream.

U.S. Pat. No. 4,791,820 to Lawrence et al, discloses an apparatus module for volatile collection.

U.S. Pat. No. 3,719,081 to Lynn et al discloses an apparatus where an effluent is discharged into a flume to float past a selectively operable sampling device, and an adjacent probe develops and transmits to a remote control point a signal, the amplitude of which is proportional to the effluent flow rate. At the control point the signal is applied to an integrator which produces an output voltage proportional to the quantity of effluent which has passed the probe in the preceding interval. Each time the voltage reaches a predetermined value, a threshold circuit resets the integrator and pulses a first register to record the quantity of effluent for a given period and simultaneously pulses a presetable counter which produces a sampler enabling signal every time the counter reaches 0 and resets.

Other patents of interest pertinent to this technology include: U.S. Pat. Nos. 4,766,550 to Byers et al: 3,930,414 to Russell: 3,253,469 to Normal: 3,546,945 to Collins; 3,929,017 to Kowalski: 3,813,945 to Krumal: 4,207,450 to Mittleman; 2,963,114 to Zucker et al: and 2,927,465 to Smith et al.

In accordance with the foregoing, it may be regarded as an object of the present invention to provide an automatic proportional integrated sampling system for collection of representative samples from liquid streams for