

CLAIMS

1. A method for recovering ~~xenon~~ a desired component from a waste gas mixture, wherein the method comprises

5 (a) at an operating facility, introducing a waste gas comprising ~~xenon~~ the desired component and one or more undesired components into an adsorber vessel containing an adsorbent material selective for the ~~xenon~~ desired component, adsorbing at least a portion of the ~~xenon~~ desired component in the adsorbent vessel, and withdrawing therefrom an effluent gas depleted in the ~~xenon~~ the desired component;

10 (b) terminating the flow of waste gas into the adsorber vessel; and

(c) recovering and concentrating the ~~xenon~~ desired component by either

15 (1) isolating the adsorber vessel, transporting the adsorber vessel to a central processing facility, withdrawing from the adsorber vessel an intermediate gas enriched in the ~~xenon~~ desired component, and separating the ~~xenon~~ desired component from the intermediate gas to provide a concentrated product gas further enriched in the ~~xenon~~ desired component, or

20 (2) withdrawing from the adsorber vessel an intermediate gas enriched in the desired component, compressing the intermediate gas and storing it in a pressure vessel, isolating the pressure vessel, transporting the pressure vessel to a central processing facility, withdrawing the intermediate gas from the pressure vessel, and separating the desired component from the intermediate gas to provide a concentrated product gas further enriched in the desired component;

wherein the operating facility is one of a plurality of operating facilities;

and further comprising

25 adsorbing on the adsorbent material at least one other component prior to adsorbing the desired component in the adsorbent vessel in step (a), wherein the desired component is more strongly adsorbed by the adsorbent material than the other component, and wherein the adsorption of the other component is effected at the central processing facility to provide an adsorber vessel containing adsorbent material having the other
30 component adsorbed thereon, the adsorber vessel is transported to said one of the operating facilities, and the waste gas is introduced into the adsorber vessel in step (a).

2. ~~The method of Claim 1 wherein the operating facility is one of a plurality of operating facilities.~~

5 3. ~~The method of Claim 1 comprising adsorbing on the adsorbent material at least one other component prior to adsorbing the xenon in the adsorbent vessel in step (a), wherein the xenon is more strongly adsorbed by the adsorbent material than the other component.~~

10 42. ~~The method of Claim 31 wherein the other component is one of the undesired components.~~

53. The method of Claim 31 wherein the adsorption of the other component is effected at or below a selected pressure and the adsorption of the ~~xenon~~ desired component is effected at a pressure equal to or greater than the selected pressure.

64. The method of Claim 31 wherein the adsorption of the other component is effected at a selected pressure and the adsorption of the ~~xenon~~desired component is effected at a pressure less than the selected pressure.

5 7. ~~The method of Claim 3 wherein the adsorption of the other component is effected at the central processing facility to provide an adsorber vessel containing adsorbent material having the other component adsorbed thereon, the adsorber vessel is transported to one of the operating facilities, and the waste gas is introduced into the adsorber vessel in step (a).~~

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85. The method of Claim 1 wherein withdrawal of the intermediate gas enriched in the ~~xenon~~desired component is effected by regenerating the adsorbent material using depressurization, evacuation, heating, purging, or any combination thereof.

15 96. The method of Claim 1 wherein the flow of waste gas into the adsorber vessel is terminated at breakthrough of the ~~xenon~~desired component.

407. The method of Claim 1 wherein during step (a) is the step of introducing the effluent gas depleted in the ~~xenon~~desired component is introduced into an additional adsorber vessel connected to the adsorber vessel in series, said additional adsorber vessel containing the adsorbent material selective for the ~~xenon~~desired component; and wherein said terminating step (b) occurs the flow of waste gas into the adsorber vessel is terminated at a time between from the breakthrough of the ~~xenon~~desired component to and including saturation of the adsorbent material in the adsorber vessel with the ~~xenon~~desired component, inclusive; flow of waste gas into the adsorber vessel is terminated; and after step (b) is the further step of initiating a flow of waste gas into the additional adsorber vessel is initiated; and an effluent gas depleted in the ~~xenon~~desired component is withdrawn therefrom from said additional adsorber vessel.

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30 448. The method of Claim 407 further comprising the steps of (1) connecting a third adsorber vessel in series with the additional adsorber and (2) introducing the effluent gas

depleted in the desired component withdrawn from the additional adsorber vessel into the third adsorber vessel wherein the adsorber vessel is transported to the central processing facility, the intermediate gas enriched in the xenon is withdrawn from the adsorber vessel, and the xenon is separated from the intermediate gas to provide the concentrated product gas further enriched in the xenon.

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429. The method of Claim 1 comprising one or more cooling steps selected from the group consisting of cooling the waste gas prior to introduction into the adsorber vessel, external cooling of the adsorber vessel, and internal cooling of the adsorber vessel.

5 10. The method of Claim 1 wherein the desired component is selected from the group consisting of xenon, krypton, argon, helium, hydrogen, deuterium, arsine, phosphine, germane, SF₆, SiH₄, H₂Se, HF, NF₃, CF₄, C₂F₆, C₃F₈, and Fluothane® (C₂HBrClF₃).

10 11. The method of Claim 1 wherein the one or more undesired components is selected or are selected from the group consisting of nitrogen, oxygen, hydrogen, helium, krypton, and argon.

15 12. The method of Claim 11 wherein a desired component is xenon and the one or more undesirable component is nitrogen.

20 13. The method of Claim 1 wherein the separating of the ~~xenon~~-desired component from the intermediate gas to provide the concentrated product gas further enriched in the ~~xenon~~-desired component at the central processing facility is effected by cryogenic distillation.

25 14. A method for recovering ~~xenon~~-a desired component from a waste gas mixture, wherein the method comprises

(a) providing an adsorption-based recovery system at an operating facility wherein the operating facility is one of a plurality of operating facilities wherein the system is adapted to recover the ~~xenon~~-desired component from a waste gas comprising the ~~xenon~~-desired component and one or more undesired components, wherein the ~~xenon~~-desired component is recovered and concentrated in a transportable vessel;

(b) providing a central processing facility adapted to receive the transportable vessel, to withdraw therefrom an intermediate gas enriched in the ~~xenon~~-desired component, and to separate the ~~xenon~~-desired component from the intermediate

gas to provide a concentrated product gas further enriched in the ~~xenon~~ desired component;

5 _____ (c) introducing the waste gas into the adsorption-based recovery system at the operating facility and recovering and concentrating the ~~xenon~~ desired component in the transportable vessel;

_____ (d) transporting the transportable vessel to the central processing facility; and
(e) separating the ~~xenon~~ desired component from the intermediate gas and providing the concentrated product gas further enriched in the ~~xenon~~ desired component;

10 wherein during the introducing step and before the transporting step are the steps of:

(1) introducing the waste gas into an adsorber vessel containing an adsorbent material selective for the desired component, adsorbing at least a portion of the desired component in the adsorbent vessel, and withdrawing from the adsorber vessel an effluent gas depleted in the desired component;

15 _____ (2) terminating the flow of waste gas into the adsorber vessel; and

_____ (3) isolating the adsorber vessel; and

after the transporting step and before the separating step, is the step of withdrawing the intermediate gas from the adsorber vessel; and following said withdrawing of the intermediate gas from the adsorber vessel, is the step of pressurizing the adsorber
20 vessel with a gas containing at least one other component, wherein the desired component is more strongly adsorbed by the adsorbent material than the other component, and further comprising the steps of isolating the adsorber vessel and transporting said adsorber vessel to one of the operating facilities for use in step (1).

17. ~~The method of Claim 16 wherein at the operating facility~~

~~(1) the waste gas is introduced into an adsorber vessel containing an adsorbent material selective for the xenon, at least a portion of the xenon is adsorbed in the adsorbent vessel, and an effluent gas depleted in the xenon is withdrawn therefrom;~~

5 ~~(2) the flow of waste gas into the adsorber vessel is terminated; and~~

~~(3) the adsorber vessel is isolated, the adsorber vessel is transported to the central processing facility, the intermediate gas enriched in the xenon is withdrawn from the adsorber vessel, and the xenon is separated from the intermediate gas to provide the concentrated product gas further enriched in the xenon.~~

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~~18. The method of Claim 17 wherein following withdrawal of the intermediate gas from the adsorber vessel, the adsorber vessel is pressurized with a gas containing at least one other component, wherein the xenon is more strongly adsorbed by the adsorbent material than the other component, and the adsorber vessel is isolated and transported~~
15 ~~to one of the operating facilities for use in step (1).~~

15. The method of Claim 14 wherein the at least one other component is one of the undesired components.

20 16. The method of Claim 14 wherein the concentrated product gas is introduced into a pressure vessel and transported to one of the plurality of operating facilities for reuse in a process that generates the waste gas.

25 17. A method for recovering a desired component from a waste gas stream comprising the steps of

(a) providing an adsorption-based recovery system at an operating facility wherein the system is adapted to recover the desired component from a waste

gas comprising the desired component and one or more undesired components, wherein the desired component is recovered and concentrated in a transportable vessel;

5 (b) providing a central processing facility adapted to receive the transportable vessel, to withdraw therefrom an intermediate gas enriched in the desired component, and to separate the desired component from the intermediate gas to provide a concentrated product gas further enriched in the desired component;

10 (c) introducing the waste gas into the adsorption-based recovery system at the operating facility and recovering and concentrating the desired component in the transportable vessel;

(d) transporting the transportable vessel to the central processing facility; and

(e) separating the desired component from the intermediate gas and providing the concentrated product gas further enriched in the desired component;

wherein at the operating facility

15 (1) the waste gas is introduced into an adsorber vessel containing an adsorbent material selective for the desired component, adsorbing at least a portion of the desired component in the adsorbent vessel, and withdrawing therefrom an effluent gas depleted in the desired component;

(2) the flow of waste gas into the adsorber vessel is terminated;

20 (3) an intermediate gas enriched in the desired component is withdrawn from the adsorber vessel, the intermediate gas is compressed and stored in a pressure vessel, and the pressure vessel is isolated; and

25 (4) the pressure vessel is transported to the central processing facility, the intermediate gas is withdrawn from the pressure vessel, and the desired component is separated from the intermediate gas to provide the concentrated product gas further enriched in the desired component.

4918. A system for recovering ~~xenon~~ a desired component from a waste gas mixture comprising

30 (a) an adsorption-based recovery system at ~~an operating facility~~ a plurality of operating facilities wherein the adsorption-based recovery system is adapted to

recover and concentrate ~~the~~the desired component from a waste gas comprising the ~~desired component~~desired component and one or more undesired components to provide a concentrated amount of the ~~desired component~~desired component wherein said adsorption-based recovery system comprises an adsorption vessel containing an adsorbant material having at least one of the undesired components adsorbed thereon prior to introducing the desired component;

(b) a transportable vessel adapted to contain and transport the concentrated amount of the ~~desired component~~desired component from the operating facility to a central processing facility, wherein the transportable vessel comprises either

(1) a pressure vessel adapted to receive and contain the concentrated amount of the desired component as a compressed gas, or

(2) a pressure vessel packed with adsorbent material adapted to contain at least a portion of the ~~desired component~~desired component in an adsorbed state; and

(c) a final recovery and concentration system adapted for the further recovery and concentration of the ~~desired component~~desired component at the central processing facility to provide a concentrated compressed product gas enriched in the ~~desired component~~desired component.

20. ~~The system of claim 19 wherein said recovery and concentration system comprises cryogenic distillation.~~