Title: APPARATUS FOR OBTAINING SAMPLES OF A FLUID AND METHOD FOR CLEANING SUCH APPARATUS

Abstract: An apparatus for obtaining samples of a fluid comprising: a sample fluid container comprising fluid to be sampled, a first pump in fluid communication with said sample container, a first valve arranged between said sample fluid container and said first pump, a primary fluid conduit tube connected to said pump, comprising along its length one or more branches to secondary fluid con-duit tubes being in fluid communication with said primary fluid conduit tube, a waste container connected to an end of said primary fluid conduit tube, a second valve arranged between said primary fluid conduit tube and said waste container, and a second pump connected to said waste container that can generate a low pressure in waste container and in said primary fluid conduit tube.
Apparatus for obtaining samples of a fluid and method for cleaning such apparatus

The invention concerns an apparatus for distributing samples of a fluid to secondary sample fluid containers that are connected a sample fluid inlet via a primary fluid conduit tube and secondary sample conduit tubes branching of the primary fluid conduit tube.

The invention further concerns a method for cleaning such apparatus, in particular for cleaning the primary fluid conduit tube.

In the prior art, a number of arrangements for distributing fluid samples from one primary sample fluid container to one or more secondary sample fluid containers is known. With such arrangement there is always the problem that residual fluid sample may remain in the conduit tubes and can contaminate subsequent samples.
It is an object of the invention to provide an apparatus for obtaining fluid samples and a method for cleaning such apparatus that prevent contamination of subsequent fluid samples as good as possible.

According to the invention, this object is achieved by an apparatus for obtaining samples of a fluid comprising:

- a sample fluid container comprising fluid to be sampled,
- a first pump in fluid communication with said sample container,
- a first valve arranged between said sample fluid container and said first pump,
- a primary fluid conduit tube connected to said pump, comprising along its length one or more branches to secondary sample conduit tubes being in fluid communication with said primary fluid conduit tube,
- a waste container connected to an end of said primary fluid conduit tube,
- a second valve arranged between said primary fluid conduit tube and said waste container, and
- a second pump connected to said waste container that can generate a low pressure in waste container and in said primary fluid conduit tube.

Further, the object of the invention is achieved by a method for cleaning the apparatus comprising the steps of

A. Feeding said primary fluid conduit tube with said cleaning fluid from said cleaning container, then
B. Draining said primary fluid conduit tube from said cleaning fluid, then

C. Applying low-pressure to said primary fluid conduit tube, and then

D. Releasing said low-pressure from said primary fluid conduit tube by allowing gas to enter said primary fluid tube at an upstream position.

It is a basic concept of the invention to provide a second pump connected to the waste container, that acts as a suction pump for creating a low pressure in the primary conduit tube when the first valve between the sample fluid container and the primary fluid conduit tube and possible further valves arranged in the sample conduit tubes are closed.

By creating a low pressure in the primary fluid conduit tube and releasing said low pressure by letting air streaming into the primary fluid conduit tube add an upstream position, a high velocity air stream is created that improves cleansing of the primary fluid conduit tube.

The cleaning effect can be even improved if the primary fluid conduit tube is made from elastic material such as Silicone, Couthouc, Polyvinylchloride (PVC), Pharmed, ISO Versinic or Tygon.

It is further preferred, that the second pump for creating the low pressure is adapted or controlled to produce a higher flow rate than the first pump.

A first pump preferably is a peristaltic pump. The second, stronger pump preferably is a rotary or a centrifugal pump, a cam pump or a piston pump.

In order to allow gas to stream into the primary fluid conduit tube after creating a low pressure in the primary fluid conduit tube preferably a first gas inlet is provided that is connected to the primary fluid conduit tube between the first pump and that branch that is arranged closest to the first pump. A third valve may be provided that is arranged to close said gas inlet. Thus, after having created a low
pressure in the primary fluid conduit tube the third valve can be opened in order to create a gas stream for cleaning the primary fluid conduit tube along a major portion of its length. Since the first gas inlet is arranged upstream of a first branching of the primary fluid conduit tube, the air stream at least passes all branches and thus also cleans possible t-shaped connectors provided at the branches.

In order to allow the use of ordinary air as cleaning gas, preferably a sterile filter is arranged at said first gas inlet.

Further, a bypass fluid conduit by passing the first pump and comprising a valve for closing said bypass fluid conduit tube may be provided.

Further, preferably a cleaning fluid container comprising cleaning fluid may be provided, that is connected to said primary fluid conduit tube via fourth valve. The fourth valve is positioned upstream of the first pump. The cleaning fluid container may comprise liquid cleaning fluid for cleaning the primary fluid conduit tube.

Further, a second gas inlet that may be connected to a cleaning gas container is connected to said primary fluid conduit upstream of the first pump via a fifth valve. The second gas inlet preferably also comprises a second sterile filter thus allowing to use ordinary air as cleaning gas. The second gas inlet together with the bypass fluid conduit may replace the first gas inlet in an alternative embodiment of the apparatus.

The first valve and - as far as applicable, the fourth valve and the fifth valve are arranged to form a first sterile barrier in an upstream position of the primary fluid conduit tube.

Preferably, a second sterile barrier comprising a second valve is providing between said waste container and said primary fluid conduit tube.

Further valves may be provided for each secondary fluid conduit tube branching of the primary fluid conduit tube.
Further preferred embodiments may occur from combining preferred features of the apparatus in a manner not explicitly disclosed herein.

With respect for the method for cleaning the apparatus, it is preferred, that while feeding the primary fluid conduit tube with a cleaning fluid possible valves forming a first sterile barrier and a second sterile barrier are opened.

Further, it is preferred, when these valves are left open, while the primary fluid conduit tube is drained from the cleaning fluid.

It is further preferred to operate two pumps simultaneously when draining the primary fluid conduit tube. A first pump is arranged between first sterile barrier at the upstream end of the primary fluid conduit tube and the second pump is connected to the waste container that is connected to the downstream end of the primary fluid conduit tube.

Further, a second gas inlet being arranged at the upstream end of the primary fluid conduit tube may be provided and be connected to the primary fluid conduit tube via further valve that is also part of the first sterile barrier. This valve also is preferably opened while draining the primary fluid tube from the cleaning fluid thus allowing gas flow into the primary fluid conduit tube when the primary fluid conduit tube is drained from the cleaning fluid.

While creating a low pressure in the primary fluid conduit tube according to step C of the method, preferably all valves arranged close to the upstream end of the primary fluid conduit tube are closed. Further, the first pump arranged close to the upstream end of the primary fluid conduit tube is switched off while creating the low pressure.

When releasing the low pressure, preferably a first gas inlet that is arranged downstream the first pump and upstream a first branch branching off the primary fluid conduit tube is opened to let air stream into the primary fluid conduit tube downstream the first pump. Preferably, the second pump that has created the low pressure is stopped while releasing low pressure.
The foregoing and other objects, advantages and novel features of the present invention can be understood and appreciated by reference to the following detailed description of the invention taken in conjunction with the accompanying drawings in which:

Fig. 1 is schematic diagram of an apparatus according to the invention; and Fig. 2 shows a t-shaped connected for use in the arrangement of Fig. 1.

The apparatus 10 for obtaining samples of fluid, as depicted in Fig. 1, is designed to distribute a sample fluid entering the apparatus 10 at A to a number N of secondary sample fluid containers 12. The secondary sample fluid containers 12 are connected to a primary fluid conduit tube 14 and N secondary fluid conduit tubes 16. Both, the primary fluid conduit tube 14 and the secondary fluid conduit tubes 16 are made from an elastic material such as silicone.

Between each secondary sample fluid container 12 and the primary fluid conduit tube 14 valves 18 are arranged in the secondary fluid conduit tubes 16.

Close to an upstream end of the primary fluid conduit tube 14 near the sample fluid inlet at A a first valve 20 is arranged that allows closing of the sample fluid inlet. In order to supply fluid, a first pump 22 is arranged downstream of the first valve 20 and upstream of a first branch to a secondary sample fluid container 12. The first pump is a peristaltic pump. An advantage of such peristaltic pump is that the sample fluid conduit tube can be left intact thus avoiding any connectors. The peristaltic pump compresses the flexible fluid conduit tube and thus conveys fluid in a peristaltic manner.

At the downstream end of the primary fluid conduit tube 14 a second valve 24 is arranged that can be closed when sample fluid is to be filled into one of the secondary sample fluid containers in order to prevent the fluid from leaving the primary fluid conduit tube into a waste container 26 arranged at the downstream end of the primary fluid conduit tube 14.

A second pump 28 is connected to the waste container 26 and adapted to create low pressure in the waste container 26 and - if the second valve 24 is opened -
in the primary fluid conduit tube 14. The second pump 28 preferably is a rotary pump, a piston pump or a cam pump that can produce a higher flow rate than the first pump 22.

The arrangement described so far is suitable for distributing a sample fluid to one or more secondary sample fluid containers 12. In order to supply sample fluid entering the primary fluid conduit tube 14 at the sample fluid inlet at A to the secondary sample fluid containers 12, the first valve 20 is opened and the first pump 22 is operated to pump the sample fluid to the primary fluid conduit tube 24. At least one of valves 18 will be opened to allow the sample fluid to enter one of the secondary fluid conduit tubes in order to be filled into one of the secondary sample fluid containers. As already pointed out, the second valve 24 will be closed when sample fluid is filled into one of the sample fluid containers 12.

The features described now serve for cleaning of apparatus 10 each time when delivery of sample fluid to one of the secondary sample fluid containers is finished.

For cleaning the primary fluid conduit tube 14, a cleaning fluid inlet 30 is provided, that is connected to the primary fluid conduit tube 14 via a fourth valve 32 at a position upstream of a first pump 22. Further, a second gas inlet 34 is connected to the primary fluid conduit tube 14 via a fifth valve 36 arranged upstream of the first pump 22. The first valve 20, the fourth valve 32 and the fifth valve 36 together form a first sterile barrier.

Further, a first gas inlet 40 is provided downstream of the first pump 22 and upstream of a first branch branching off to a first secondary fluid conduit tube 16. The first gas inlet 40 is connected to the primary fluid conduit tube 40 via a third valve 42.

Both, the first gas inlet 40 and the second gas inlet 34 are provided with a sterile filter 44 and 38, respectively.

It is to be noted, that all valves are preferably designed as pinch valves. A pinch valve has the advantage that a fluid conduit tube passing the pinch valve may
stay intact, since closing the pinch valve is achieved by squeezing the fluid conduit tube. Especially cleaning of the apparatus can easily done by cleaning or changing the set of tubes, only. Thus, the set of tubes can be designed as disposable.

Now the operation of the apparatus for cleaning the primary fluid conduit tube 14 after finishing sample fluid delivery to one of the secondary sample fluid containers is described.

First, first valve 20 is closed, then, fifth valve 36 is opened and cleaning gas is pumped by the first pump 22 through the primary fluid conduit tube 14 and any secondary fluid conduit tube 16 belonging to a sample fluid container 12 that just has been filled with sample fluid.

Then, all valves 18 are closed and the second valve 24 is open. Thus, any sample fluid remaining in the primary fluid conduit tube 14 is conveyed into the waste container 26 by means of cleaning gas entering the apparatus at the second gas inlet 34.

Then, the primary fluid conduit tube 14 is rinsed. To rinse the primary fluid conduit tube 14, the fifth valve 36 is closed and the fourth valve 32 is opened and the first pump 32 is operated. Cleaning fluid enters the apparatus at the cleaning fluid inlet 32 via the fifth valve 32. The cleaning fluid is conveyed by first pump 22 through the primary fluid conduit tube 14 into the waste container 26. Then, the primary fluid conduit tube 14 is drained by closing valve 32 and opening the fifth valve 36 and letting cleaning gas enter the primary fluid conduit tube 14 and replace cleaning fluid.

During this step of draining the primary fluid conduit tube, the first pump 22 and the second pump 28 both are active.

Then, the third valve 42 is opened to increase the flow speed of cleaning air in the primary fluid conduit tube 14.
The first pump 22 and the third and the fifth valve 42 and 36 may be closed and opened several times in order to create pressure changes in the primary fluid conduit tube 14 that lead to deformation of the flexible primary fluid conduit tube 14 and thus to releasing any fluid drops which may otherwise stick to the fluid conduit tube.

The steps of cleaning apparatus 10 may be repeated several times before further sample fluid is filled into one of the secondary sample fluid containers 12.

It is to be noted, that the fluid conduit tubes are only interrupted at those positions, where branches are provided. Where the fluid conduit tubes are interrupted, connectors such as the t-shaped connector 50 depicted in Fig. 2 are provided. It is to be noted, that the inner diameter of the conduits in the connectors corresponds to the inner diameter of the fluid conduit tubes. The outer diameter of the connectors tapers outwardly to thus allow for a smooth transition from the fluid conduit tube to the connector.

Although an exemplary embodiment of the present invention has been shown and described and should apparent to those of ordinary skill that a number of changes and modifications to the invention may be made without departing from the spirit and scope of the invention. E. g., it is possible to provide a bypass conduit to bypassing the first pump 22 and comprising a valve for closing the bypass conduit tube. Further amendment may be made to the material of the conduit tubes, to the type of the fluid pumps or the type of the valves. The invention can readily be adapted to such devices by following the present teaching. All such changes, modifications and alterations should therefore be recognized as falling within the scope of the present invention.
Claims

1. An apparatus for obtaining samples of a fluid comprising:

   h) a sample fluid container comprising fluid to be sampled,

   i) a first pump in fluid communication with said sample container,

   j) a first valve arranged between said sample fluid container and
      said first pump,

   k) a primary fluid conduit tube connected to said pump, comprising
      along its length one or more branches to secondary fluid con-
      duit tubes being in fluid communication with said primary fluid
      conduit tube,

   l) a waste container connected to an end of said primary fluid
      conduit tube,

   m) a second valve arranged between said primary fluid conduit
      tube and said waste container, and

   n) a second pump connected to said waste container that can
genenerate a low pressure in waste container and in said primary
      fluid conduit tube.

2. The apparatus according to claim 1, wherein said second pump is
   adapted or controlled to produce a higher flow rate than said first pump.

3. The apparatus according to claim 1 or 2, further comprising a first gas
   inlet (intake) that is connected to said primary fluid conduit tube be-
   tween said first pump and that branch that is arranged closest to said
   first pump.
4. The apparatus according to claim 3, comprising a third valve that is arranged to close said gas inlet.

5. The apparatus according to claim 3 or 4, wherein said first gas inlet comprises a sterile filter.

6. The apparatus according to claim 1 or 2, further comprising a bypass fluid conduit bypassing said first pump and comprising a valve for closing said bypass fluid conduit tube.

7. The apparatus according to anyone of claims 1 to 6, further comprising a cleaning fluid container comprising cleaning fluid, said cleaning fluid container is connected to said primary fluid conduit tube at an position upstream of the first pump via a fourth valve.

8. The apparatus according to anyone of claims 1 to 7, further comprising a second gas inlet that is connected to said primary fluid conduit via a fifth valve.

9. The apparatus according to claim 8, wherein said second gas inlet comprises a second sterile filter.

10. The apparatus according to any one of claims 9, wherein said first valve, said fourth valve and said fifth valve form each or in combination with each other a first sterile barrier.

11. The apparatus according to anyone of claims 1 to 10, wherein said second sterile barrier comprises a valve arranged between said waste container and said primary fluid conduit tube.

12. The apparatus according to any one of claims 1 to 11, wherein between each branch and each secondary fluid conduit tube a further valve is arranged.
13. Method for cleaning the apparatus according to any one of claims 1 to 12 comprising:

   a) Feeding a primary fluid conduit tube with a cleaning fluid from a cleaning container, then

   b) Draining said primary fluid conduit tube from said cleaning fluid, then

   c) Applying low-pressure to said primary fluid conduit tube, and then

   d) Releasing said low-pressure from said primary fluid conduit tube by allowing gas to enter said primary fluid tube at an up-stream position.

14. The method according to claim 13, wherein when conducting step a) valves forming a first sterile barrier arranged between said cleaning container and said primary fluid conduit tube at an upstream position of said primary fluid conduit tube and valves forming a second sterile barrier arranged between a downstream end of said primary fluid conduit tube and a waste container connected to said downstream end of the primary fluid conduit tube are opened.

15. The method according to claim 13 or 14, wherein when conducting step b) said valves of the first sterile barrier arranged between said first gas container and said primary fluid conduit tube and said valves of the second sterile barrier arranged between said primary fluid conduit tube and said waste container are opened.

16. The method according to claim 14 and 15, wherein a first pump arranged between said first sterile barrier and a first branch branching the primary fluid conduit tube and a second pump arranged downstream of said waste container are simultaneously operated when step b) is conducted.
17. The method according to claim 15 or 16, wherein a further valve arranged between a second gas inlet and an upstream end of said primary fluid conduit tube is opened for conducting step b).

18. The method according to claim 16, wherein said first pump is stopped when step c) is conducted.

19. The method according to claim 18, wherein said valves of the first sterile barrier arranged between said first gas container and said primary fluid conduit tube and said valves arranged between said second gas container and said primary fluid conduit tube are closed for conducting step c).

20. The method according to claim 16, wherein said second pump is stopped when step d) is conducted.

21. The method according to claim 20, wherein a valve arranged between a first gas inlet and said primary fluid conduit tube at a position downstream of the first pump is opened while conducting step d).
**A. CLASSIFICATION OF SUBJECT MATTER**

INV.-- G01N1/18

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

GOIN

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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**X** Further documents are listed in the continuation of Box C. **X** See patent family annex.

* Special categories of cited documents :

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Date of the actual commencement of the international search

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