

to add a computer (a central processing unit) which could be programmed to control the sampling sequences.

While the embodiment described herein features (FIG. 2) a three-way valve incorporating two check valves, it is also conceivable to employ a set-up in which the check valves 32 and 34 would be installed on the lines 38 and 41 respectively, spaced from the three-way valve 10. This alternative, however, adds unnecessary dead volume to the sampling system.

It is relatively easy to determine, by way of a simple test, the volume of liquid that will be discharged from the tubing 22 and the valve 10 after these components have been filled with liquid due to the operation of the pump 12 in the left-hand direction as seen in FIG. 1. That amount of liquid, when the operation of the pump 12 is reversed, will be discharged and its volume will be the volume of a single sample. This total volume, assuming that the volume held within the valve 10 is steady, can be adjusted by changing the length and/or diameter of the tubing 22.

OPERATION OF THE APPARATUS

The sampling procedure may be preceded if necessary, by sterilization of the waste container 14, the three-way valve 10, the check valves 32,34 and the tubings 22 and 38. The tubing 41 does not require sterilization as it will be flushed by liquid from a closed system. After the sterilization is completed and all connections are secured, the peristaltic pump 12 is operated in the "left-hand" direction as seen in FIG. 1. This results in a liquid from the fermenter 18 being drawn through the conduit 38, the first port 26 and the check valve 32, now open, into the three-way valve 10 and on to fill the tubing 22. The check valve 34 is now closed due to the tension in the spring 36. The continuing operation of the pump 12 results in some liquid from the line 22 overflowing into the waste container 14. This ensures that an exact amount of liquid is available for discharge when the operation of the pump is subsequently reversed and also results in the disposal of the stagnant volume ("dead volume") of liquid from valve 10, check valve 32 and tubing 38. The reversal causes a certain overpressure in the line 24 and in the three-way valve. The pressure should be sufficient to open the check valve 34 against the pressure of spring 36 while closing the check valve 32. In this manner, the sampled liquid is prevented from returning to the container. The resulting underpressure created in the waste container 14 draws a corresponding amount of air thereinto. The ensuing risk of contaminating the system by microorganisms from the ambient air is eliminated through the provision of the porous plug 20 or an equivalent filter.

It is evident that the amount of liquid that is held in the vertical leg of the three-way valve 10 (FIG. 2) will not be discharged through the port 30 when the pump 12 operates in its right-hand direction. For that reason, it is advantageous to incorporate the check valve 32 within the three-way valve 10 as close as possible to the other check valve 34.

To facilitate an understanding of the operation of the apparatus, the flow of sample liquid in the system has been illustrated with arrows 48, 50 and 52.

The choice of a peristaltic pump is obviously advantageous in the case where sterility of sampling is of concern, since the design of such pump estimates the contact of mechanical parts with the sampling liquid.

If the fermenter 18 is aerated, a consideration must be given to the gas bubbles that may be carried with the sample into the system and consequently reduce the volume of liquid drawn. In such a case, the inlet of the tubing 38 should be disposed at an area of the fermenter 18 where the amount of dispersed gas in the liquid is minimal.

Another aspect of the aeration is a certain overpressure that develops in the fermenter 18 due to the gas supply and may cause the valve 34 to open at a "wrong" time or even result in the draining of the fermenter. This problem can be virtually eliminated e.g. by the provision of tension adjustment for the spring 36.

The sampling apparatus of the invention can be used for sampling of any sterile stream such as found in the food/beverage industry or in the pharmaceutical industry.

We claim:

1. An apparatus for taking liquid samples from a container, comprising:
 - (a) a three-way valve having a first port communicating with the container, a second port and an outlet port,
 - (b) a waste liquid vessel,
 - (c) a reversible pump communicating on one side thereof with the second port and with the waste liquid vessel on a second side of the pump,
 - (d) a first flow control means associated with the first port for only permitting the flow of liquid therethrough from the container to said three-way valve, and
 - (e) a second flow control means associated with the outlet port for only permitting the discharge of liquid therethrough from said three-way valve.
2. An apparatus of claim 1 further comprising a control means for operating the reversible pump alternately in reverse directions.
3. An apparatus according to claim 2 wherein the control means includes a timer and a controller, the control means adapted to operate the pump for a selected period of time at preset intervals.
4. The apparatus as set forth in claim 4 wherein the first and second flow control means are check valves associated with the first port and the outlet port of the three-way valve respectively.
5. An apparatus as defined in claims 1, 2 or 3 wherein the pump is a peristaltic pump.
6. An apparatus as defined in claims 1, 2 or 3 further comprising means for preventing the contamination-of the liquid from outside.
7. An apparatus as defined in claim 2 or 3 wherein the control means are coupled with a central processing unit.
8. An apparatus as defined in claim 1 wherein the reversible pump is connected to the three-way valve and to the waste liquid vessel with a tubing having a predetermined volume, the volume of the tubing corresponding substantially to the desired volume of the sample.
9. An apparatus as defined in claim 1 further comprising a sample receptacle communicating with the outlet port of the three-way valve.
10. An apparatus as defined in claim 1 wherein said three-way valve, waste liquid vessel and the interconnecting tubing and the flow control means are sterilizable.

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