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Rule et al.

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[54] **DRUM BUBBLER TRITIUM PROCESSING SYSTEM**

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[52] **U.S. Cl.** **95/226**; 96/351

[58] **Field of Search** 95/226; 96/329, 96/340, 342, 351

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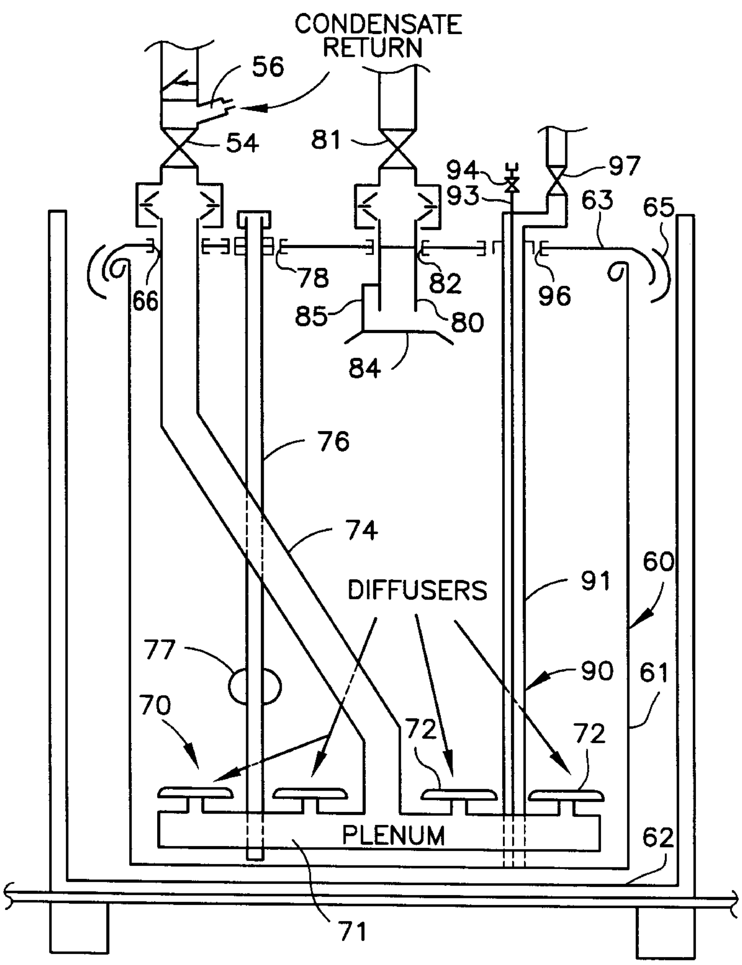
[57] **ABSTRACT**

A method of separating tritium oxide from a gas stream containing tritium oxide. The gas stream containing tritium oxide is fed into a container of water having a head space above the water. Bubbling the gas stream containing tritium oxide through the container of water and removing gas from the container head space above the water. Thereafter, the gas from the head space is dried to remove water vapor from the gas, and the water vapor is recycled to the container of water.

32 Claims, 2 Drawing Sheets



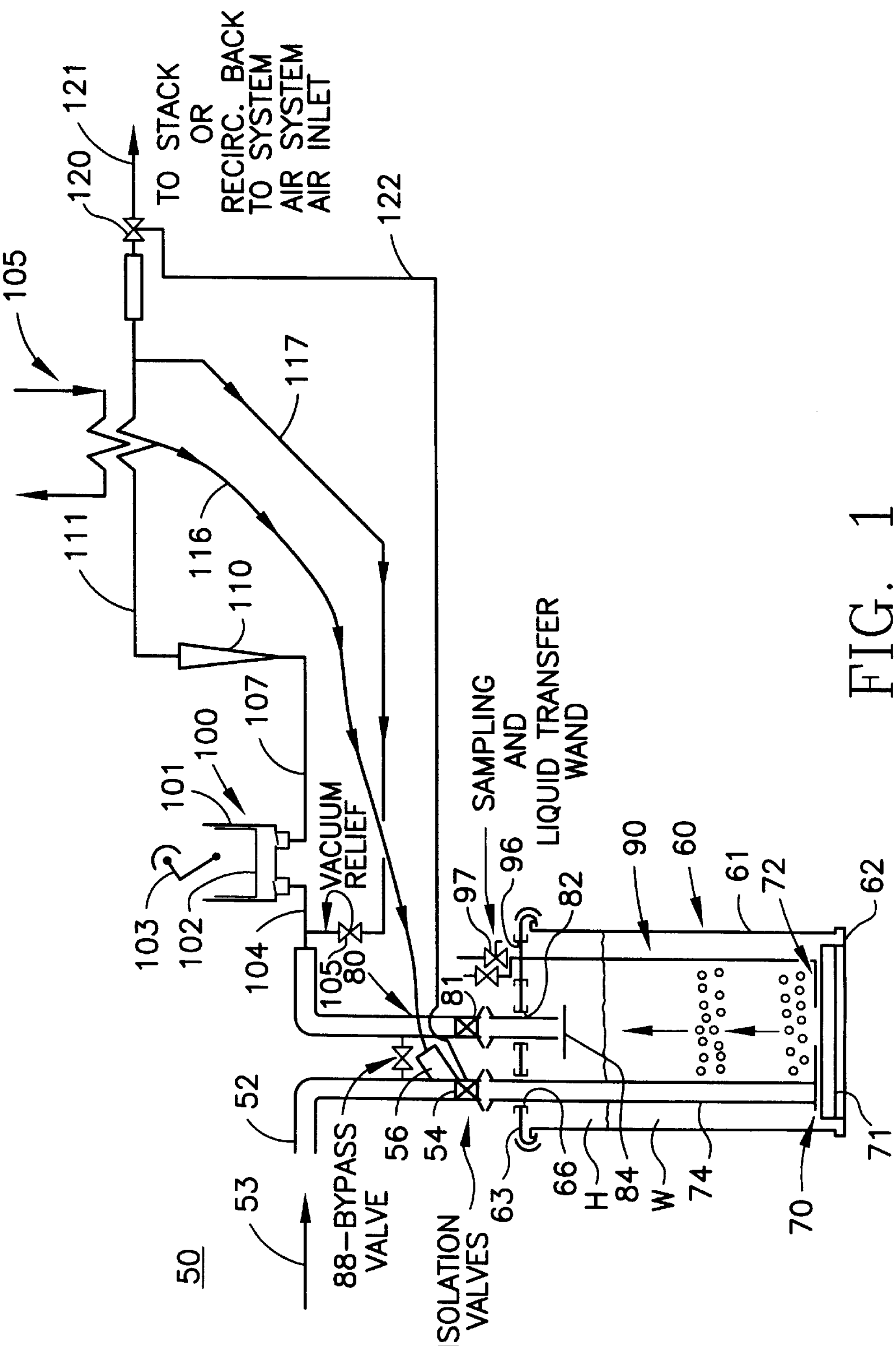

TO STACK
OR
RECIRC. BACK
TO SYSTEM
AIR SYSTEM
AIR INLET
VACUUM
RELIEF
SAMPLING
AND
LIQUID TRANSFER
WAND
88–BYPASS
VALVE
ISOLATION
VALVES
50
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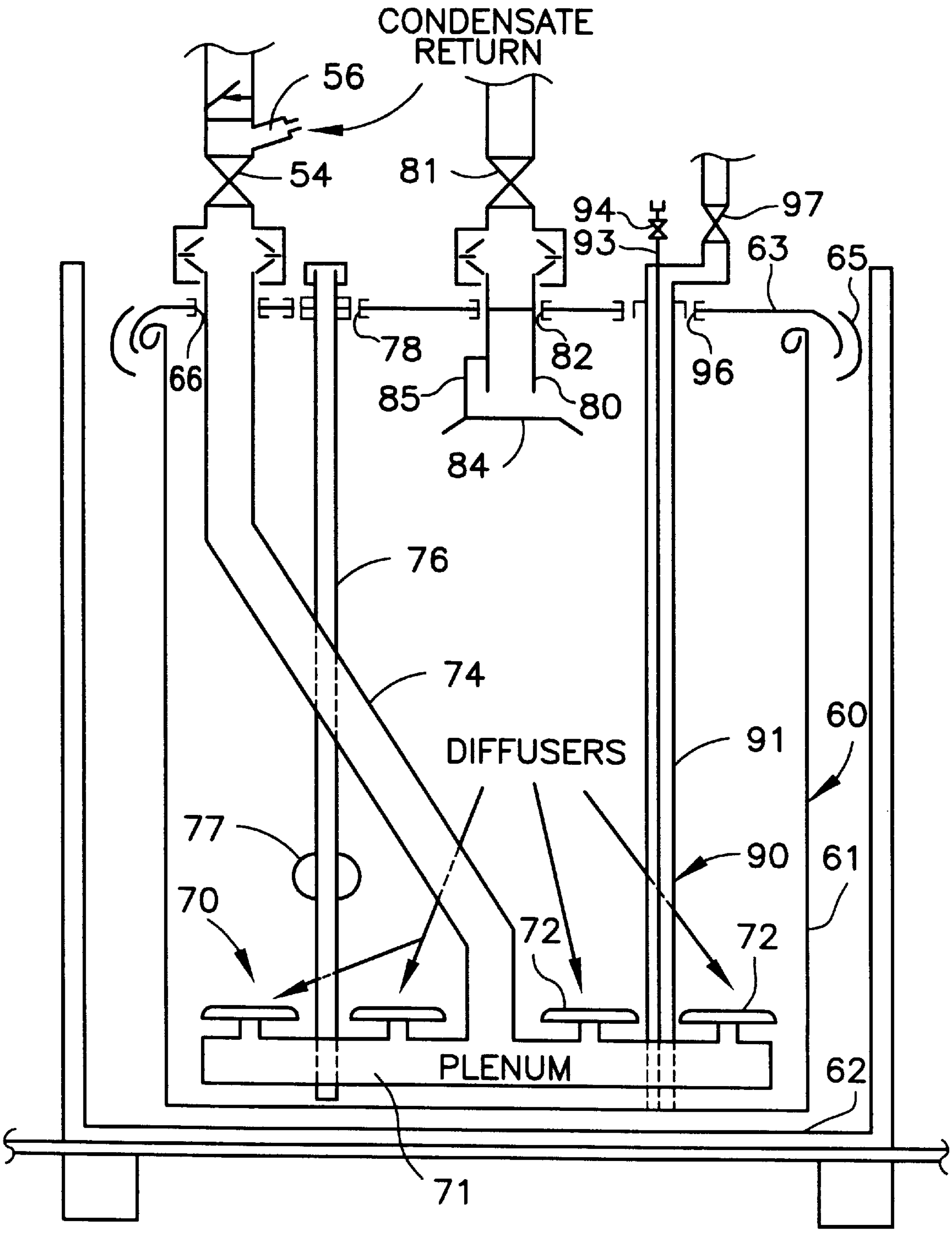
FIG. 1


CONDENSATE
RETURN
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81
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93
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78
82
96
85
80
84
76
74
DIFFUSERS
91
60
77
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61
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72
72
PLENUM
62
71

FIG. 2

DRUM BUBBLER TRITIUM PROCESSING SYSTEM

CONTRACTUAL ORIGIN OF THE INVENTION

The United States Government has rights in this invention pursuant to Contract No. W-31-109-ENG-38 between the U.S. Department of Energy and The University of Chicago representing Argonne National Laboratory.

BACKGROUND OF THE INVENTION

This invention relates to the absorption, storage and disposal of tritium oxide. More particularly, this invention relates to a tritium oxide absorption in a water media which is more efficient than commonly used molecular sieves. The subject process is particularly advantageous when the process gas has a high moisture content, on order of >50% relative humidity. The currently used molecular sieves are approximately 23% efficient for water absorption, that is absorption of tritium oxide in the form of water when the curie amount of tritium is loaded onto a type A quantity container of about 1,000 curies. The subject invention permits the same amount of radioactivity to be absorbed in a 55 gallon drum more efficiently and which can be disposed of using current technology.

The invention comprises a system and method utilizing a 55 gallon drum containing water with an internal configuration which provides for the aeration of the tritium and the absorption of the tritium by the water media. The aeration process is effective for removing tritium in the oxide form, from a gas process stream containing tritium oxide. A separate free-standing support system provides the motive force for the flow of gas through the drum apparatus using a vacuum pump. The free-standing system also contains a refrigeration unit to condensate the moisture from the drum exhaust-gas stream and return the condensate moisture as liquid to the drum. The result of this system is a dry air exhaust containing less than 10% of the original tritium oxide, resulting in the system which is 90% effective in removing tritium oxide from a gas process stream. In another iteration of the invention, the dried gas can be recirculated to the system for additional treatment.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the invention to provide a method and system for separating tritium gas from a gas stream containing tritium oxide which is at least 90% effective in removing the tritium from the process gas stream.

Yet another object of the invention is to provide a method of separating tritium oxide from a gas stream containing tritium oxide, comprising introducing the gas stream containing tritium oxide into a container of water having a head space above the water, bubbling the gas stream containing tritium oxide through the container of water, removing gas from the container head space above the water, drying the gas from the head space to remove water vapor from the gas, and recycling the water vapor to the container of water.

Still another object of the invention is to provide a method of separating tritium oxide from a gas stream containing tritium oxide, comprising introducing the gas stream containing tritium oxide into a container of water having a head space above the water, providing a vacuum in communication with the head space in the container, introducing the gas stream containing tritium oxide near the bottom of the container of water to cause bubbles to form in the water and

migrate towards the head space, removing gas from the container head space above the water, drying the gas from the head space to remove water vapor from the gas and recycling the water vapor to the container of water.

The invention consists of certain novel features and a combination of parts hereinafter fully described, illustrated in the accompanying drawings, and particularly pointed out in the appended claims, it being understood that various changes in the details may be made without departing from the spirit, or sacrificing any of the advantages of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic view of a system for practicing the method of the method; and

FIG. **2** is an enlarged version of the schematic illustration of the container forming a water media for absorbing the tritium oxide.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. **1** and **2** of the drawings, there is disclosed a system **50** for treating product stream containing tritium oxide which includes an air inlet **52** connected to a source of tritium oxide **53**. An inlet valve **54** is positioned in the inlet **52**. Above the inlet valve **54** and the line **52** is a condensate return fitting **56**, for a purpose hereinafter set forth.

A drum **60**, preferably a **55** gallon drum contains a side wall **61**, bottom **62** and a perforated top **63**. The top **63** is sealed to the side wall **61** by mechanism **65** which provides an air tight seal between the top **63** and the drum side wall **61**. A bushing **66** is provided in the top **63** for a purpose hereinafter set forth.

A distributor mechanism **70** is schematically shown in FIG. **1** and shown in more detail in FIG. **2** and is positioned at the bottom of the container **60** near the bottom wall or bottom surface **62** thereof. The distributor **70** is in the form of a plenum **71** having a plurality of apertures or bubblers or diffusers **72** spaced along the plenum **71**, it being understood that the plenum **71** may be generally circular in shape with the plurality of diffusers or bubblers **72** throughout. A conduit **74** provides communication between the plenum **71** and the valve **54** connected to the inlet conduit **52**, thereby to provide a flow path from the source of tritium oxide **53** to the inside of the container **60** near the bottom surface or wall **62** thereof.

A rod **76**, as shown in FIG. **2**, extends through a bushing **78** in the top **63** of the container **60** and is provided with a slidable float or film of magnetic material **77** which when used in conjunction with a magnetic detecting device outside the container **60** permits the level of water in the container **60** to be determined on a continuous basis. Equipment for sensing and recording the level of a liquid in a container is well known and not shown herein.

Exit conduit **80** extends outwardly from the top **63** of the container **60** through a bushing **82** thereof and has an outlet valve **81** in the conduit. The end of the conduit **80** is somewhat spaced from and above a splash baffle **84** which as shown in FIG. **2** has a mounting bracket **85** attached thereto and fixed in the container **60** either to the top **63** or to a side wall **61** thereof, as desired. A bypass valve **88** is shown in FIG. **1** connecting the inlet conduit **52** and the outlet conduit **80** so as to bypass the container **60** during maintenance and other times when tritium is not flowing within the system.

Referring to FIGS. **1** and **2**, there is a liquid sampling and transfer wand mechanism **90** which includes a conduit **91** extending through the top **63** of the container **60**. A needle device **93** extends through the center of the hollow conduit **91** and is connected to a sampling valve **94**. A bushing **96** seals the container **60** at the insertion point of the conduit **91** and the conduit is connected via a liquid transfer valve **97** to remote sampling apparatus, not shown.

A vacuum pump **100** is in communication with the outlet or exit conduit **80**. More particularly, the vacuum pump **100** shown schematically in FIG. **1** includes a housing or casing **101**, a piston **102** and a crank or other motor mechanism **103**. The vacuum pump **100** is connected by one line **104** to the exit or outlet conduit **80**, and hence, to the head space above the level of liquid in the container **60** and at the other end of the vacuum pump **100** is connected via a line **107** to a variable area flow meter **110** having a throttle mechanism which is connected via a line **111** to a refrigeration unit **115**. The refrigeration unit **115** is a heat exchanger which is connected to a source of coolant so as to reduce the temperature of the gas in the line **111** to cause water to condense from the gas after the temperature thereof has been reduced. The condensation from the gas in line **111** is returned via a line **106** to the condensate return fitting **56** above the valve **54** for reintroduction into the container **60**. A line **117** serves to connect the line **111** after the refrigeration unit **115** to the vacuum release valve **105** positioned between the line **104** inlet to the vacuum pump **100** and the line **111** after the refrigeration unit.

Finally, a valve **120** in the line **111** after the refrigeration unit serves to either pass all of the gas through line **121** to a stack or exhaust to the atmosphere or to recycle part or all of the gas after the refrigeration unit **115** through line **122** back to the valve **54** for reintroduction into the container **60**. In this manner, the valve **120** permits the entire system **50** to be a recirculating system in which no gas is vented to the atmosphere or to vent gas to the atmosphere after sufficient quantities of tritium are removed, monitoring equipment (not shown) may be in communication with any one of the lines previously discussed and more particularly maybe in communication with line **121** to ascertain the amount of tritium, if any, vented to the atmosphere.

As seen, therefore, a product gas containing tritium from a source **53** thereof is introduced into the container **60** via the conduit **52** where it is diffused through the diffuser **72** connected to the plenum **71** so that bubbles are formed at the plenum **71** and move upwardly through the water “W” in the container **60** to the head space “H” above the water level in the container **60** whereupon the product gas less the amount of tritium absorbed in the water “W” in the container **60** is exhausted from the container via the exit or outlet conduit **80** due to the vacuum pump **100** and is thereafter cooled in the refrigeration unit **115** to dry the air or product stream with the condensate being returned by a line **116** to the container **60**.

As is well known, bubbles formed at the bottom of a pressure head expand in diameter as they move upwardly. It is preferred that in a 55 gallon drum container **60** there will be approximately 40–45 gallons of water “W” in the container. The bubble size is preferably in the range of from about 10 to about 20 microns average diameter at the plenum **71**, it being understood that the bubble diameters increase as the bubbles rise to the top of the water “W” and into the headspace “H” above the water level in the container **60**. It is understood that the greater the number of, and the smaller the bubble diameter, the greater the surface area of the bubbles in contact with the water “W”, thereby promoting transfer of tritium in the product gas to the water “W” in the container **60**.

The water “W” is preferably maintained at a temperature in the range of from about 60° F. to about 80° F. If the water temperature is too low, then there is less transfer of tritium into the water and if the water temperature is too high, then the amount of tritium maintained in the water is reduced as the water would boil off into the headspace “H”. The maximum vacuum drawn on the container **30** should be about 15 inches of mercury. Higher vacuum runs the risk of collapsing the container **60**. The vacuum drawn on the container **60** may be in the range of from about 10 to about 15 inches of mercury. However, the system **50** preferably is operated at vacuum levels of between about 10 to about 12 inches of mercury which also controls the flow rate of bubbles through the water “W” in the container **60**. It is also understood that the amount of water in the container **60** contributes to the residence time of the bubbles in the container.

After sufficient tritium is absorbed into the water medium “W”, a cross-linking polymer is used to convert the water containing the tritium into a gel like substance. Well known solidifying agents are available and the preferred solidifying agent is produced by Corpex Technologies located at Research Triangle Park in North Carolina and sold under the trademark designation STERGO®.

In general, the flow rate of product gas into the container **60** should be greater than 2.5 cubic feet per minute with a maximum of about 5 cubic feet per minute. The 55 gallon drum preferably may contain 4 ceramic dome shaped diffusers **72** which have a total of 180 square inch of surface area. The conduits used in the drum or container **60** may be a variety of materials but PVC plastic is acceptable. After the tritium is absorbed in the water “W”, and the STERGO® absorption product is introduced into the drum, the drum can be disposed of in accepted disposal sites for radioactive solids.

While there has been disclosed what is considered to be the preferred embodiment of the present invention, it is understood that various changes in the details may be made without departing from the spirit, or sacrificing any of the advantages of the present invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method of separating tritium oxide from a gas stream containing tritium oxide, comprising introducing the gas stream containing tritium oxide into a container of water having a head space above the water, bubbling the gas stream containing tritium oxide through the container of water, removing gas from the container head space above the water, drying the gas from the head space to remove water vapor from the gas, recycling the water vapor to the container of water and introducing the gas containing the tritium oxide into water having a temperature in the range of from about 60° F. to about 80° F.

2. The method of claim **1**, wherein the average bubble diameter at the bottom of the container is in the range of from about 10 to about 20 microns.

3. The method of claim **1**, wherein the dried gas is vented to the atmosphere and has a relative humidity of not more than about 1% at ambient temperature.

4. The method of claim **1**, wherein the dried gas is recycled.

5. The method of claim **1**, wherein the dried gas is vented to the atmosphere.

6. The method of claim **1**, wherein a portion of the dried gas is recycled and a portion of the dried gas is vented to the atmosphere.

7. The method of claim **1**, and further comprising continuously measuring the liquid level in the container.

8. The method of claim **1**, wherein a source of vacuum is in communication with the head space to remove gas for drying.

9. The method of claim **1**, and further comprising converting the tritium containing water in the container to a gel by contact with an absorption media.

10. The method of claim **1**, wherein the recycled water vapor is mixed with the gas stream containing tritium oxide.

11. The method of claim **10**, wherein the tritium oxide containing gas is introduced into the container at a flow rate in the range of from about 2.5 ft^3/min to about 5.0 ft^3/min.

12. The method of claim **1**, wherein the container is a fifty-five gallon drum containing from about 40 gallons to about 45 gallons of water.

13. A method of separating tritium oxide from a gas stream containing tritium oxide, comprising introducing the gas stream containing tritium oxide into a container of water having a temperature in the range of from about 60° F. to about 80° F. and having a head space above the water, providing a vacuum in communication with the head space in the container, introducing the gas stream containing tritium oxide near the bottom of the container of water to cause bubbles to form in the water and migrate towards the head space, removing gas from the container head space above the water, drying the gas from the head space to remove water vapor from the gas and recycling the water vapor to the container of water.

14. The method of claim **13**, wherein the dried gas is recycled to the gas stream containing tritium oxide.

15. The method of claim **14**, wherein a portion of the dried gas is vented to the atmosphere.

16. The method of claim **14**, wherein the vacuum in communication with the head space does not exceed about 15 inches of Hg.

17. The method of claim **16**, wherein the average bubble diameter at the bottom of the container is in the range of from about 10 to about 20 microns.

18. The method of claim **17**, wherein the tritium oxide containing gas is introduced into the container at a flow rate in the range of from about 2.5 ft^3/min to about 5.0 ft^3/min.

19. The method of claim **18**, wherein the container is a fifty-five gallon drum containing from about 40 gallons of water to about 45 gallons of water.

20. A method of separating tritium oxide from a gas stream containing tritium oxide, comprising introducing the gas stream containing tritium oxide into a container of water as small bubbles by means of a diffuser, having a head space above the water, flowing the gas stream containing tritium oxide through the water, removing gas from the container head space above the water, drying the gas from the head space to remove water vapor from the gas, recycling the water vapor to the container of water, and maintaining a water temperature below the temperature at which the water would boil.

21. The method of claim **20**, wherein the average bubble diameter at the bottom of the container is in the range of from about 10 to about 20 microns.

22. The method of claim **20**, wherein the dried gas is vented to the atmosphere and has a relative humidity of not more than about 1% at ambient temperature.

23. The method of claim **20** wherein the dried gas is recycled.

24. The method of claim **20**, wherein the dried gas is vented to the atmosphere.

25. The method of claim **20**, wherein a portion of the dried gas is recycled and a portion of the dried gas is vented to the atmosphere.

26. The method of claim **20**, and further comprising continuously measuring the liquid level in the container.

27. The method of claim **20**, wherein a source of vacuum is in communication with the head space to remove gas for drying.

28. The method of claim **20**, and further comprising converting the tritium containing water in the container to a gel by contact with an adsorption media.

29. The method of claim **20**, wherein the recycled water vapor is mixed with the gas stream containing tritium oxide.

30. The method of claim **29**, wherein the tritium oxide containing gas is introduced into the container at a flow rate in the range of from about 2.5 ft^3/min to about 5.0 ft^3/min.

31. The method of claim **20**, wherein the container is a fifty-five gallon drum containing from about 40 gallons to about 45 gallons of water.

32. The method of claim **20**, wherein the gas containing the tritium oxide is introduced into water having a temperature in the range of from about 60° F. to about 80° F.

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