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PREPARATION OF FRUIT JUICES

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FIG. 1.

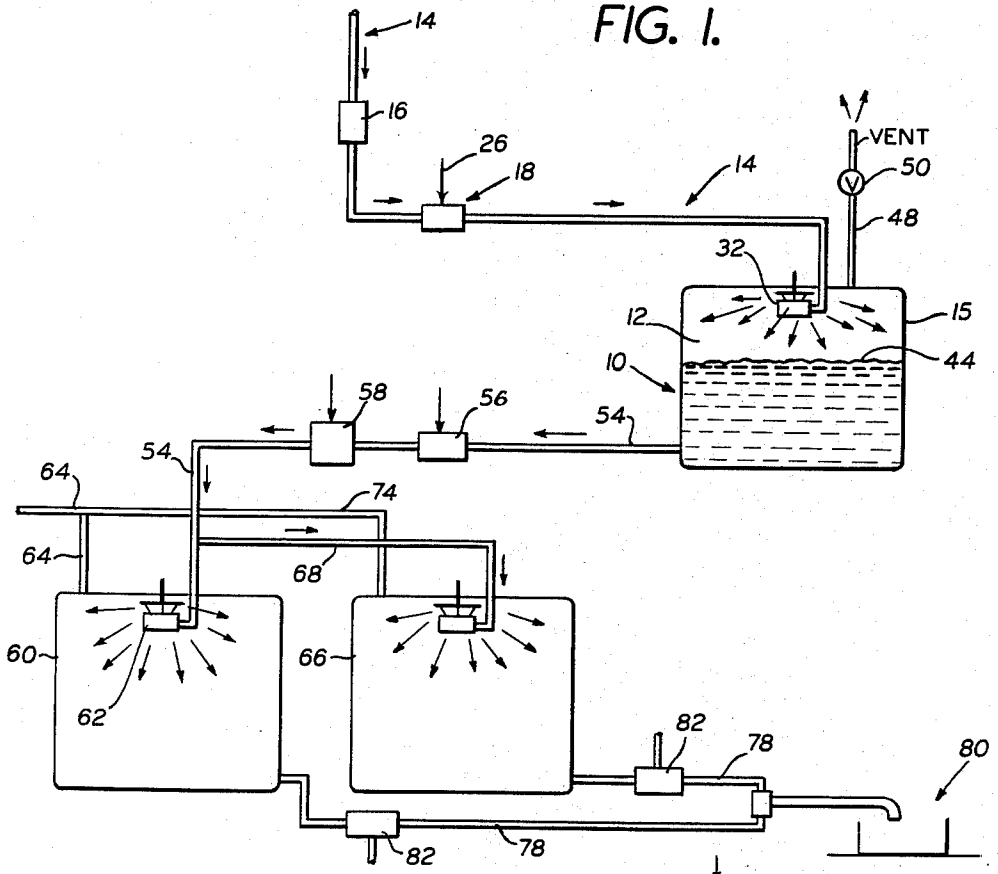


FIG. 2.

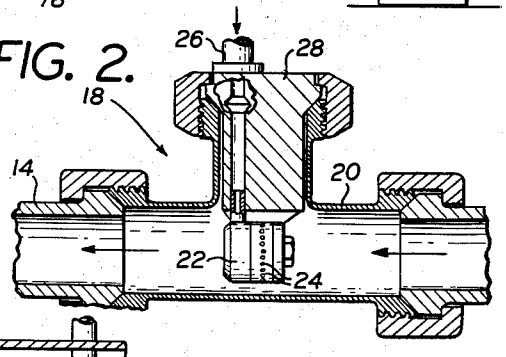
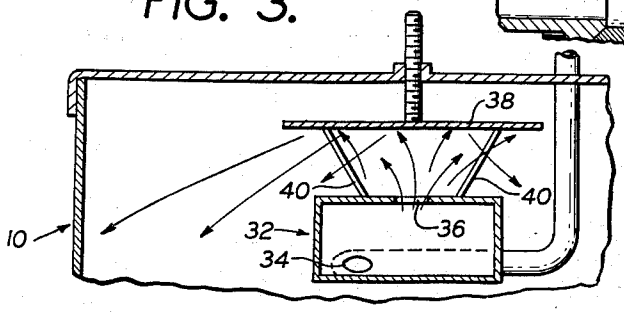


FIG. 3.



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PREPARATION OF FRUIT JUICES

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This invention relates to methods and apparatus for treating liquid, and especially fruit juices, such as orange juice, preparatory to packaging of the liquid. In order to give the liquid good keeping qualities, contaminant gas, such as oxygen, which will cause loss in product quality or change in flavor, must be removed. More particularly, the invention relates to the removal of residual oxygen or other contaminant gas from a liquid prior to packaging and without producing undesirable foaming of the liquid.

It has been the practice to remove residual gas from juices by flushing the liquid with inert gas, but the methods employed have resulted in substantial foaming of the liquid.

Foaming is deleterious from the standpoint of appearance and loss of certain quality factors of certain liquids, particularly orange juice.

It is an object of this invention to provide an improved method of and apparatus for removing oxygen and other contaminant gas from liquids, especially fruit juices, with little or no foaming.

Another object is to provide more efficient oxygen or other gas removal from liquids with a resulting reduction in the consumption of gas used for flushing.

In the preferred embodiment, the invention removes the residual gas by atomizing the liquid at the region of pressure release and in the upper part of a chamber from which the liquid rains down on a tranquil body of liquid in the bottom portion of the tank with little or no surface agitation.

It is another object of the invention to provide improved apparatus for removing gas in accordance with the method of this invention. The apparatus includes means for charging the liquid and for releasing gas in a single chamber, mostly by sudden release of pressure and atomization, and partly by standing of accumulated liquid in contact with a substantially inert gas atmosphere. Such removal of gas is performed in one stage; but for reduction in the residual gas to lower quantities a second stage is employed, and this may be performed in a blending tank where cut-back juice is mixed with concentrate to provide a juice with the desired level of concentration prior to packaging. This feature reduces the amount of equipment necessary for removing gas in accordance with this invention.

The apparatus includes, as an additional refinement, another means for charging the liquid with inert gas just prior to the packaging of the liquid to prevent the contamination by atmospheric oxygen at the packaging station.

Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views,

FIGURE 1 is a diagrammatic view showing different steps for removing contaminant gas from a liquid in accordance with this invention and showing apparatus for carrying out the method;

FIGURE 2 is an enlarged diagrammatic view of one of the spargers shown in FIGURE 1; and

FIGURE 3 is a greatly enlarged sectional view through the centrifugal spray head shown in FIGURE 1.

FIGURE 1 shows a tank 10 enclosing a chamber 12 to which liquid is supplied through a supply line 14. The liquid is put under substantial pressure by a pump 16 located in the supply line; and there is a sparger 18 in the supply line on the downstream side of the pump.

FIGURE 2 shows the sparger 18 on an enlarged scale. It includes a fitting 20 which is equivalent to a T fitting in the supply line 14. This fitting serves as a housing for a head 22 located in the liquid stream and having perforations 24 through which gas escapes into the liquid flowing through the fitting 20 and past the head 22. Gas under high pressure is supplied to the hollow interior of the head 22 through a gas pipe 26 which extends through a plug 28 in the top of the fitting 20.

The gas in the pipe 26 may be nitrogen or any gas which is inert with respect to the liquid in the supply line 14. This gas may be supplied through a regulator from a high-pressure storage cylinder, or from any other source, at a pressure higher than the liquid pressure in the fitting 20. The inert gas is absorbed by the liquid, and because of the excess pressure of the gas, the liquid reaches the tank 10 in a supersaturated condition and with entrained bubbles of unabsorbed gas.

The sparger 18 should not be located too far from the tank because small entrained bubbles of gas tend to coalesce as the liquid travels from the sparger to the tank and this reduces the efficiency of the flushing operation. While the distance depends upon the velocity of flow, it should be between four and fifteen feet for most installations.

There are means in the tank 12 at the end of the supply line 14 for effecting a sudden release of pressure on the liquid. The means used in the illustrated embodiment of the invention is a centrifugal spray head 32. Considering the invention in its broader aspects, the centrifugal spray head 32 is merely representative of means for releasing the pressure on the liquid and its entrapped gas, and for atomizing the liquid in the space provided in the upper part of the tank 10. In the preferred operation of the invention, the liquid and entrained gas is supplied to the spray head 32 at superatmospheric pressure up to about 150 pounds per square inch. Experience indicates that about 75% of the flushing occurs in the atomized stage and about 25% from the tranquil body of liquid.

FIGURE 3 shows the centrifugal spray head 32 on an enlarged scale. This spray head includes a section 34 of generally cylindrical shape and into which the supply line opens in a tangential direction so as to impart a spiral whirling motion to the liquid as it enters the lower section 34 of the spray head.

There is a center opening 36 through the top of the lower section 34 and whirling liquid is discharged through this opening 36 and upwardly against a top plate 38 which is supported from the lower section 34 by angularly-spaced struts 40. The liquid is discharged against the top plate 38 at various angles and splashes outwardly and downwardly in various directions dependent upon the angles of incidence and also upon interference of

the particles of liquid with one another. This turbulent action of the liquid combined with the sudden release of pressure and the substantially instantaneous discharge of large quantities of gas from the liquid results in an atomizing of the liquid into very small particles which still further promotes escape of gas from the liquid.

Some of the particles of liquid come into contact with the sides of the tank and run down the sides into an accumulation of liquid 44 in the lower part of the tank 10. Other particles atomized into the gas space in the tank rain down into the liquid 44. The level of the liquid 44 is far enough below the spray head 32 to avoid any substantial agitation of the liquid 44 by the direct atomizing action of the pressure release one the liquid and gas at the spray head 32. The tank 10 is preferably from 50–60% full during the stripping operation.

Although there is some minor disturbance of the liquid 44 by the raining of droplets of the atomized liquid, the body of liquid 44 remains substantially tranquil and there is essentially no foaming at the surface of the liquid such as would ordinarily occur with gas bubbling upwardly through the liquid, or with the release of pressure within the body of the liquid, when not accompanied by the desired methods according to the present invention. When the invention is used for liquids which do not present a foaming problem, the introduction of gas below the liquid and some agitation is not objectionable. Furthermore, the delivery of an impregnated liquid through a spray head above the surface of the liquid in accordance with the present invention has been found effective to suppress and avoid the accumulation of surface foam even when gas may be bubbled upwardly through the body of the liquid. It will be evident, however, that an important advantage of the preferred embodiment of the present invention resides in the fact that under sufficient pressure impregnation and with adequate spray atomization that the agitation of the accumulated body of liquid in the lower portion of the vessel can be substantially eliminated and any interference or objection from such a source thereby avoided.

Gas escapes from the chamber 12 in the tank 10 through a vent pipe 48. This pipe 48 is shown communicating directly with the atmosphere and there is a check valve 50 in the vent pipe for preventing any entrance of air into the tank 10.

The gas space in the tank 10 above the level of the liquid 44 is filled mostly with nitrogen, or other inert gas, which is charged into the liquid by the sparger 18. The partial pressure of oxygen, or other contaminant gas, is extremely low in the space above the liquid 44. This promotes flow of the oxygen, or other contaminant, from the liquid to the gas space; and the atomizing of the liquid accompanied by the escape of the nitrogen greatly facilitates the flushing of the oxygen out of the liquid being treated.

Most of the oxygen is removed from the liquid while the liquid is in atomized condition in the upper part of the tank 10, but there is some additional discharge of oxygen from the accumulated liquid in the lower part of the tank into the gas space above the liquid level.

Liquid is removed from the tank 10 through a conduit 54. There is a pump 56 in the conduit 54; and if a still further reduction in the oxygen content of the liquid is desired, a sparger 58 is also located in the conduit 54. The pump 56 delivers the liquid, through the sparger 58, to another tank 60 where the liquid may be discharged into the tank through another centrifugal spray head 62 to provide a second flushing stage similar to that in the tank 10.

Ordinarily, two similar flushing stages are not used because they are not necessary in order to reduce the oxygen content below significant quantities. Even though a full-fledged second stage of flushing is not necessary, it is a precaution to maintain a charge of inert gas in the liquid as it is delivered by the conduit 54 to the tank 60.

The apparatus illustrated is a system for orange juice and the liquid which is treated to remove oxygen is the cut-back juice. The tank 60 is the blend tank in which the concentrate from a supply line 64 is mixed with the cut-back juice from the conduit 54 to make the juice that is to be packaged. Although the conduit 54 is shown terminating in the tank 60 in a centrifugal spray head 62; it will be understood that this cut-back juice can be introduced into the tank 60 in any other way, except that it is undesirable to introduce it below the level of the liquid in the tank 60 if there is sufficient charge of gas in the liquid to cause objectionable foaming.

The drawing shows a second blend tank 66 to which concentrated juice is supplied through a branch 68 of the supply line 54; and to which cut-back juice is supplied from a branch 74 of the conduit 64. Both of the tanks 60 and 66 have discharge lines 78 leading to a packaging station 80 where the juice is put into bottles or cans or other containers for shipping.

As a further precaution against oxygen contamination, the mixed juice is charged with nitrogen, or other inert gas, on its way from the blend tanks 60 and 66 by spargers 82 inserted in the lines 78. The inert gas escaping from the juice at the packaging station serves to flush any remaining oxygen from the juice, and in any event to prevent absorption of oxygen from the atmosphere at the packaging station where it is very difficult to prevent some contact with air. Foaming of the concentrate at this stage is controlled by the gas flow control or balance.

A certain degree of foaming at the packaging station is not objectionable. If the headspace of the can contains foam, it will contain no oxygen. As the can is frozen, there will be a collapse of the foam. The gas flow rates must be balanced to insure against excessive foaming and loss in fill weights.

Although the invention has been described in connection with the treatment and packaging of orange juice, it will be understood that it can be used for any liquid where removal of oxygen or other gas from the liquid is desirable to improve its keep qualities or for any other reason.

What is claimed is:

1. The method of treating fruit juice containing a contaminant gas, which method comprises supplying the juice under pressure to a chamber, charging the juice with an inert gas before delivery of the juice to the chamber, releasing the pressure on the charged juice in the chamber and above the level of juice accumulated in the bottom of the chamber, atomizing the juice in said chamber above said level to release the inert and contaminant gas from the atomized particles, accumulating juice as it settles in the chamber, venting gas from the chamber above the juice level while preventing entrance of atmospheric air into the chamber, maintaining accumulated juice in the bottom part of the chamber with the upper surface of the juice in contact with the gas in the upper part of the chamber, and removing the juice from the lower part of the chamber.

2. In a process for removing oxygen from citrus juice, the steps comprising charging nitrogen at superatmospheric pressure into a flowing stream of citrus juice by sparging said stream with said nitrogen thereby forming a stream supersaturated with said nitrogen containing bubbles of unabsorbed nitrogen gas therein, releasing the nitrogen charged citrus juice stream into a chamber at substantially atmospheric pressure and atomizing said charged stream into minute droplets, said chamber containing nitrogen gas and being substantially devoid of oxygen other than that liberated from said atomized juice stream, continuously removing nitrogen from said chamber together with oxygen liberated from said atomized citrus juice, collecting an accumulated body of said atom-

ized citrus juice stream and removing oxygen-free citrus juice from said body.

3. In the preparation of fruit juices in which a quantity of the juice is concentrated and then mixed with cut-back juice in unconcentrated condition, the improvement which comprises removing oxygen from said cut-back juice by the process of claim 2, recharging the cut-back juice with nitrogen following deoxygenation thereof, and mixing said recharged cut-back juice with the said concentrated juice.

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