**Title:** ANTI-OXIDATION DEVICE AND METHOD FOR USE THEREOF

**Abstract:** An anti-oxidation device for retarding oxidation of an oxidizable liquid after opening a liquid container. The device includes an antioxidant for scavenging oxygen and a membrane for containing the antioxidant. The membrane is a gas permeable/liquid impermeable membrane. The device is adapted for positioning itself in the container, substantially at the gas-liquid interface within the container, where the device scavenges oxygen which has entered the opened container. A method for scavenging oxygen in open containers using an anti-oxidation device constructed as described above. Particularly important is the application of the device and method described herein to retarding oxidation and spoilage in beverages and other comestibles.
ANTI-OXIDATION DEVICE AND METHOD FOR USE THEREOF

FIELD OF THE INVENTION

The present invention relates to an anti-oxidation device and method for retarding oxidation of oxygen sensitive liquids. A particularly important area to which the device and method may be applied is to retarding oxidation and spoilage of oxygen sensitive beverages.

BACKGROUND OF INVENTION

It is known that many foods and drinks rapidly oxidize subsequent to opening the sealed containers in which they are packaged. These containers include inter alia bottles, jars, cans or multi-layered containers such as those used for milk and juices. It is also known that oxidation often leads to deterioration or spoilage, manifesting itself by a change of color, of smell and/or of flavor.

Several methods have been used to solve this oxidation problem including, vacuum packing, nitrogen replacement of oxygen introduction during packaging, and the use of oxygen absorbents. In a typical application, it has been proposed that oxygen absorbents be placed adjacent to a cover of a beer container.

Methods to prevent oxidation can be classified into several types depending on whether the oxygen absorbent is contained in a resin and/or whether the oxygen absorbent is fixed to a cover or crown of a container via a barrier membrane. The latter prevents direct contact of the oxygen absorbent with the food or drink.

According to the teachings of Japanese Laid-Open Patents HEI-1-308781 and HEI-1-315438, a mixture of a low-density polyethylene, ascorbic acid and/or sodium sulfite, a lubricant and an antioxidant is affixed onto the surface of a crown or cover of a beer container, thereby increasing the life of the beer. Alternatively, a polypropylene containing ascorbic acid can be affixed to the crown or cover of the beer container, thereby increasing the stability of the beer.

Japanese Utility Models Laid-Open Patents SHO 55-161858 and SHO 56-38056 and U.S. Pat. Nos. 4,287,995, 4,421,235 and 4,756,436 disclose methods for fixing an oxygen absorbent within a container, and with the oxygen absorbent being covered with a sheet permeable to oxygen but impermeable to water. The above prior art proposes to coat the antioxidant with a silicone resin or fluorocarbon in order to increase its water repellency.

PCT W0 89/12119 discloses a method wherein the oxygen absorbent is made insoluble to water by applying a metallic complex of polyalkylamine onto silica gel. The gel
is fixed to the inside of a crown or cover of a beer container together with a gas permeable barrier membrane.

Japanese Laid-Open Patent SHO 56-2164 discloses an oxygen scavenger wherein a composite wrapping material, including a layer of a non-woven fabric and a layer permeable to oxygen but impermeable to water, is used to for wrapping an oxygen absorbent with a membrane.

US Pat. No. 5,143,763 to Yamada provides for an oxygen scavenger including an oxygen absorbent composition including an oxygen absorbent and a resin provided with an oxygen permeable member covering the oxygen absorbent composition and involving a polymeric asymmetric porous membrane.

All of the methods discussed above attempt to prevent oxidation prior to a consumer opening a beverage container. However, beverages which are not fully consumed after opening the beverage container may rapidly deteriorate when contacting air or oxygen.

There is therefore a need for an effective anti-oxidation device for preventing a beverage from coming into contact with air after a beverage container has been opened.

Since oxidation generally occurs between a beverage and the layer of air immediately above it, i.e. the layer which contacts the beverage, there is a need for an effective anti-oxidation device, which remains adjacent to the surface of the beverage and which scavenges oxygen from the air above the beverage after the beverage container is open.

DEFINITIONS

In what is hereinabove and hereinafter discussed, the following terms have the following definitions.

Spoilage- any deterioration of a beverage and decrease in the period of its freshness subsequent to opening a beverage container. This includes oxidation of a beverage and fungal and/or bacterial growth due to the beverage coming into contact with air.

Antioxidant- any material, substance, compound, or device, which is capable of preventing, limiting, inhibiting, reversing and counteracting beverage spoilage and deterioration due to the beverage being in contact with air. The antioxidant is used for preventing, limiting, inhibiting, reversing and counteracting the chemical reaction of the beverage with oxygen.

Wine- any wines, liquors, alcoholic drinks, brewed beverages, consumable alcoholic and non-alcoholic products produced from grapes, grape seeds, fruit, wheat, barely, malt, hops, rice, sugar cane and the like.
Beverage- any drinkable liquid, including wine as defined above, fruit juices, milk, etc. Moreover, the term beverage as used herein inter alia includes solid foods packaged in liquids such as fruits, vegetables and fish, and non-drinkable liquids, such as sauces, soups and the like.

Container- any bottle, jar, can, flask, tin or the like used for storing and distributing beverages as defined above.

Cover- a cap, lid, crown, plug, cork or the like used to close or seal off a container as defined above.

Liquid- any beverage as defined above and any other oxidizable liquid.

In what is described herein, the term “surface” and the terms “gas-liquid interface”, “gas-beverage interface”, “oxygen-liquid interface”, “oxygen-beverage interface”, “air-liquid interface”, or “air-beverage interface” will be used interchangeably, without any intent at distinguishing between them. Furthermore in what is described herein as the device “... floating on the surface...” or “...floating on the gas-liquid interface ...” or floating on any of the previously mentioned interfaces, it should readily be appreciated that the device may be partially, but not completely, submerged in the liquid.

While the discussion herein is in terms of beverages and other comestibles, it should readily be appreciated that the anti-oxidation device, container and method of using the anti-oxidation device described herein, can be used with any liquid susceptible to oxidation when exposed to oxygen. For example, many liquid chemicals, paints and lubricants which are readily oxidized when exposed to air, may have their lifetimes extended by using the devices discussed herein. Accordingly, it is to be understood that wherever beverages as defined above are used in the discussion herein, the intent is to include all oxidizable liquids and the present invention is contemplated for use with such liquids.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a device for retarding spoilage and for extending the period of beverage freshness subsequent to opening a container in which the beverage has been packaged.

An additional object of the invention is to provide a method for scavenging oxygen from opened beverage containers.

A further object of the present invention is to provide a beverage container, which assists in retarding beverage spoilage.
Yet another object of the present invention is to provide a device, container and
method which can be used to retard oxidation in any liquid sensitive to oxygen.

It is a further object of the present invention to provide a device which scavenges
oxygen at, or near, the gas-liquid interface of a liquid, before the oxygen entering an opened
container has a chance to diffuse through the liquid.

There is thus provided according to one aspect of the present invention an anti-
oxidation device for retarding oxidation of an oxidizable liquid after opening a container
storing the liquid, thereby permitting the entry therein of ambient air. The device includes an
antioxidant material for scavenging oxygen, and a gas permeable, substantially liquid
impermeable membrane for containing the antioxidant material. The membrane facilitates
oxygen scavenging communication between ambient air in the container and the antioxidant
material. The device is adapted for positioning substantially at a gas-liquid interface within
the container to facilitate oxygen scavenging of the ambient air at least adjacent to the gas-
liquid interface, thereby preventing oxidation of the liquid contents of the container.

In another embodiment of the device of the present invention the membrane is a
spherical-shaped membrane.

Further in accordance with an embodiment of the present invention, the device is
detachably attached to a cover of the container storing the liquid. When the cover is removed,
the device detaches from the cover and drops to the gas-liquid interface of the liquid where
upon it floats.

According to another embodiment, the device has a buoyancy such that it floats on the
gas-liquid interface. In another embodiment the device has a gas content sufficient to ensure
its buoyancy so that it floats on the gas-liquid interface of the liquid.

Further in accordance with yet another embodiment of the present invention, the
device includes a means for positioning the device substantially at the gas-liquid interface
within the container so as to facilitate oxygen scavenging of the ambient air at least adjacent
to the gas-liquid interface, thereby preventing oxidation of the liquid contents of the container.
In one embodiment, the means is a buoyant material, the buoyant material imparting a
buoyancy to the device wherein the device floats on the gas-liquid interface of the beverage.
In some embodiments, this buoyant material is contained within the membrane containing the
antioxidant material and the membrane is affixed to the means. In some embodiments of the
present invention the buoyant material is chosen from the group consisting of styrofoam and
powdered cork.
Additionally, in another embodiment of the present invention, the means is a buoyant body to which the membrane containing the antioxidant material is affixed, the body being constructed to impart sufficient buoyancy to the device so that the device floats on the gas-liquid interface of the liquid. In some embodiments, the buoyant body has at least one extendable member joined to the body. The at least one extendable member, when extended, prevents inadvertent removal of the device from the container storing the liquid. In other embodiments, the buoyant body further includes a buoyant material, the buoyant material having a specific gravity smaller than the specific gravity of the liquid, so that the device floats on the gas-liquid interface of the liquid. In embodiments of the present invention, the body is chosen from one of the following bodies: a y-shaped body, a butterfly-shaped body, a resilient contractible body and a resilient foldable body.

Additionally, in other embodiments of the present invention, the butterfly-shaped or y-shaped body has at least one of the following features: at least one extendable member joined to the body, the at least one extendable member, when extended, preventing inadvertent removal of the device from the liquid container; a specific gravity smaller than the specific gravity of the liquid, so that the device is buoyant and floats on the gas-liquid interface of the liquid; includes a second material, the second material having a specific gravity smaller than the specific gravity of the liquid, imparting buoyancy to the device so that the device floats on the gas-liquid interface of the liquid; and at least one extendable member constructed to have a large surface area and including a membrane containing an antioxidant.

In yet another embodiment, the resilient foldable body has at least one of the following features: the body is constructed of phase separator (PS) paper; an additional barrier is attached to the PS paper for substantially preventing the liquid and the antioxidant material from contacting each other; a specific gravity smaller than the specific gravity of the liquid, so that the device is buoyant and floats on the gas-liquid interface of the liquid; includes a second material, the second material having a specific gravity less than the specific gravity of the liquid, imparting buoyancy to the device so that the device floats on the gas-liquid interface of the liquid; and includes a resilient material, said material imparting resiliency to said body.

In another embodiment, the resilient contactable body is further characterized by at least one of the following features: a specific gravity smaller than the specific gravity of the liquid, so that the device is buoyant and floats on the gas-liquid interface of the liquid; includes a second material, the second material having a specific gravity smaller than the
specific gravity of the liquid, imparting buoyancy to the device so that the device floats on the gas-liquid interface of the liquid; an elongated body having at least one pre-formed fold line for readily contracting the body; and includes a resilient material, said material imparting resiliency to said body.

According to another embodiment of the invention there is provided an antioxidation device for retarding the oxidation of an oxidizable liquid, thereby permitting the entry therein of ambient air, the device including: a body to which is affixed a gas-permeable membrane containing an antioxidant material, the membrane allowing air and oxygen to reach the antioxidant material while substantially preventing the liquid and components thereof from reaching and contacting the antioxidant material; and a second material, the second material having a specific gravity less than the specific gravity of the liquid imparting buoyancy to the device so that the device floats on the gas-liquid interface of the liquid. In another embodiment, the body of the device further includes an extendable member joined to the body, the member, when extended, preventing inadvertent removal of the device from the liquid container.

In some embodiments of the present invention, the device is attached to a cover of the liquid container in a manner so that upon removal of the cover the device detaches from the cover and drops to the gas-liquid interface of the liquid. In other embodiments, at least one extendable member constructed to have a large surface area and including a membrane containing an antioxidant. In yet other embodiments, the device has a specific gravity substantially smaller than the specific gravity of the liquid so that the device is buoyant and floats on the gas-liquid interface of the liquid whereupon it floats.

In another aspect of the present invention, there is provided a liquid container. The container is designed to contain a liquid and the container includes a body for containing the liquid the body having a cover and an anti-oxidation device. The device is detachably affixed to the cover and it detaches from the cover and drops to the gas-liquid interface of the liquid where it floats when the cover is removed from the body. The antioxidant device further includes an antioxidant material for scavenging oxygen and a gas permeable, substantially liquid impermeable membrane. The membrane contains the antioxidant material and facilitates oxygen scavenging communication between ambient air in the container and the antioxidant material.

Additionally, in another embodiment of the liquid container, the anti-oxidation device has at least one extendable member which extend after the device passes through a narrow neck of the liquid container, thereby preventing inadvertent removal of the device.
from the liquid container.

In yet another aspect of the present invention, there is provided a method for retarding the oxidation of an oxidizable liquid, thereby permitting the entry therein of ambient air, the method including the following steps:

opening a liquid container; and

inserting a device including a membrane containing an antioxidant material into the liquid container, where the device is adapted for positioning substantially at a gas-liquid interface of the liquid, so as to facilitate oxygen scavenging of the ambient air, at least adjacent to the gas-liquid interface, thereby preventing oxidation of the liquid in the container.

In another embodiment of the method, the inserting step further includes the step of dropping the device directly into the liquid container, the device being a buoyant device so that it floats on the gas-liquid interface of the liquid.

In some embodiments of the method, the inserting step is effected manually while in others the inserting step is effected mechanically.

Additionally, in another embodiment of the method, the method further includes the step of:

attaching the device in a detachable manner to a cover of the container during packaging of the liquid;

and wherein the inserting step includes the step of:

detaching the device during the opening step, the detaching occurring so that the device drops to the gas-liquid interface of the liquid and floats thereon.

Further features of the invention, its nature, and its advantages will be more apparent from the accompanying drawings and the following detailed description of the preferred embodiments.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The present invention will be understood and appreciated more fully from the following detailed description taken in conjunction with the drawings in which:

Fig. 1 is a frontal view of a spherical embodiment of an anti-oxidation device constructed in accordance with the present invention;

Fig. 2A shows a frontal view of a y-shaped embodiment of an anti-oxidation device constructed in accordance with the present invention;

Figs. 2B and 2C show side views of the deployment of the y-shaped embodiment of
the anti-oxidation device shown in Fig. 2A;

Figs. 3A and 3B show side views of a butterfly-shaped embodiment of an anti-oxidation device constructed in accordance with the present invention with the device's extendable members extended and not extended, respectively;

Figs. 3C and 3D show side views of the deployment of the butterfly-shaped embodiment of the anti-oxidation device shown in Figs. 3A and 3B;

Fig. 4 is a perspective view of a contractible embodiment of the anti-oxidation device constructed in accordance with the present invention;

Fig. 5A is a side view of a foldable embodiment of the anti-oxidation device constructed in accordance with the present invention in its unfolded position; and

Fig. 5B is a perspective view of the foldable embodiment of the anti-oxidation device of the present invention in a folded configuration and being inserted into a bottle.

Similar elements in the Figures are often numbered with similar reference numerals.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference is now made to Fig. 1 where an embodiment constructed and operative according to the present invention is shown. An anti-oxidation device, generally referenced 10, includes an antioxidant material referenced 12 contained in a membrane 14, typically a spherical membrane. Antioxidant material 12 scavenges oxygen from, or near, the surface of a beverage 16, contained in a beverage container 18.

Antioxidant material 12 includes an antioxidant such as, by way of example only and without being limiting, a salt of ascorbic acid, a salt of dithionite, boron, oil soluble antioxidants such as ethoxyquin, ascorbyl palmitate, stearate or oleate, propyl gallate and other gallate esters, butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), either natural or synthetic tocopherols and salts thereof, tertiary butyl hydroquinone (TBHQ), and the like.

Membrane 14, typically a spherical membrane, is a gas permeable membrane allowing air and oxygen to reach antioxidant material 12 while substantially preventing beverage 16, or components thereof, from reaching and contacting antioxidant material 12.

Typically, subsequent to removing a cover 20 of container 18, thereby allowing air and oxygen to enter container 18, device 10 is inserted, manually or mechanically, into container 18 for scavenging oxygen from, or near, the surface of beverage 16, thereby retarding spoilage of beverage 16.

In some embodiments, device 10 is attached to cover 20 and is detachable therefrom,
dropping to the surface of beverage 16 and floating thereon, when cover 20 is removed from container 18.

In some embodiments, anti-oxidation device 10 has a specific gravity smaller than the specific gravity of beverage 16, so that device 10, typically a spherical device, floats on the surface of beverage 16. Alternatively, membrane 14 may contain additional material, such as styrofoam or powdered cork for example, having a specific gravity less than the specific gravity of beverage 16, thereby assisting device 10 to float on the surface of beverage 16. In yet another embodiment, antioxidant material 12 has a specific gravity smaller than the specific gravity of beverage 16, so that device 10 floats on the surface of beverage 16.

In another embodiment, typically spherical device 10 is attached to a string 22 which can be used to remove device 10 from container 18 when beverage 16 is poured from container 18. Additionally, string 22 can be used to position device 10 at the surface of beverage 16 when the specific gravity of device 10 is greater than the specific gravity of beverage 16.

Figs. 2A-2C, to which reference is now made, shows an anti-oxidation device, generally referenced 24, which has a y-shaped body referenced 26, to which is affixed an antioxidant material 28 contained in a membrane 30. Device 24 is constructed and operative according to an embodiment of the present invention. Anti-oxidation device 24 scavenges oxygen from, or near, the surface of beverage 16 contained in container 18 and generally floats thereon.

Antioxidant material 28 includes an antioxidant such as, by way of example only and without being limiting, a salt of ascorbic acid, a salt of dithionite, boron, oil soluble antioxidants such as ethoxyquin, ascorbyl palmitate, stearate or oleate, propyl gallate and other gallate esters, butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), either natural or synthetic tocopherols and salts thereof, tertiary butyl hydroquinone (TBHQ), and the like.

Membrane 30 is a gas permeable membrane, allowing air and oxygen to reach antioxidant material 28 while substantially preventing beverage 16, or components thereof, from reaching and contacting antioxidant material 28.

Y-shaped anti-oxidation device 24 may be constructed so as to resemble a flower having two, three or more “petals” forming a substantially y-shaped cross section.

Preferably, y-shaped body 26 includes at least one floating member 32, also called an extendable member, so that y-shaped body 26 floats on the surface of beverage 16. A lower portion 34 of y-shaped body 26 acts as a keel for stabilizing and orientating y-shaped body 26
on the surface of beverage 16, while anti-oxidation device 24 scavenges oxygen at, or near, the surface, thereby retarding spoilage of beverage 16.

In some embodiments, subsequent to removing cover 20 from container 18, permitting air and oxygen to enter container 18, y-shaped anti-oxidation device 24 is manually introduced into container 18 where it scavenges oxygen from the surface of beverage 16, thereby retarding spoilage of beverage 16. In other embodiments, as shown in Figs. 2B and 2C, y-shaped anti-oxidation device 24 is attached to cover 20 (Fig. 2B) of container 18. Device 24 detaches from cover 20 and drops to the surface of beverage 16, where it floats thereon, when cover 20 is removed from container 18 (Fig. 2C).

Preferably, y-shaped anti-oxidation device 24 has a specific gravity substantially smaller than the specific gravity of beverage 16, so that y-shaped anti-oxidation device 24 floats on the surface of beverage 16. Alternatively, membrane 30 may contain other materials, such as styrofoam or powdered cork, having a specific gravity smaller than the specific gravity of beverage 16 allowing y-shaped anti-oxidation device 24 to float on the surface of beverage 16. In yet other embodiments, antioxidant material 28 has a specific gravity substantially smaller than beverage 16, such that y-shaped anti-oxidation device 24 floats on the surface of beverage 16.

A butterfly-shaped anti-oxidation device, generally referenced 36, shown in Figs. 3A-3D, to which reference is now made, includes a body referenced 38, having at least one extendable member 40; device 36 is able to float on the surface of beverage 16. Butterfly-shaped anti-oxidation device 36 also includes an antioxidant material 28 which is contained in a membrane 30 affixed to body 38.

Antioxidant material 28 includes an antioxidant such as, by way of example only and without being limiting, a salt of ascorbic acid, a salt of dithionite, borón, oil soluble antioxidants such as ethoxyquin, ascorbyl palmitate, stearate or oleate, propyl gallate and other gallate esters, butylated hydroxy anisole (BHA), butylated hydroxytoluene (BHT), either natural or synthetic tocopherols and salts thereof, tertiary butyl hydroquinone (TBHQ), and the like.

Membrane 30 is preferably a gas permeable membrane allowing air and oxygen to reach antioxidant material 28 while substantially preventing beverage 16, or components thereof, from reaching and contacting antioxidant material 28.

Subsequent to removing cover 20 from container 18 allowing air and oxygen to enter container 18, butterfly-shaped anti-oxidation device 36 is introduced, either manually or mechanically, into container 18. Device 36 scavenges oxygen from, or near, the surface of
beverage 16 retarding spoilage of beverage 16.

When introduced into container 18, extendable members 40 of device 36 are not extended (Fig. 3B). After butterfly-shaped anti-oxidation device 36 passes the neck 42 (Fig. 3C) of container 18 or contacts the surface of beverage 16, extendable members 40 extends in the direction generally designated “A” in Fig. 3A. When contacting the surface of beverage 16, device 36 floats on the surface of beverage 16.

Without being limiting, extendable members 40 can be made of a resilient, elastic material which allows them to extend when they pass neck 42 of container 18, or of a material which distends when engorged with beverage 16. In yet another embodiment, extension of extendable members 40 can be effected by a spring mechanism. It is therefore readily understood that the mechanism of extension determines if extendible members 40 extend prior to, or after, device 36 contacts beverage 16.

In yet another embodiment, as shown in Figs. 3C and 3D, butterfly-shaped anti-oxidation device 36 is attached to cover 20. Extendable members 40 of butterfly-shaped anti-oxidation device 36 are compressed while device 36 is attached to cover 20 (Fig. 3C). When cover 20 is removed, butterfly-shaped anti-oxidation device 36 detaches from cover 20 and drops to the surface of beverage 16 (Fig. 3D). Extendable members 40 then extend in the direction generally designated “A” as shown in Fig. 3A and butterfly-shaped anti-oxidation device 36 floats on the surface of beverage 16.

Preferably, extendable members 40 extend to create a span larger than the width of neck 42 of container 18. Thus, when beverage 16 is poured from container 18, butterfly-shaped anti-oxidation device 36 remains inside container 18 and does not interfere with the dispensing of beverage 16. When pouring is complete, butterfly-shaped anti-oxidation device 36 returns to float on the surface of the remaining unpoured beverage 16.

Preferably, butterfly-shaped anti-oxidation device 36 has a specific gravity smaller than the specific gravity of beverage 16, so that butterfly-shaped anti-oxidation device 36 floats on the surface of beverage 16. In other embodiments, membrane 30 may contain additional other material, such as styrofoam and powdered cork, the other material having a specific gravity less than the specific gravity of beverage 16, allowing butterfly-shaped anti-oxidation device 36 to float on the surface of beverage 16. Alternatively, antioxidant material 28 has a specific gravity smaller than beverage 16, such that butterfly-shaped anti-oxidation device 36 floats on the surface of beverage 16.

Reference is again made to the embodiment of Figs. 2A-2C which show membrane 30, containing antioxidant material 28, being fixed to, but not integral with, floating members
32. The general purpose of members 32 has been previously discussed. Members 32 are configured to aid in flotation of device 24 and to prevent device 24 from being inadvertently removed from container 18 when beverage 16 is dispensed without interfering with the dispensing of beverage 16.

Floating members 32, however, have an additional purpose. Members 32 can be constructed so that antioxidant material 28 within membrane 30 are an integral part of members 32. The large surface area of members 32 then significantly increases the oxygen scavenging efficiency of antioxidant 28.

The same is true of extendable members 40 shown in the embodiment of Figs. 3A-3D. Extendable members 40 have a large surface area. When antioxidant material 28 and membrane 30 are included as an integral part of members 40, the large surface area of members 40 allows for increased, more efficient, oxygen removal.

Reference is now made to Fig. 4 which shows a contractible anti-oxidation device, generally referenced 42, having an elongated body referenced 44 with at least one pre-formed fold line 46 usable for contracting anti-oxidation device 42. Preferably, contractible anti-oxidation device 42 is constructed of a resilient or elastic-like material, so that contractible device 42 substantially returns to its original elongated shape when lateral pressure on device 42 is removed. As shown in Fig. 4, when contractible anti-oxidation device 42 substantially returns to its original shape, contractible anti-oxidation device 42 expands to a width such that inadvertent removal of device 42 from container 18 during pouring is impossible.

Contractible anti-oxidation device 42 contains an antioxidant material 28 which is contained in a membrane 30. Membrane 30 of device 42 is preferably a gas permeable membrane which allows air and oxygen to reach antioxidant material 28 while generally preventing beverage 16, or components thereof, from reaching and contacting antioxidant material 28.

Antioxidant material 28 includes an antioxidant such as, by way of example only and without being limiting, a salt of ascorbic acid, a salt of dithionite, boron, oil soluble antioxidants such as ethoxyquin, ascorbyl palmitate, stearate or oleate, propyl gallate and other gallate esters, butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), either natural or synthetic tocopherols and salts thereof, tertiary butyl hydroquinone (TBHQ), and the like.

In one embodiment, subsequent to removing cover 20 from container 18, thereby allowing air and oxygen to enter container 18, contractible anti-oxidation device 42 is manually or mechanically inserted into container 18 for scavenging oxygen from the surface.
of beverage 16. Upon contractible anti-oxidation device 42 passing container neck 49, lateral pressure on contractible anti-oxidation device 42 decreases sufficiently to allow device 42 to return to its original elongated shape. As shown in Figure 4, when anti-oxidation device 42 substantially returns to its original shape, contractible anti-oxidation device 42 expands to the width of the space available in container 18 or at least to a width greater than neck 49, thereby preventing inadvertent removal of device 42 from container 18 during dispensing of beverage 16.

In another embodiment, contractible anti-oxidation device 42 is attached to cover 20, so that contractible anti-oxidation device 42 is compressed while attached to cover 20. Upon removal of cover 20, contractible anti-oxidation device 42 detaches from cover 20 and drops to the surface of beverage 16. Thereafter, contractible anti-oxidation device 42 expands in the direction generally designated as “A” in Fig. 4 to a width greater than neck 49 of container 18. Once device 42 has expanded, inadvertent removal of device 42 from container 18 when beverage 16 is dispensed can not occur and device 50 does not interfere with the dispensing of beverage 16. When pouring is complete, contractible anti-oxidation device 42 again floats on the surface of the remaining beverage 16.

Preferably, contractible anti-oxidation device 42 has a specific gravity smaller than the specific gravity of beverage 16, so that contractible anti-oxidation device 42 floats on the surface of beverage 16. Alternatively, membrane 30 may contain additional other material, such as styrofoam or powdered cork, which has a specific gravity smaller than the specific gravity of beverage 16 and which allows contractible anti-oxidation device 42 to float on the surface of beverage 16. Alternatively, antioxidant material 28 has a specific gravity substantially smaller than beverage 16, so that contractible anti-oxidation device 42 floats on the surface of beverage 16.

Figs. 5A and 5B, to which reference is now made, show a flexible, foldable anti-oxidation device, generally referenced 50, having, in the embodiment shown, a substantially elliptical body referenced 52. Preferably, elliptical body 52 is constructed from two pieces of phase separator (PS) paper 54 pasted, welded or pressed together according to any method of attachment known in the art. In Fig. 5A, the two pieces of PS paper 54 are shown having an exaggerated separation. In fact, the two pieces lie adjacent to each other, except for the region, which contains antioxidant material 56. That region can be thought of as a tea bag-like region holding antioxidant material 56. In the embodiment of Figs. 5A and 5B, the antioxidant material 56 is positioned in a substantially central area 58 of elliptical body 52. However, this positioning is optional, and other positions in elliptical body 52 are also possible.
PS paper 54 is preferably a high-grade filter paper treated with a special food grade silicone retardant. The silicone retardant repels water while allowing the transfer of oily substances and gases through the PS paper. Although a food grade silicone has been suggested here, it should be apparent to one skilled in the art that other water repellent coatings may also be used. It should be appreciated that in this embodiment, the silicone treated PS paper functions as a gas permeable, substantially liquid impermeable membrane.

It is desired in the embodiment shown in Figs. 5A and 5B that anti-oxidation device 50 is foldable and resilient. When the silicone treated PS paper is found to be insufficiently flexible and resilient, device 50 may be constructed with a further layer of a resilient material which imparts additional flexibility to anti-oxidation device 50 making it more readily foldable. Resilient materials which can be used, but without being limiting, include Mylar®, polyethylene and polyesters. The resilient material may be applied by coating the outside of the PS paper or by inserting a layer of the resilient material within the two PS paper 54 layers.

Now referring specifically to Fig. 5B, subsequent to removing cover 20 from container 18 allowing air and oxygen to enter container 18, folded anti-oxidation device 50 is inserted, typically but not necessarily manually, into container 18. Anti-oxidation device 50 scavenges oxygen from the surface of beverage 16 retarding spoilage.

After foldable, resilient anti-oxidation device 50 passes through neck 49 of container 18, lateral pressure on foldable anti-oxidation device 50 decreases sufficiently to allow anti-oxidation device 50 to return to its original elliptical shape. It returns to a size larger than the width of neck 49 of container 18 so that when beverage 16 is poured from container 18, device 50 remains inside container 18 without interfering with the dispensing of beverage 16. When pouring is complete, foldable, resilient anti-oxidation device 50 floats on the surface of the remaining beverage 16.

In some embodiments, foldable, resilient anti-oxidation device 50 has a specific gravity smaller than beverage 16, so that device 50 floats on the surface of beverage 16. In other embodiments, foldable, resilient anti-oxidation device 50 includes an additional material 62 having a specific gravity smaller than the specific gravity of beverage 16 allowing anti-oxidation device 50 to float on the surface of beverage 16. Without being limiting, materials which can be used as additional material 62 are styrofoam and powdered cork. Alternatively, antioxidant material 56 has a specific gravity substantially smaller than beverage 16 so that foldable, resilient anti-oxidation device 50 floats on the surface of beverage 16.

In the present embodiment, antioxidant material 56 includes an antioxidant such as, by way of example only and without being limiting, a salt of ascorbic acid, a salt of dithionite,
boron, oil soluble antioxidants such as ethoxyquin, ascorbyl palmitate, stearate or oleate, propyl gallate and other gallate esters, butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), either natural or synthetic tocopherols and salts thereof, tertiary butyl hydroquinone (TBHQ), and the like.

While in discussing Figs. 5A and 5B, reference has been made to an elliptically-shaped body, it should readily be appreciated by one skilled in the art that other shapes can be used as well, such as, but without being limiting, circular and polygonal shapes.

In other embodiments, an additional water barrier may be attached to, or integrally formed with, PS paper 54 of resilient, foldable device 50 for substantially preventing beverage 16 and antioxidant material 56 from contacting each other. This barrier would be in addition to the silicone treatment of the PS paper 54 or possibly even in place of the silicone treatment. In yet another embodiment, an additional organic or oil barrier may be attached to, or integrally formed with, PS paper 54 of resilient, foldable device 50.

In yet another embodiment of resilient, foldable anti-oxidation device 50, a membrane which allows for the permeability of gases while preventing beverage 16, or components thereof, from coming into contact with antioxidant material 56 may be added to the PS paper 54 base structure. The membrane 30 would contain antioxidant material 56, thereby allowing oxygen and other gases to reach antioxidant material 56 while substantially preventing any beverage, or components thereof, from reaching antioxidant material 56. In still another embodiment of a resilient, foldable anti-oxidation device, this membrane could be used without the PS paper 54 base construction.

Without intending to be limiting, materials which can be used to make such membranes, as well as the other membranes discussed herein, are Teflon® or polyethylene. Suitable membranes can be purchased from Millipore Corp. (Bedford, MA), Whatman, Inc. (Clifton, NJ) and Schleicher & Schuell, Inc. (Keene, NH).

Another aspect of the present invention teaches a method for retarding spoilage and extending the period of freshness of a beverage. The method includes the steps of:

opening a beverage container; and

positioning a device, including a membrane containing an antioxidant on, or near, the surface of the beverage so that the antioxidant scavenges oxygen entering the beverage container after it is opened.

In some embodiments of the method, the positioning step further includes the steps of:

introducing the device into the container after opening the container; and

dropping the device into the beverage, the device being a floatable device, so that it
floats on the surface of the beverage.

The introducing step may be effected either manually or mechanically.

In yet other embodiments of the method, the method further includes the step of attaching the device in an easily detachable manner to the cover of the container during packaging of the beverage, while the positioning step includes the step of detaching the device when opening the beverage container, the device dropping to the surface of the beverage and floating thereon.

In a further aspect of the present invention, the invention contemplates a beverage container employing the anti-oxidation device herein above described. The device is attached in a relatively temporary fashion to the container’s cover and is intended to detach when the beverage container is opened. After detachment of the device, the device drops to the surface of the beverage and floats thereon where it scavenges oxygen. The anti-oxidation device may be constructed according to any of the embodiments of the device described herein above. Methods for temporary attaching the device to the cover and for its easy detachment upon opening the beverage container are well known to those skilled in the art.

Although the present invention has been described above in terms of covers and the Figures generally indicate bottles, it will be appreciated that the present invention may be used with other types of beverage containers- bottles, jars, cans, flasks, tins or multi-layered containers such as those used for milk, juices and wine. Similarly, the present invention may be used with different types of covers such as caps, corks, plugs, crowns or lids.

In what has heretofore been described as “...a membrane containing an antioxidant...” the term “containing” in addition to indicating circumscribing antioxidant particles, also includes embodiments in which the antioxidant particles are encased or impregnated within the membrane. In such latter cases, the membrane may further include an additional waterproof coating to prevent the antioxidant particles from directly contacting the beverage.

While the description herein above is in terms of beverages and other comestibles, it should readily be appreciated that the anti-oxidation device, container and method of using the anti-oxidation device described herein, can be used with any liquid which is sensitive to oxygen and susceptible to oxidation.

It will be appreciated by persons skilled in the art that the present invention is not limited by what has been particularly shown and described herein above. Rather the scope of the invention is defined solely by the claims that follow.
CLAIMS

1. An anti-oxidation device for retarding oxidation of an oxidizable liquid after opening a container storing the liquid, thereby permitting the entry therein of ambient air, said device including:

   an antioxidant material for scavenging oxygen; and

   a gas permeable, substantially liquid impermeable membrane for containing said antioxidant material operative to facilitate oxygen scavenging communication between ambient air in the container and said antioxidant material; and

   wherein said device is adapted for positioning substantially at a gas-liquid interface within the container so as to facilitate oxygen scavenging of the ambient air at least adjacent to the gas-liquid interface, thereby preventing oxidation of the liquid contents of the container.

2. A device according to claim 1, wherein said membrane is a spherically shaped membrane.

3. A device according to claim 1, wherein said antioxidant material includes an antioxidant selected from the group consisting of a salt of ascorbic acid, a salt of dithionite, boron, oil soluble antioxidants such as ethoxyquin, ascorbyl palmitate, stearate and oleate, propyl gallate and other gallate esters, butylated hydroxyanisole, butylated hydroxytoluene, natural and synthetic tocopherols and salts thereof, and tertiary butyl hydroquinone.

4. A device according to claim 1, wherein said device is attached to a cover of the container storing the liquid in a manner so that upon removal of the cover said device detaches from the cover and drops to the gas-liquid interface of the liquid whereupon it floats.

5. A device according to claim 1, wherein said device has a buoyancy such that it floats on said gas-liquid interface.
6. A device according to claim 1, wherein said device has a gas content that is sufficient to ensure its buoyancy enabling said device to float on the gas-liquid interface of the liquid.

7. A device according to claim 1, further including a means for positioning said device substantially at the gas-liquid interface within the container so as to facilitate oxygen scavenging of the ambient air at least adjacent to the gas-liquid interface and thereby preventing oxidation of the liquid contents of the container.

8. A device according to claim 7, wherein said means is constructed of a buoyant material, said buoyant material imparting a buoyancy to said device wherein said device floats on the gas-liquid interface of the liquid.

9. A device according to claim 8, wherein said buoyant material is contained within said membrane containing said antioxidant material, said membrane being affixed to said means.

10. A device according to claim 9, wherein said buoyant material is chosen from the group consisting of styrofoam and powdered cork.

11. A device according to claim 7, wherein said means is a buoyant body to which said membrane containing said antioxidant material is affixed, said body being constructed to impart sufficient buoyancy to said device so that said device floats on the gas-liquid interface of the liquid.

12. A device according to claim 11, wherein said buoyant body has at least one extendable member joined to said body, said at least one extendable member, when extended, prevents inadvertent removal of said device from the container storing the liquid.

13. A device according to claim 11, wherein said buoyant body further includes a buoyant material, said buoyant material having a specific gravity smaller than the specific gravity of the liquid, so that said device floats on the gas-liquid interface of the liquid.
14. A device according to claim 11, wherein said body is chosen from one of the following bodies: a y-shaped body, a butterfly-shaped body, a resilient contractible body and a resilient foldable body.

15. A device according to claim 14, wherein said butterfly-shaped body has at least one of the following features:

(i) at least one extendable member joined to said body, said at least one extendable member, when extended, preventing inadvertent removal of said device from the liquid container;

(ii) a specific gravity smaller than the specific gravity of the liquid, so that said device is buoyant and floats on the gas-liquid interface of the liquid;

(iii) includes a second material, said second material having a specific gravity smaller than the specific gravity of the liquid, imparting buoyancy to said device so that said device floats on the gas-liquid interface of the liquid; and

(iv) at least one extendable member constructed to have a large surface area including a membrane containing an antioxidant.

16. A device according to claim 14, wherein said resilient foldable body has at least one of the following features:

(i) said body is constructed of phase separator (PS) paper;

(ii) an additional barrier is attached to said PS paper for substantially preventing the liquid and said antioxidant material from contacting each other;

(iii) a specific gravity smaller than the specific gravity of the liquid, so that said device is buoyant and floats on the gas-liquid interface of the liquid;

(iv) includes a second material, said second material having a specific gravity less than the specific gravity of the liquid, imparting buoyancy to said device so that said device floats on the gas-liquid interface of the liquid; and

(v) includes a resilient material, said material imparting resiliency to said body.

17. A device according to claim 14, wherein said resilient contractible body is characterized by at least one of the following features:

(i) a specific gravity smaller than the specific gravity of the liquid, so that said device is buoyant and floats on the gas-liquid interface of the liquid;

(ii) includes a second material, said second material having a specific gravity
smaller than the specific gravity of the liquid, imparting buoyancy to said device so that said device floats on the gas-liquid interface of the liquid;

(iii) an elongated body having at least one pre-formed fold line for readily contracting said body; and

(iv) includes a resilient material, said material imparting resiliency to said body.

18. An anti-oxidation device according to claim 14, wherein said y-shaped body has at least one of the following features:

(i) a specific gravity smaller than the specific gravity of the liquid, so that said device is buoyant and floats on the surface of the liquid;

(ii) includes a second material, said second material having a specific gravity smaller than the specific gravity of the liquid, imparting buoyancy to said device so that said device floats on the gas-liquid interface of the liquid; and

(iii) at least one extendable member constructed to have a large surface area including a membrane containing an antioxidant.

19. An anti-oxidation device for retarding oxidation of an oxidizable liquid after opening a container storing the liquid, thereby permitting the entry therein of ambient air, said device including:

(i) a body to which is affixed a gas-permeable membrane containing an antioxidant material, said membrane allowing air and oxygen to reach said antioxidant material while substantially preventing the liquid and components thereof from reaching and contacting said antioxidant material; and

(ii) a second material, said second material having a specific gravity less than the specific gravity of the liquid, imparting buoyancy to said device so that said device floats on the gas-liquid interface of the liquid.

20. A device according to claim 19, further including an extendable member joined to said body, said member, when extended, preventing inadvertent removal of said device from the liquid container.

21. A device according to claim 19, further including at least one extendable member constructed to have a large surface area and including a gas permeable, substantially liquid impermeable membrane containing an antioxidant.
22. A device according to claim 19, wherein said antioxidant material includes an antioxidant selected from the group consisting of a salt of ascorbic acid, a salt of dithionite, boron, oil soluble antioxidants such as ethoxyquin, ascorbyl palmitate, stearate or oleate, propyl gallate and other gallate esters, butylated hydroxy anisole, butylated hydroxytoluene, natural and synthetic tocopherols and salts thereof and tertiary butyl hydroquinone.

23. A device according to claim 19, wherein said device is attached to a cover of the liquid container in a manner so that upon removal of the cover said device detaches from the cover and drops to the gas-liquid interface of the liquid where upon it floats.

24. A device according to claim 19, wherein said device has a specific gravity smaller than the specific gravity of the liquid so that said device is buoyant and floats on the gas-liquid interface of the liquid.

25. An anti-oxidation device for retarding oxidation of an oxidizable liquid after opening a container storing the liquid, thereby permitting the entry therein of ambient air, said device including:

   (i) a butterfly-shaped body to which is affixed a gas permeable, substantially liquid impermeable membrane which contains an antioxidant material, said membrane allowing air and oxygen to reach said antioxidant material, while substantially preventing the liquid and components of the liquid from reaching and contacting said antioxidant material;

   (ii) at least one extendable member joined to said body, said member, when extended, preventing inadvertent removal of said device from the liquid container;

   (iii) at least one extendable member constructed to have a large surface area and including a membrane containing an antioxidant; and

   (iv) a material having a specific gravity less than the specific gravity of the liquid thereby allowing said device to float on the gas-liquid interface of the liquid.

26. An anti-oxidation device for retarding oxidation of an oxidizable liquid after opening a container storing the liquid, thereby permitting the entry therein of ambient air, said device including:

   (i) a y-shaped body, to which is affixed an antioxidant material contained in a
gas permeable, substantially liquid impermeable membrane, said membrane allowing air and oxygen to reach said antioxidant material, while substantially preventing the liquid and components of the liquid from reaching and contacting said antioxidant material;

(ii) at least one extendable member joined to said body, said member when extended preventing inadvertent removal of said device from the liquid container;

(iii) at least one extendable member constructed to have a large surface area and including a membrane containing an antioxidant; and

(iv) a material having a specific gravity less than the specific gravity of the liquid thereby allowing said device to float on the gas-liquid interface of the liquid.

27. An anti-oxidation device for retarding oxidation of an oxidizable liquid after opening a container storing the liquid, thereby permitting the entry therein of ambient air, said device including:

a resilient contractible body having a specific gravity smaller than the liquid, said body being an elongated body having a pre-formed fold line for readily contracting said body, said resilient contractible body including:

(i) an antioxidant material; and

(ii) a gas permeable, substantially liquid impermeable membrane containing said antioxidant material, said membrane allowing contact of oxygen with said antioxidant material, while substantially preventing the liquid from contacting said antioxidant material.

28. An anti-oxidation device for retarding oxidation of an oxidizable liquid after opening a container storing the liquid, thereby permitting the entry therein of ambient air, said device including:

a resilient foldable body constructed of phase separator (PS) paper; and

an antioxidant material positioned in a substantially central area of said foldable body.

29. A device according to claim 28, which is characterized by at least one of the following features:

(i) an additional barrier is attached to said PS paper for substantially preventing the liquid and said antioxidant material from contacting each other;

(ii) a material having a specific gravity smaller than the specific gravity of the
liquid allowing said device to float on the gas-liquid interface of the liquid;

(iii) a specific gravity smaller than the liquid, so that said device floats on the gas-liquid interface of the liquid; and

(iv) includes a resilient material, said material imparting resiliency to said body.

30. A liquid container, said container designed to contain an oxidizable liquid, said container including:

a body for containing the liquid said body having a cover; and

an anti-oxidation device, said device detachably affixed to said cover, said device automatically detaching from said cover and dropping to the gas-liquid interface of the liquid and floating thereon when said cover is removed from said body, said antioxidant device further including:

an antioxidant material for scavenging oxygen; and

a gas permeable, substantially liquid impermeable membrane for containing said antioxidant material operative to facilitate oxygen scavenging communication between ambient air in said container and said antioxidant material.

31. A liquid container according to claim 30, wherein said anti-oxidation device has at least one extendable member which extends after said device passes through a narrow neck of said liquid container, thereby preventing inadvertent removal of said device from said liquid container.

32. A method for retarding oxidation of an oxidizable liquid, said method including the following steps:

opening a liquid container; and

inserting a device, including a membrane containing an antioxidant material, into the liquid container, where the device is adapted for positioning substantially at a gas-liquid interface of the liquid, so as to facilitate oxygen scavenging of the ambient air, at least adjacent to the gas-liquid interface, thereby preventing oxidation of the liquid in the container.

33. A method according to claim 32, wherein said inserting step further includes the step of dropping the device directly into the liquid container, the device being a buoyant device so that it floats on the gas-liquid interface of the liquid.
34. A method according to claim 32, wherein the inserting step is effected manually.

35. A method according to claim 32, wherein the inserting step is effected mechanically.

36. A method according to claim 32, wherein said method further includes the step of:

   attaching the device in a detachable manner to a cover of the container during
   packaging of the liquid;

   and wherein said inserting step includes the step of:

   detaching the device during said opening step, the detaching occurring so that the
   device drops to the gas-liquid interface of the liquid and floats thereon.