AUTOMATIC FLUID SAMPLING AND FLOW MEASURING APPARATUS AND METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to an integrated automatic fluid sampling and flow measuring apparatus having a compact unitary structure and capable of pacing sampling in proportion to flow rate. More particularly, the invention relates to a unitary fluid sampling and flow measuring apparatus provided with a computer control system for automatically computing flow rate, controlling sampling operations in proportion to time and/or flow volume and/or flow rate, and monitoring and storing flow rate and sample collection data for later retrieval by a user. The stored data can be retrieved by displaying same on an alphanumeric display built into the apparatus, and/or by transferring the data via a portable data transfer unit according to the invention to a remote output device such as a printer and/or a personal computer.

2. Description of the Relevant Art

Mounting concerns over environmental pollution, and legislation enacted to limit the discharge of industrial effluent, have caused municipal water pollution agencies to carefully monitor the composition and volume of wastewater discharged from industrial concerns. Typically, an automatic liquid sampling apparatus is used to monitor the composition of fluid waste by repeatedly collecting samples for subsequent analysis, together with a separate flowmeter for monitoring the volume of flow and pacing the sampler in proportion to flow rate. The sampler and flowmeter are regularly transported to the field for temporary set up, or left in a place permanently, to monitor a sewer line containing industrial discharge.

Various problems arise in transporting and mounting the sampler and flowmeter for use in a sewer manhole. First, sampling sites are frequently remote, so that transporting the two separate devices is cumbersome and inconvenient. Moreover, positioning and mounting of the two devices as well as the associated sampler intake and flow transducer within a manhole often proves to be difficult and sometimes impossible due to the close confines of the sewer manhole, which severely restricts manipulation of the devices for positioning and later retrieval. Past practice has frequently dictated that the separate sampler and flowmeter be suspended one over the other from a manhole ladder or other support means. Typically, the operator first enters the manhole to position the flow transducer and sampler intake line. Next he exits the manhole to retrieve the flowmeter, re-enters the manhole, and then suspends or otherwise positions the flowmeter. Once done, he must exit again to retrieve the sampler and then re-enter the manhole to position the sampler.

Problems also arise in access to and removal of the separate sampler and flowmeter. Once in place, the sampler typically blocks access to the flowmeter, or vice versa. If access to the lower of the two units is needed, the unit above must be removed first. Removal of the units after monitoring is completed is often as awkward and time consuming as mounting them.

Another critical problem which arises with presently known samplers is the inability to obtain a hard copy of sample collection data, e.g., times and dates of collected and/or missed samples and parameters of the sampling program such as the volume of the collected sample, the interval between samples, and time or flow units remaining until the next sample. To comply with federal and state requirements, it is important that a record be kept of sample collection and flow rate data. With known sampler devices, the only means by which such a record can be obtained is by recording the data by hand when it appears temporarily on a display of the device. This limitation leads to inaccurate or incomplete records at best, and no hard copy of the data at worst.

Known systems which use an automatic fluid sampler in conjunction with a flowmeter have failed to overcome the foregoing problems. Although some of these systems provide for electrical connection between the sampler and the flowmeter to permit flow proportional sampling, they fail to overcome the positioning and mounting problems described above because they rely on two separate monitoring devices, each of which must be separately positioned and mounted within a manhole. An example of such a known system is that disclosed in U.S. Pat. No. 4,022,059 issued in 1977 to Schontzler et al.

The fluid sampling device disclosed for use in the system of U.S. Pat. No. 4,022,059 represents one of various known types of sampling devices. In U.S. Pat. No. 4,022,059 the sampling device is provided with a sample collection chamber in which a vacuum is generated to draw a sample into the chamber, after which the sample is deposited in a storage container. Other known sampling devices are disclosed in U.S. Pat. No. 3,838,719 issued in 1974 to Lederer and U.S. Pat. No. 3,927,701 issued in 1975 to Lederer.

Another known fluid sampling device is disclosed in U.S. Pat. No. 4,660,607 issued in 1987 to Griffith et al. The device includes a reversible, positive displacement pump having a tube passing therethrough which extends from a fluid supply at one end to a sample collector at the other end. The pump is cyclically operated in a reverse purging direction or a forward sample drawing direction depending on signals supplied by a processor. The processor determines the rate of liquid flow and the time the pump must operate to fill the entire tube plus a desired sample volume on the basis of signals from a fluid detection sensor disposed upstream of the pump inlet, and user programmed data relating to an intake portion of the tube. Advantages afforded by such device over other known samplers include reliability, minimized power consumption, contact of the sample liquid by the tube only, and minimization of any effect on sample volume by changes in vertical lift, power supply voltage or motor RPM.

Known devices or systems for monitoring the volume of fluid flow include those disclosed in U.S. Pat. No. 3,866,018 issued in 1975 to Schontzler et al and U.S. Pat. No. 3,929,017 issued in 1975 to Kowalski.

The present invention overcomes the problems encountered in the use of known fluid samplers and flowmeters as separate monitoring devices by providing an integrated automatic liquid sampling and flow measuring apparatus having a compact unitary structure and capable of pacing sampling in proportion to flow rate. Positioning and mounting of the unitary structure within a manhole is greatly simplified relative to having to position and mount two separate monitoring devices as has heretofore been required. The compact unitary structure of the invention also simplifies positioning of sample intake tubes and flow transducers, as well as