

Title: **BEVERAGE DISPENSING ASSEMBLY PREVENTING
MICRO-ORGANISM REFLUX**

FIELD OF THE INVENTION

5 The invention relates to a dispensing assembly for dispensing a beverage, a system for dispensing a beverage, a beverage container and a fluid conduit.

BACKGROUND

10 In known beverage dispensing assemblies, a beverage is typically held in a beverage container, such as a pressurisable keg, that is fluidly coupled via a dispensing line to a dispenser, e.g. a faucet. The dispenser may be operated as desired to flow an amount of beverage from the container through the dispensing line to a dispensing opening of the dispenser for dispensing the
15 beverage in a suitable receptacle such as a drinking glass or cup. Usually the beverage container is detachably coupled to the dispensing line and dispenser in order to allow an exchange of beverage containers. For example once a beverage container is emptied, i.e. has no or not sufficient beverage remaining for dispensing, such container may be uncoupled from the dispensing line and
20 be replaced by a beverage container holding a fresh amount of beverage in order to allow further dispensing of beverage with the dispenser. During its lifetime in use, the dispensing assembly is exposed to microorganisms present in the environment of the dispensing assembly. These microorganisms pose a risk of infiltrating particularly the dispensing line, for example during an
25 exchange of beverage containers when the uncoupled dispensing line is open at its coupling end to the environment. Upon following coupling of the dispensing line to a new beverage container holding a fresh amount of beverage such microorganisms may migrate from the dispensing line into the beverage kept in the beverage container which forms a suitable and sufficient source of
30 nutrients for the microorganisms to expand rapidly by multiplication. This provides the problem of contaminating the beverage. As a result a shelf life of

such beverage contained in the beverage container, i.e. period in which the beverage in the container may normally be suitably consumed, may decrease and/or the beverage may prematurely become spoiled otherwise. Furthermore, if the beverage has a low alcohol by volume percentage, or is completely alcohol free, and/or has a relatively high sugar content, such as some alcohol free beers, the beverage is particularly susceptible for contamination by fermenting microorganisms such as wild yeast which may lead to unwanted increase of alcohol contents in the beverage due to fermentation.

Known dispensing assemblies employ cooling of the beverage container and the beverage held therein, such that, in case contamination of the container does occur, the applied low temperature minimises or prevents growth and reproduction rates of the microorganisms in the beverage, maintaining a contamination level within acceptable limits.

Known beverage dispensing assemblies thus require cooling means, such as a refrigerator, arranged for cooling at least the beverage container particularly to temperatures of 4° Celsius or lower. A drawback of these known assemblies is the needed extra space for provision of such cooling means near to the beverage container, which is often not available. Moreover, cooling an entire beverage container with beverage is also rather time and energy consuming, which is particularly disadvantageous when the container has a relatively large volume and/or needs to be replaced regularly.

It is an object of the invention to provide a beverage dispensing assembly which slows down spoiling of the beverage. In particular, it is an object of the invention to prevent microorganism contamination of the beverage container of such beverage dispensing assembly. More particular, it is an object of the invention to provide a beverage dispensing assembly that prevents an alcohol formation in the beverage container without need of cooling the beverage container.

DESCRIPTION OF THE INVENTION

Accordingly, in a first aspect of the invention there is provided a beverage dispensing assembly comprising a beverage container with a container body defining a beverage chamber arranged for holding a beverage; a dispenser, particularly a faucet with a tapping handle, with a dispensing opening for dispensing the beverage; and a dispensing line extending between the beverage chamber and the dispensing opening to form a flow path enabling a flow of beverage from the beverage chamber to the dispensing opening, the dispensing line comprising a first dispensing line part attached to the container body and a separate second dispensing line part attached to the dispenser, the first and the second parts fluid tightly coupled to each other with detachable coupling means, wherein the first dispensing line part defines an upstream flow path section for flow of beverage from the beverage chamber to the coupling means, and the second dispensing line part defines a downstream flow path section for flow of beverage from the coupling means to the dispensing opening of the dispenser, wherein the upstream flow path section in the first dispensing line part is arranged to at least reduce a microorganism migration rate from the downstream flow path section into the beverage chamber.

The first part of the dispensing line provides an increased distance, i.e. a length of the upstream flow path section, for microorganisms to travel from the coupling end, which is the main 'hot spot' for microorganism infiltration in the dispensing line, to the beverage kept in the beverage chamber. As such an almost immediate contamination of the beverage in the beverage chamber upon coupling to an infiltrated dispensing line, is prevented.

Particularly the upstream flow path section is arranged such that a shelf life of beverage contained in the beverage container remains at least mostly unaffected and the beverage does not become prematurely spoiled otherwise without need of cooling the beverage container. Preferably the upstream flow path section is arranged such as to completely prevent microorganisms from migrating into the beverage chamber.

The upstream flow path section may be arranged such to, in use, comprise a beverage flow channel through the first part of the dispensing line extending in a horizontal or downward flow direction from the beverage chamber to the coupling means. Such flow channel in the dispensing line
5 extending horizontally or downwards in a flow direction from the container to the coupling means, is effective in reducing a migration rate of microorganisms as migration through such channel in the opposite direction, i.e. horizontally or upwards, is thereby rendered fully dependent on expansion by multiplication of the microorganisms as gravity assisted movement of the microorganisms into
10 the beverage chamber is prevented. The flow channel thus acts as a barrier means for microorganisms migrating from downstream of the flow channel in a direction upstream of the flow channel towards the beverage chamber. Microorganisms particularly need to migrate in a horizontal or an upward direction against gravity through the length of the flow channel in order to
15 reach the container. In use, the beverage dispensing assembly provides sufficient retardation or reduction of contamination of the beverage in the beverage chamber to allow consumption of the total beverage amount at an average consumption rate before spoil of the beverage occurs when containing microorganisms in the upstream flow path section, i.e. premature spoilage of
20 beverage due to microorganism contamination is prevented. Typically in beverage dispensing assemblies, the beverage container is provided below the dispenser. For example, the beverage container may be provided underneath a counter of a bar, wherein the dispenser is provided above the counter. In such case, the flow path in the dispensing line extends upwardly with respect to the
25 flow direction from the container towards the dispenser. By instead providing a downwardly extending flow channel in the first part of the dispensing line, upstream of the coupling to the second part of the dispensing line, microorganisms that may have infiltrated the second part of the dispensing line will settle at a low region, e.g. a local minimum, of the dispensing line a
30 distance away from the beverage chamber of the beverage container. The horizontal or downward extending flow channel may be provided over a full

length of the upstream flow path section in the first dispensing line part or may be a part thereof with other parts of the upstream flow path section extending in another direction, e.g. in an upward flow direction from the beverage chamber to the coupling means.

5 In an embodiment of a beverage container suitable for use in the beverage dispensing assembly the first dispensing line part is sealingly attached to the container body such that entry of microorganisms into the beverage chamber through an attachment interface between the container body and first dispensing line part is prevented. For example, the first dispensing
10 line part may be integral with the container body or at least a part thereof. Direct infiltration of the beverage chamber through the container body and first dispensing line part by microorganisms is thereby prevented while the first dispensing line part acts to counter microorganism migration into the beverage chamber upon coupling of the beverage container to the second
15 dispensing line part of the dispenser.

The first dispensing line part may conveniently comprise a tube defining the flow channel, which tube is attached on one end to the container body and an opposite end of the tube being provided with coupling means for coupling to the second dispensing line part. The first dispensing line part or at
20 least the tube may be a body separate from the container body, for example be designed as a disposable body. Being disposable may imply that the first dispensing line part or the tube is relatively cheap and/or easy to manufacture and may be disposed of, e.g. discarded, after use thereof. As such, the first dispensing line part or the tube may be made entirely out of polymers suitable
25 for beverage dispensing assemblies, for example silicone. Thus, the first dispensing line part may comprise a plastic tube or be made out of a plastic tube. The first dispensing line part may optionally be recyclable or made of recyclable material. The first dispensing line part may comprise attachment means for attachment to the container body. For example the first dispensing
30 line part may comprise a coupler body arranged to be fitted on the container body at a fluid outlet of the container body. A plastic tube or other fluid conduit

defining the upstream flow path section extends from the coupler body to a coupling end for coupling to a second dispensing line part. The first dispensing line part may comprise coupling means for coupling to the second dispensing line part. For example the coupling means may comprise a snap-fit connector for coupling to corresponding snap-fit means of the second dispensing line part. For example the first dispensing line part may be fitted with a coupling end comprising releasable or reversible snapping means into a snap cavity of coupling means at the coupling end of the second dispensing line part to allow for coupling and decoupling of the first and second dispensing line parts.

Preferably the beverage dispensing assembly is provided by coupling of the beverage container, comprising the first dispensing line part attached to the container body, to the second dispensing line part. The first dispensing line part and the container body may be preassembled to form the beverage container. The first dispensing line part and the container body may be sterilized after preassembling thereof and/or are, preferably, preassembled in a sterile environment. Preferably the first dispensing line part and the container body are maintained sterile, i.e. closed off from the environment, until coupling thereof to the second dispensing line part and dispenser to form the beverage dispensing assembly. For example a free coupling end of the first dispensing line part for coupling to the second dispensing line part may be closed prior to coupling, e.g. by means of a seal. The seal may be openable or removable at least in part so as to allow a flow of beverage through the dispensing line after coupling of the first dispensing line part and second dispensing line part. The seal may for example comprise a foil attached at and spanning over the free coupling end of the first dispensing line part. The foil may for example be perforated upon coupling to the second dispensing line part or may be manually peeled off the coupling end of the first dispensing line part prior to coupling to the second dispensing line part, to open the flow path through the dispensing line.

The second dispensing line part may for example be formed by a normal beer tube that is connected to a dispenser, such as a faucet, comprising

the dispensing opening. The second dispensing line part may be removably connected to the dispenser. The second dispensing line part and the dispenser may be preassembled.

5 The beverage dispensing assembly in accordance with the foregoing allows coupling and uncoupling, i.e. exchange, of beverage containers to an existing dispenser on site, such as in a bar, with a reduced risk of microorganisms which may be present in the second part of the dispensing line or the dispenser, or which may enter the second part of the dispensing line during coupling, from migrating into the beverage chamber of the coupled
10 beverage container.

Optionally, the upstream flow path section comprises a bend extending downwards in a flow direction from the beverage chamber to the coupling means. Along the bend, the dispensing line could vary in steepness for creating a suitable migration barrier for microorganisms.

15 Optionally the bend defines an almost 360° turn in the upstream flow path section, and preferably is provided as a looping in the first dispensing line part. The 360° turn creates a suitable barrier for microorganisms to reduce migration into the beverage container. Particularly, in the almost 360 degrees turn, the dispensing line defines a vertically oriented flow path section and an
20 overhanging flow path section which are particularly difficult for microorganisms to migrate across.

Optionally the first dispensing line part comprises a plurality of loops consecutively provided along the upstream flow path section. A majority of microorganisms in the dispensing line will settle at a low region, e.g. a lowest
25 part of the first 360 degrees turn relative to the coupling means. In the event that some microorganisms do migrate past said first 360 degrees turn the consecutive 360 degrees turns effectively prevent such microorganisms from migrating into the beverage chamber of the beverage container.

Optionally, the loops or loopings define a spiraling section of the flow
30 path. In the spiraling section the loops or loopings may be provided with a same loop diameter, i.e. two or more loops of the plurality of loops have the

same size, or with a varying loop diameter, i.e. two or more loops of the plurality of loops have different sizes. In the spiraling section the loops or loopings may be provided in the same plane or may be provided in three dimensions, i.e. form a helical section or helix. Optionally, the spiralling section of the flow path defines a helical section of the flow path. The spiraling section is effective in preventing migration of microorganisms there through while requiring minimal space between the beverage container and the coupling means. A central axis of the spiraling section or helical section, i.e. the axis around which the loops or loopings revolve, may extend in any direction with respect to a direction of the flow path downstream of the first 360 degrees turn relative to the coupling means. Optionally the central axis of the spiraling section or helical section extends in the same direction, i.e. in line, as the flow path downstream of the first 360 degrees turn relative to the coupling means. The central axis of the spiraling section or helical section may instead also extend under an angle, i.e. not in line, to the flow path downstream of the first 360 degrees turn relative to the coupling means, for example transverse to the flow path downstream of the first 360 degrees turn relative to the coupling means.

Optionally, the first part of the dispensing line comprises a flexible tube or other flexible liquid conduit. Flexibility of the tube or other liquid conduit allows for easy arrangement of the upstream flow path to comprise a beverage flow channel extending in a horizontal or downward flow direction from the beverage chamber to the coupling means, for instance by bending the flexible tube or other liquid conduit. The tube or other liquid conduit may be provided in a length suitable to sufficiently reduce a microorganism migration rate from the downstream part there through into the beverage chamber such that premature spoilage of beverage due to microorganism contamination is prevented. A suitable length may depend on a total volume of beverage to be consumed and kept in the beverage container. Preferably the length of the tube or other liquid conduit is at least 5 cm. A length of the tube or other liquid conduit is preferably sufficient to provide a loop in the tube or other liquid

conduit and more preferably sufficient to provide multiple loops or a spiralling section in the tube or other liquid conduit. The length of the tube or other liquid conduit may for example be at least 30 cm. For convenience in storage, transport, and handling a length of the tube or other liquid conduit is preferably not excessively long. For instance when the tube or other liquid conduit is preassembled with the container body, the length preferably does not exceed 1-2 meter, although longer lengths may be used if needed or desired for any reason. A length of the tube or liquid conduit may determine the length of the upstream flow path section and/or beverage flow channel. That is, a length of the flexible tube or flexible other liquid conduit provided with a bend or loop or multiple loops may, in a straight form of such tube or liquid conduit, be identical to a length of the upstream flow path section and/or beverage flow channel defined therein. Thus the tube or other liquid conduit may for example be provided with a spiralling section and have a length of approximately 100 cm, whereas a distance between the container body on one end of the tube or other liquid conduit and the coupling end of the second part of the dispensing line on the opposite end of the tube or other liquid conduit is merely several centimetres.

Optionally, the upstream flow path section comprises a yeast trap. The yeast trap provides a further barrier in the upstream flow path section particularly against yeast for migrating into the beverage chamber. The yeast trap may for example in addition to a main beverage flow channel through which beverage may flow from the beverage chamber to the dispenser comprise one or more spaces, e.g. chambers or side channels, branching of the main beverage flow channel in a direction of migration of the microorganisms towards the beverage chamber, the one or more spaces adapted to capture microorganisms while not hindering a fluid flow through the main beverage flow channel from the beverage chamber to the dispenser. For example the upstream flow path section in the first dispensing line part may fork one or multiple times in a height direction with an upper fork path continuing as part of the main beverage flow channel and a lower fork path adapted, e.g. by

having a dead end, to capture yeast cells, which under gravity will sediment in the lower fork path, and thus be inhibited from further migrating through the upper fork path toward the beverage chamber.

Optionally the yeast trap may comprise means for actively separating
5 yeast from the fluid, such as centrifugal means. For example the centrifugal means may comprise magnetic means, such as a magnetic element, provided and arranged to cause whirling of the fluid in the upstream flow path section such that the yeast is actively forced outward by centrifugal forces.
Alternatively or additionally yeast capture spaces may be provided in the first
10 dispensing line part along the upstream flow path section to trap yeast from moving further in an upstream direction. For example the first dispensing line part may comprise a body such as a tube having a central fluid lumen defining the beverage flow channel in the upstream flow path section through which in use pressurized fluid may flow under influence of centrifugal forces, with the
15 body of the first dispensing line comprising one or more yeast capture chambers provided along a length of the central fluid lumen, wherein the one or more yeast capture chamber is/are arranged such that in use a direction of flow of pressurized fluid is through the central fluid lumen past the chamber(s), i.e. there is no pressurized fluid flow in the chamber(s), while enabling by
20 means of centrifugal forces the capture of yeast in the chamber(s).

In a preferred embodiment of a beverage dispensing assembly, cooling means are provided and arranged for cooling at least the flow channel of the flow path such that microorganisms are prevented from migrating through an amount of beverage residing in the flow channel to enter the beverage
25 container. Additional cooling of the upstream flow path section inhibits growth and reproduction of the occasional microorganisms that may have advanced into said flow path section to prevent that those microorganisms expand by multiplication and reach the beverage container.

Optionally, the cooling means comprises one or more cooling systems
30 selected from the group consisting of liquid cooling systems, air cooling systems, and evaporative cooling systems. Such cooling means may be

arranged to specifically cool the upstream flow path section or beverage flow channel of the beverage dispensing assembly. Cooling of other parts of the beverage dispensing assembly is optional. Cooling of just the upstream flow path section or beverage flow channel allows the cooling means to be relatively
5 simple and compact for cooling only that section of the dispensing line.

Optionally, the cooling means comprise a housing defining an inner cooling chamber, wherein at least the upstream flow path section of the dispensing line is provided in the inner cooling chamber. Optionally cooling liquid means, e.g. a circuit through which cooling liquid flows, may be provided
10 in a heat exchange region together with the upstream flow path section of the dispensing line to cool the upstream flow path section by heat exchange. For example, the first part of the dispensing line may be arranged with multiple loops or as a spiralling section, within the inner cooling chamber of cooling means in heat exchange contact with a cooling liquid circuit.

Optionally, the cooling means are arranged to cool the flow path section of the dispensing line to a temperature of 6°C or lower. Below 6°C metabolism of the microorganisms lowers which reduces growth and reproduction rates of the microorganisms. Migration of microorganisms through the flow path section is effectively halted at temperatures of 4°C or
20 lower. Preferably the flow path section of the dispensing line is cooled to between 0°C - 3°C to prevent freezing of beverage resident in the flow path section.

Optionally, a coupling interface provided between the first part of the dispensing line and the container body differs from a coupling interface
25 between the first part of the dispensing line and the second part of the dispensing line such that direct coupling of the second part of the dispensing line to the container body without the first part of the dispensing line is not possible.

Optionally, the beverage container contains a beverage having an
30 alcohol by volume percentage of 2 % or less, preferably 1.2 % or less, and more preferably 0.5 % or less. Contamination prevention is particularly important

for beverages with low alcohol contents, as these form particularly suitable growth environments for microorganisms, such as yeasts. Moreover, yeasts and/or other microorganisms may convert sugars present in the beverage which may adversely affect the taste of the beverage and yeasts may particularly
5 convert the sugars into alcohol by fermentation, disadvantageously increasing the alcohol content thereof.

Optionally, the beverage is essentially free of alcohol.

Optionally, the beverage is an alcohol-free malt beverage, for example, alcohol-free beer, or an alcohol-free fermented fruit beverage, for example,
10 alcohol-free cider.

According to a second aspect of the invention, there is provided a beverage dispensing system comprising a beverage dispensing assembly in accordance with the foregoing and comprising one or more further beverage containers each further beverage container comprising a flexible tube
15 preassembled to a container body, the flexible tube arranged to be coupled to the second part of the dispensing line of the beverage dispensing assembly, wherein the beverage container of the beverage dispensing assembly is interchangeably coupled with a flexible tube as the first part of the dispensing line to the second part of the dispensing line so as to allow an exchange of
20 beverage containers in the system. The system upon exchanging a used beverage container, e.g. an emptied beverage container, for a new beverage container e.g. a container with a fresh amount of beverage, to the second dispensing line part and dispenser reduces a microorganism contamination rate of the beverage kept in the new beverage container because of the flexible
25 tube preassembled to the container body providing an increased distance for microorganisms to travel from the coupling end to the beverage kept in the beverage chamber.

In another aspect of the invention there is provided a beverage container for use in a beverage dispensing assembly in accordance with the
30 first aspect or in a beverage dispensing system in accordance with the second aspect, comprising a container body defining a beverage chamber holding a

beverage and comprising a flexible tube as the first part of a dispensing line, with one end sealingly attached to the container body such that beverage can flow from the beverage chamber into the flexible tube while entry of microorganisms into the beverage chamber through an attachment interface
5 between the container body and the flexible tube is prevented, and an opposite end of the flexible tube arranged for coupling to a second part of the dispensing line coupled to a dispenser.

Optionally, the container body and the flexible tube are preassembled with the opposite end of the flexible tube being closed off by a removable seal
10 prior to use.

EXPERIMENTAL DATA

In an experimental setup a dispensing line of transparent tubing is attached in open fluid communication to a beverage container filled with an alcohol free beer beverage. The dispensing line is inoculated with
15 microorganisms, in particular a strain of commonly found wild yeasts. Specifically, *Saccharomyces cerevisiae diastaticus* was used as this 'wild yeast' is a well known contaminant of beverages such as beers. In the experiment, the dispensing line was provided between the inoculation position and the beverage
20 container with a flow path section that either comprises a single 360° bend or a double 360° bend. In each of the two configurations, yeast migration through the flow path section was investigated for the dispensing line uncooled, i.e. room temperature or 21°C, as well as the dispensing line having been cooled to approximately 4°C.

25 After inoculation of yeast into the dispensing line at the inoculation position, visual inspection of yeast sedimentation and CO₂ bubbles produced by the yeast was done daily in the tubing of the dispensing line. Sampling and microbiological analysis of the beverage was done after 14 days of inoculation. Sampling included taking 100 ml of the beer beverage from the beverage
30 container, and analysing the amount of yeast cells in the sample. A clean sample means there are 0 yeast cells detected per 100 ml of beverage.

Alternatively, alcohol levels in the beverage may be analysed as an indication of yeast cells fermenting the beverage. However, this method proved less sensitive as at limited number of yeast cells in the beverage a change in alcohol levels in the beverage is very slow and/or difficult to detect.

5 Results of the experiments are shown in the tables below.

Table 1 shows results of a first test setup of the dispensing line with the flow path section comprising a single 360 degrees turn in the dispensing line, i.e. a single loop, wherein the dispensing line was maintained at ambient temperature of approximately 21°C. The experiment with this first test setup
10 was repeated 6 times, the results of which are designated in table 1 as samples 1-6.

Sample	CO2 bubbles in loop	Yeast in loop	Yeast in container after 14 days
1	Yes	Yes	Yes
2	Yes	Yes	Yes
3	Yes	Yes	Yes
4	Yes	Yes	Yes
5	Yes	Yes	Yes
6	Yes	Yes	Yes

Table 1: Single loop at approximately 21°C

15 After inoculation of the dispensing line at the inoculation position yeasts are shown to settle down in a lowest point of the dispensing line, i.e. on a bottom of the tubing and to migrate in an upstream direction from the inoculation position towards the beverage container. Some days after inoculation it is visually observable that the biggest concentration of yeast cells
20 collects just prior to a start point of the bend in the flow path section. Thus, the bend in the flow path section acts as migration barrier wherein a migration

rate of yeast cells through the bend is reduced compared to the migration rate prior to the bend. Yeast cells are not completely prevented from migrating through the bend flow path section as evidenced in all 6 samples (i.e. 100%) by observable carbon dioxide (CO₂) bubbles produced by the yeast cells in a
5 highest point of the loop, and detectable amounts of yeast cells being found in the loop as well as in the container at the 14 days analysis of the beverage composition. Thus at approximately 21°C a single loop in the flow path section between the inoculation position and the beverage chamber reduces a migration rate of yeast cells into the beverage chamber, but does not prevent
10 yeast cells from ultimately migrating through the flow path section into the beverage container.

Table 2 shows results of a second test setup of the same dispensing line as the first test setup with the flow path section comprising a single 360
15 degrees turn in the dispensing line, i.e. a single loop, wherein the dispensing line was instead cooled to and maintained at a temperature of approximately 4°C. The experiment with this second test setup was repeated 10 times, the results of which are designated in table 2 as samples 1-10.

Sample	CO ₂ bubbles in loop	Yeast in loop	Yeast in container
1	No	No	No
2	No	No	No
3	No	No	No
4	No	No	No
5	Yes	Yes	Yes
6	No	No	No
7	No	No	No
8	No	No	No
9	Yes	Yes	Yes

10	No	No	No
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Table 2: Single loop at approximately 4°C

As shown in table 2, an effectiveness of the loop in the flow path section as a migration barrier that prevents yeast cells from migrating through the flow path section is greatly increased by cooling the flow path section to 4°C. Only 2 out of 10 samples, i.e. sample 5 and sample 9, showed yeast cells being able after inoculation to migrate through the cooled loop into the beverage container, which is a big improvement over the 100% infiltration result in the first test setup.

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Table 3 shows results of a third test setup with the dispensing line comprising a flow path section provided with a double loop, i.e. two 360 degrees turns, in the dispensing line to test if this setup would render it more difficult for yeast cells to migrate through the flow path section into the beverage container as compared to the first test setup with a single loop. The dispensing line was maintained at a temperature of approximately 21°C. The experiment was repeated 10 times, the results of which are designated in table 3 as samples 1-10.

Sample	CO2 bubbles in loop 1	Yeast culture pre loop 2	CO2 bubbles in loop 2	Yeast post loop 2	Yeast in container
1	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes
3	Yes	Yes	Yes	Yes	Yes
4	No	No	No	No	No
5	Yes	Yes	Yes	Yes	Yes

6	Yes	Yes	Yes	Yes	Yes
7	Yes	Yes	Yes	Yes	Yes
8	Yes	Yes	Yes	Yes	Yes
9	Yes	Yes	Yes	Yes	Yes
10	No	No	No	No	No

Table 3: Double loop at approximately 21°C

As shown in table 3, the addition of an extra loop, slightly increases the effectiveness of the barrier, as in 2 out of 10 samples no CO₂ bubbles and cell cultures were visible, and after the 14 days analysis of the beverage composition these proved to be clean samples. Nevertheless, the majority, 8 out of 10 samples, still showed the yeast cells able to infiltrate the beverage in the beverage chamber.

Table 4 shows results of a fourth test setup of the same dispensing line as the third test setup, having a double loop, wherein the dispensing line was instead cooled and maintained at a temperature of approximately 4°C. The experiment with this fourth test setup was repeated 10 times, the results of which are designated in table 4 as samples 1-10.

Sample	CO₂ bubbles in loop 1	Yeast culture pre loop 2	CO₂ in loop 2	Yeast post loop 2	Yeast in container
1	No	No	No	No	No
2	No	No	No	No	No
3	No	No	No	No	No
4	No	No	No	No	No
5	No	No	No	No	No

6	No	No	No	No	No
7	No	No	No	No	No
8	No	No	No	No	No
9	No	No	No	No	No
10	No	No	No	No	No

Table 4: double loop at approximately 4°C

As shown in table 4, effectiveness of the dispensing line with double loop at cooled temperature of 4°C as a barrier in preventing microorganisms to migrate past the flow path section into the beverage container is increased compared to the single loop set up as shown in table 2. All 10 samples remained clean at the 14 days analysis of the beverage composition. Cooling of the loops reduces the metabolism, growth rate and reproduction rate of the yeast cells. Consequently, the relatively few yeast cells that migrate past the first cooled looping are presumably prevented from expansion by multiplication due to the cool temperatures, rendering the second looping to provide a fully effective barrier for those few yeast cells to migrate into the beverage container.

In a further experiment an experimental setup similar to the ones as described herein above was used to test migration rates of yeast to the beverage container by visual inspection. However in this experiment the setup respectively had a) no first dispensing line part, i.e. the yeast was inoculated in the coupling means near to the beverage container opening, b) a first dispensing line part between the inoculation point and beverage container opening forming a straight horizontal flow path section, c) a first dispensing line part between the inoculation point and beverage container opening defining a flow path section with a single loop, and d) a first dispensing line part between the inoculation point and beverage container opening defining a flow path section with a double loop. The migration rate was tested at least 4-fold under static conditions, i.e. no active or pressurized flow of beverage fluid,

and at warm (RT or higher) or cold (3°C) temperatures. In the non dispensing line setup yeast was visually detectable in the beverage container within hours after inoculation, both for warm and cold temperatures. With the straight horizontal flow path section, setup b), at warm temperatures the earliest visual
5 detection of yeast at the inspection point at the end of the horizontal flow path was 3 days after inoculation, with an average detection over all performed tests of 3.5 days. This demonstrates that compared to the setup of a) which resembles a conventional direct coupling of the beverage container to the dispensing line part of the dispenser, a simple piece of tube of only several
10 centimetres in length extending horizontally between the coupling means of the dispensing line part of the dispenser and the beverage container already provides a significant reduction in migration rate of the yeast into the beverage container. For the single loop, setup c), at warm temperatures the average time of visual detection of yeast at the inspection point immediately upstream of the
15 single loop was 4,7 days. This demonstrates that a loop in the flow path provides a noticeable further reduction in migration rate of the yeast into the beverage container as compared to the horizontal flow path section of setup b). For the double loop, setup d), at warm temperatures the average time of visual detection of yeast at the inspection point immediately upstream of the double
20 loop was 6 days. This demonstrates that a double loop in the flow path even further reduces the migration rate of yeast into the beverage container as compared to the single loop of setup c). The earliest visual detection of yeast at the inspection point for the double loop setup at cold temperatures was 11 days, with an average time of visual detection being undetermined as for some of the
25 beverage containers in this setup d) yeast was not visually detectable during the extent of the experiment. This demonstrates that a migration rate of yeast present in the dispensing line through this setup d) at cold temperatures is reduced severely compared to the conventional direct coupling of the beverage container to the dispensing line part of the dispenser.

BRIEF DESCRIPTION OF THE FIGURES

These and other aspects of the present invention are hereinafter further elucidated by the appended drawing and the corresponding embodiments, which form part of the present application. The drawing is not in
5 any way meant to reflect a limitation of the scope of the invention, unless this is clearly and explicitly indicated. In the drawing:

Fig. 1 shows part of an embodiment of a beverage dispensing assembly;

Fig 2A shows a detailed perspective view of an embodiment of a
10 coupling interface between an end of a first dispensing line part coupled to a coupling end of a second dispensing line part of a beverage dispensing assembly in accordance with the invention;

Fig. 2B shows a detailed cross sectional view of the embodiment of figure 2A.

15 Figs. 3A-E show a schematic representation of other embodiments of a beverage dispensing assembly according to the invention.

In this application similar or corresponding features are denoted by similar or corresponding reference signs. The description of the embodiments is not limited to the examples shown in the figures and the reference numbers
20 used in the detailed description and the claims are not intended to limit the description of the embodiments, but are included to elucidate the embodiments by referring to the examples shown in the figures.

DETAILED DESCRIPTION OF THE FIGURES

25 Fig. 1 shows part of an embodiment of a beverage dispensing assembly 200. The beverage dispensing assembly 200 comprises a keg 201 as a beverage container, comprising keg body 202 as the container body for containing e.g. alcohol-free beer as a beverage. The keg 201 comprises an extractor tube 204, which provides the keg fluid outlet 206, and comprises head
30 208, which extends out of the keg body 202.

Fitted to the head 208 of the keg body 202 is a coupler 210 arranged to couple the keg 201 to a beer line 220 which constitutes a second dispensing line part arranged to be coupled to a dispenser 230 such as a faucet or tap, schematically represented. The coupler 210 comprises a coupler body 231 fitted to the head 208 of the keg when the assembly 200 is assembled.

The coupler 210 comprises a flexible tube 211 as a first dispensing line part, which tube extends from the coupler body 231 to the keg and is provided in fluid connection with the keg fluid outlet 206 when the coupler 210 is coupled to the keg 201. The coupler 210 enables coupling of the flexible tube 211 to the beer line to form a dispensing line for flow of beverage from the keg 201 to the dispenser 230. The coupler 210 further enables decoupling of the flexible tube 211 from the beer line, so that the keg may be exchanged, for example once emptied, for a new keg filled with a fresh amount of beverage. The flexible tube 211 provides an increased distance for microorganisms that possibly infiltrated the coupler 201 and/or beer line 220, for example as a result of an earlier exchange of kegs in the assembly, to travel to the beverage kept in the keg. As such an almost immediate contamination of the beverage in the keg upon coupling thereof to an infiltrated dispensing line, is prevented.

Further means to prevent contamination of the beverage in the keg by microorganisms are provided in the coupler 210 at a distal end of the beer tube 211, and as such provided in a flow path for beverage through the disposable coupler 210, in the form of a duckbill valve 104 as a flow restriction module, shown here in the closed state. The duckbill valve 104 is arranged to be opened upon flow of pressurised beverage from the flexible tube 211 to the beer line 220, for example by virtue of gas pressure on the beverage in the keg body 202 if the dispenser 230 is correspondingly activated, so that flow of beverage to the dispenser is not hindered. When the dispenser 230 is deactivated or closed again, the flow of beverage is halted, and the pressure on both sides of the duckbill valve 104 is substantially equalised. By virtue of the resilient material of the duckbill valve 104, the duckbill valve returns in a closed state, and in this closed state substantially or entirely blocks passage of

microorganisms from downstream of the valve to upstream of the valve. Thus, even if the keg 201 is not used for a longer time and the keg 201 is not cooled, no path is provided for microorganisms to migrate into the keg 201.

Figures 2A and 2B show part of an embodiment of a beverage
5 dispensing assembly in which a coupling interface between an end of a first dispensing line part coupled to a coupling end of a second dispensing line part of a beverage dispensing assembly is shown in respectively a perspective view and a cross sectional view. Similar to the embodiment of figure 1, the coupling interface comprises a coupler 210 arranged to be fitted to a container body such
10 as a beer keg and arranged to couple the container body to a beer line 220 which constitutes a second dispensing line part arranged to be coupled to a dispenser such as a faucet or tap. The coupler 210 is further arranged to couple the container body to a gas line 240 for supplying gas to the container for pressurizing a beverage in the container. The coupler 210 is provided with a
15 fluid conduit 211 in accordance with the invention as a first dispensing line part, which conduit 211 extends from the coupler body to the beverage container. One end 212 of the fluid conduit 211 is arranged for assembly to a beverage container in fluid connection with a beverage container fluid outlet (not shown). As shown the fluid conduit 211, e.g. a flexible tube, is in this case
20 provided with a spiraling section between the one end 212 and an opposite end 213 of the fluid conduit 211, which opposite end 213 is arranged to couple with the coupler 210. For example the opposite end 213 may be fitted releasable or reversible into a cavity provided at a coupling end of the coupler 210 as shown in figure 2B.

25 The coupler 210 enables coupling of the flexible tube 211 to the beer line 220 to form a dispensing line for flow of beverage from a beverage container to a dispenser. The coupler 210 further enables decoupling of the flexible tube 211 from the beer line, so that a beverage container to which it is coupled may be exchanged, for example once emptied, for a new beverage
30 container filled with a fresh amount of beverage. A manually rotatable lever 300 is coupled to the coupler 210 as a convenient and intuitive means for

opening or closing the dispensing line for flow of beverage from a beverage container to a dispenser in dependence of coupling of the fluid conduit 211 to the coupler 210. The lever may also secure a connection of the fluid conduit with the coupler.

5 The spiralling section effectively reduces a migration rate of microorganisms from migrating to the beverage container such that contamination of the beverage is practically prevented. Accordingly, undesired contaminants, particularly microorganisms, which may be present in the beer line 220 or coupler 210, will be prevented from migrating through the spiralling
10 section of the fluid conduit to the beverage container, allowing for exchange of beverage containers, for example once a used beverage container is emptied, without risk of prematurely spoiling a fresh beverage in the newly coupled beverage container. The spiralling section further provides a relatively compact form of the fluid conduit to this end, needing only limited space near the
15 beverage container and coupler.

As shown in figure 3A another embodiment of a dispensing assembly comprises a beverage container 201 defining a beverage chamber for holding a beverage, a second dispensing line part 220 arranged to be coupled to a dispenser such as a faucet or tap (not shown) and a first dispensing line part
20 211 extending between the beverage chamber of the beverage container 201 and the second dispensing line part 220, enabling a flow of beverage from the beverage container to the dispenser. The first dispensing line part 211 is in addition to an otherwise conventional dispensing assembly in which the dispensing line part 220 is coupled directly to the beverage container 201. The
25 first dispensing line part 211 and second dispensing line part 220 are to this end fluid tightly coupled to each other with detachable coupling means 215 which may be at least almost identical or similar to the coupling means between the second dispensing line part 220 and the beverage container 201 in the conventional dispensing assembly. In this embodiment the first dispensing
30 line part 211 is a transparent fluid tube allowing visual inspection of fluid flowing there through in use, which tube comprises a single loop 214 in a

downstream flow path section defined by the first dispensing line part. The loop 214 may be preformed in the tube prior to use in the beverage dispensing assembly, e.g. during production of the tube. Alternatively the fluid tube may be a flexible tube such that the loop may be formed in the tube manually
5 during instalment or replacement of a beverage container in the beverage dispensing assembly by simple and suitable bending of the flexible tube. The loop 214 effectively reduces a migration rate of possible microorganisms present in the second dispensing line part 220 and/or coupling means 215 into the beverage chamber. Further shown in this embodiment is that
10 microorganisms may be inoculated in a beverage fluid flowing through the dispensing line via an inoculation point 216 in the second dispensing line part 220 near to or in the coupling means 215 for use as a test setup. It will be understood that such inoculation point may be absent in an embodiment for use of the dispensing assembly in practice. Visual inspection (indicated by
15 arrow and eye symbol) of the first dispensing line allows a determination of the time needed by the microorganisms in static state, i.e. no pressurized flow of beverage fluid, to migrate past the single loop 214. The thus obtained visual data may be supported by sampling and analysis of beverage in the beverage container to detect whether microorganism have contaminated the beverage.

20 As shown in figure 3B-3E alternative embodiments of the first dispensing line part 211 useable in a dispensing assembly as for example shown in figure 3A have instead of the single loop in the downstream flow path section respectively a double loop, helical multiloop, spiral shape or wave shape in the downstream flow path section.

25 Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Methods and materials are described herein for use in the present invention. However other suitable methods and materials known in the art can also be used. The materials and examples are
30 illustrative only and not intended to be limiting, unless so indicated. For the purpose of clarity and a concise description, features are described herein as

part of the same or separate aspects and preferred embodiments thereof, however, it will be appreciated that the scope of the invention may include embodiments having combinations of all or some of the features described.