

## AUTOMATED SAMPLE EXTRACTOR OR FEEDER/INOCULATOR FOR BIOREACTORS AND SIMILAR EQUIPMENT

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates to an automated sample extractor or feeder/inoculator for a vessel or conduit. This vessel or conduit can be a bioreactor or other similar equipment.

#### 2. Description of the Background Art

Development of new or more efficient commercialization of existing products requires faster and more effective methods to measure process variables. This is particularly true in processes which require cell culture and fermentation processes conducted in bioreactors where the accuracy of measurements in the research and development are critical for achieving economic production of high purity and highly refined end products.

Some factors which must be controlled include temperature and pressure. These factors are easily measured by utilizing standard sensors. However, many other factors can be measured only by removing samples for external laboratory analysis. The frequency of sample extraction for testing and measurement, number of tests on each sample and the time constraints on the process vary widely as do the methods and equipment used to obtain the samples.

In most cases, measurement processes for variables do not lend themselves to in-situ measurement by remote sensors directly in the process. Instead, samples must be physically extracted from the process and examined and manipulated outside the vessel or conduit. Before this examination and manipulation process can be effectively carried out either in a manual or automated fashion, a safe, effective means of sample extraction must be made available. This sampling process must provide a product that is an accurate subsample of the process composition.

Furthermore, since prior art designs do not lend themselves to use in existing systems, substantial modification to the system is required. The apparatus needs to minimize or eliminate the dangers associated with the sampling process in an efficient and cost effective manner while providing quality, reproducible results in order to be of value for commercial application.

One danger which must be avoided is danger to the operator or environment. When working with samples and especially hazardous samples, it is necessary to remove or feed/inoculate a sample without endangering the integrity of the process, subsequent samples, the operator or the outside environment. Many prior art devices are unsatisfactory in this area.

Also, some prior art systems are not automated. Therefore, there is potential danger posed by human procedural errors and operator and environmental exposure. Accordingly, a need exists for an automatable apparatus with the capacity for independent verification of equipment operation built in.

The materials being sampled themselves are often expensive. Therefore, excessive removal of sample should be avoided.

When taking samples, it is often important to maintain an aseptic environment. It is important that contamination from previous sampling or from the environment not contaminate the current sample or the process being

sampled. Loss of a sample run or contamination of the process can have extremely expensive ramifications. Therefore, it is important to obtain a sample without the sampling procedure causing contamination.

Many prior art devices permit accumulation or pooling of samples or cleansing medium. When the device is first used this may not create a problem; however, upon subsequent runs, the samples will be contaminated or at least diluted.

Additionally in the prior art, technology used for taking samples is generally unsatisfactory for feeding/inoculating the vessel or container.

### SUMMARY OF THE INVENTION

Accordingly, it is a primary object of the present invention to provide an apparatus for moving a sample of flowable material either into a vessel or conduit (an inoculation apparatus) or to move a sample of the flowable material from the vessel or conduit (a sample extractor).

It is an object of the present invention to provide an apparatus which can be retrofitted to existing standard tank port holes without other equipment modification.

Another object of the present invention is to provide an apparatus which will provide a representative subsample of the process composition.

Still another object of the present invention is to eliminate or minimize the dangers of the sampling process such as contamination of the sample, process or surrounding environment.

It is a further object of the present invention to provide an apparatus which will conduct sampling and maintain the sample in sealed arrangement such that there will be no danger to the sample itself or to the operator, the process and the surrounding environment.

Another object of the present invention is to provide an automatable system to eliminate operator error.

Yet another object of the present invention is to provide for a built-in verification of proper operation of the apparatus.

Still another object of the present invention is to provide a sample apparatus which avoids contact of the sample with dynamic (sliding or rotating) seals, thereby avoiding potential sites for accumulation of carryover contaminants.

A further object of the present invention is to eliminate the usual static crevice areas which may collect contaminants but yet are inaccessible to cleaning and sterilization agents and thus eliminates areas which might harbor carryover contaminants.

It is a further object of the present invention to avoid dead (stagnant) spaces in the apparatus which would result in samples that are not truly reflective of the process.

Yet another object of the present invention is to avoid obstacles or barriers to free drainage of the samples.

Still another object of the present invention is to provide a flushing arrangement for the apparatus whereby contaminants and other material will be forced from the system.

Yet a further object of the present invention is to avoid excess process void volume inside the apparatus which would result in sample volume measurement difficulties and material wastage.

Still another object of the present invention is to avoid passive "breathing" between the seals of the apparatus and the outside environment.