

AUTOMATIC FLUID SAMPLING AND MONITORING APPARATUS AND METHOD

This is a continuation-in-part of application Ser. No. 5 455,981 filed Dec. 22, 1989 now U.S. Pat. No. 5,091,863.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to an inte- 10grated automatic sampling and monitoring apparatus capable both of automatically performing fluid sampling operations and of automatically monitoring one or more conditions of the fluid.

More particularly, the invention relates to a compact 15unitary fluid sampling apparatus having a computer control system which automatically controls sampling and also calculates the value of a given fluid condition, such as pH level, on the basis of input from a sensor. By virtue of such novel arrangement, the apparatus of the invention provides the unique capability of triggering 20sampling operations on the basis of critical levels of a given fluid condition, such as automatically triggering sample collection to begin when pH level falls outside a pre-set acceptable range. The apparatus also automatically stores sample collection data and calculated levels 25of a given fluid condition, and permits sampling operations to be controlled on the basis of time as well as the detected level of the fluid condition. The stored data can be retrieved by displaying same on an alphanumeric 30display of the apparatus, and/or by transferring the data via a portable transfer unit to a remote output device such as a printer to provide a hard copy of the data.

The term "conditions" as employed herein is intended to connote various conditions of a fluid, i.e., 35physical and/or chemical properties thereof, which may be analytically measured for monitoring purposes and/or for triggering sampling operations. Such conditions include, but are not limited to, pH level, oxidation reduction potential ("ORP"), temperature, solution 40conductivity or resistivity, salinity, the activity of specific ions other than hydrogen ("pION"), dissolved oxygen, and/or turbidity. Monitoring of such conditions complements sampling operations of the apparatus not only with respect to tracking the history of a given 45condition in a process stream, but also with respect to controlling sampling operations on the basis of predetermined levels or values of given condition(s).

2. Description of the Relevant Art

In today's climate of deep concern over environmen- 50tal pollution, municipal agencies and private organizations alike are faced with the responsibility of carefully monitoring fluid waste, especially in order to comply with stringent statutory and regulatory pollution limits or to conduct pollution research. To this end, an automatic fluid sampling apparatus is commonly used to 55monitor the composition of fluid waste by repeatedly collecting samples for subsequent laboratory analysis. In addition, a separate analytical meter may be used for on-site monitoring of a critical fluid condition, such as pH level, to alert the user in a relatively immediate fashion to an upset in the process stream. A separate flow meter may also be used for monitoring the volume 60of fluid flow and for pacing the sampling operations in proportion to flow rate. The sampler, analytical meter and/or flowmeter are regularly transported to remote field sites for research purposes, or are positioned in

municipal or industrial manholes to monitor sewer lines containing fluid waste.

Various problems arise in transporting the separate 5sampler and meter devices for use at a remote field site, or in mounting the separate devices in a sewer manhole. Transporting a number of separate devices to a remote sampling site is cumbersome and inconvenient. On the other hand, mounting of the separate devices in a man- 10hole, such as commonly required in municipal and industrial situations, presents additional difficulties. The close confines of the manhole severely restricts manipulation of the devices, so that positioning and mounting of the separate devices often proves difficult, and sometimes impossible. The operator must repeatedly enter 15and re-enter the manhole to separately retrieve and position each device. The devices must often be mounted one above the other, so that access to and removal of the lower device(s) is blocked by the upper device(s). Removal of the devices after monitoring is 20completed is often as awkward and time consuming as mounting them.

Another problem which arises with known samplers 25is 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 re- 30quirements, it is important that a record be kept of sample collection and other data. With known sampler and meter 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 35best, and no hard copy of the data at worst.

The present inventors, in their prior U.S. patent application Ser. No. 455,981 filed Dec. 22, 1989, have overcome many of the problems associated with using 40separate samplers and flow meters by providing an integrated, compact automatic liquid sampling and flow measuring apparatus capable of pacing sampling in proportion to flow rate, and of storing sample collection and flow data for retrieval in hard copy form.

The integrated automatic sampling and monitoring 45apparatus of the present invention, which also has a compact structure, overcomes the problems particularly associated with separate automatic sampler and analytical meter devices. By combining a sampler and analytical meter in a single unitary structure, a number 50of advantages are attained. The elimination of a separate second device reduces the size and weight of the equipment, facilitating transport to remote sites and mounting in limited spaces. Further, because the sampler and analytical meter share the same microprocessor, digital 55display, keyboard, circuitry, etc., redundant components are eliminated and substantial cost savings are realized.

The present invention also provides important advantages with respect to sampling and monitoring capabilities. The integrated apparatus of the invention includes 60computer control means for automatically calculating fluid condition(s) such as pH level, and for controlling sampling operations on the basis of time and/or fluid condition(s). For example, the apparatus may be instructed by the user to begin a program of sample collection when actual pH falls outside a pre-set acceptable range. The apparatus also stores sample collection and fluid condition(s) data, with access thereto being had