CLAIMS

1. A pressure swing adsorption-type oxygen enrichment device comprising:

a plurality of adsorption cylinders filled with an adsorbent which selectively adsorbs nitrogen relative to oxygen;

a compressor for supplying raw material air to the adsorption cylinders;

means for performing an adsorption step for supplying compressed air to each of the adsorption cylinders and extracting an oxygen-enriched gas by sequentially switching flow channels between the compressor and each of the adsorption cylinders;

means for performing a desorption step for depressurizing each of the adsorption cylinders and regenerating the adsorbent;

means for performing a pressure equalizing step for communicating each of the adsorption cylinders;

a flow-channel switching means for repeating a purge step in a specific timing, in which highly concentrated oxygen from the adsorption cylinder in the adsorption step is introduced into the adsorption cylinder in the desorption step;

a flow setting means for supplying the oxygen-enriched gas to a user at a specific flow rate;

an oxygen concentration sensor for detecting an oxygen concentration of the oxygen-enriched gas produced by the oxygen enrichment device;

a temperature sensor for measuring a temperature of the device; and

a purge step control means which controls a length of a purge step so as to maximize the oxygen concentration by changing opening/closing timing of the flow-channel switching means, when an output value of the oxygen concentration sensor is lower than a specified value, or the output value of the temperature sensor is out of a specific temperature range, wherein:

the oxygen concentration of the oxygen-enriched gas just before a control for changing the length of a purge step is started is used as a reference concentration,

a control for increasing the length of a purge step by a specific length and detection of the oxygen concentration after the control are performed,

the reference concentration is replaced by the oxygen concentration after the change of the length of a purge step if the oxygen concentration is increased, and

controls for increasing the length of a purge step and detection of the oxygen concentration are repeated until the oxygen concentration is decreased compared to the reference concentration (this point is referred to as P^1 point below);

the oxygen concentration at P^1 point is used as a reference concentration,

a control for decreasing the length of a purge step by a specific length and detection of the oxygen concentration after the control are performed,

the reference concentration is replaced by the oxygen concentration after the change of the length of a purge step if the oxygen concentration is increased, and

controls for decreasing the length of a purge step and detection of the oxygen concentration are repeated until the oxygen concentration is decreased compared to the reference concentration (this point is referred to as Q^1 point below);

the oxygen concentration at Q^1 point is used as a reference concentration,

the control for increasing the length of a purge step by a specific length and detection of the oxygen concentration after the control are performed,

the reference concentration is replaced by the oxygen concentration after the change of the length of a purge step if the oxygen concentration is increased, and

controls for increasing the length of a purge step and detection of the oxygen concentration are repeated until the oxygen concentration is decreased compared to the reference concentration (this point is referred as R^1 point below); and

the midpoint between points Q^1 and R^1 is determined as an optimal length of a purge step.

2. A pressure swing adsorption-type oxygen enrichment device comprising:

a plurality of adsorption cylinders filled with an adsorbent which selectively adsorbs nitrogen relative to oxygen;

a compressor for supplying raw material air to the adsorption cylinders;

means for performing an adsorption step for supplying compressed air to each of the adsorption cylinders and extracting an oxygen-enriched gas by sequentially switching flow channels between the compressor and each of the adsorption cylinders;

means for performing a desorption step for depressurizing each of the adsorption cylinders and regenerating the adsorbent;

means for performing a pressure equalizing step for communicating each of the adsorption cylinders;

a flow-channel switching means for repeating a purge step in a specific timing, in which highly concentrated oxygen from the adsorption cylinder in the adsorption step is introduced into the adsorption cylinder in the desorption step;

a flow setting means for supplying the oxygen-enriched gas to a user at a specific flow rate;

an oxygen concentration sensor for detecting an oxygen concentration of the oxygen-enriched gas produced by the oxygen enrichment device;

a temperature sensor for measuring a temperature of the device; and

a purge step control means which controls a length of a purge step so as to maximize the oxygen concentration by changing opening/closing timing of the flow-channel switching means, when an output value of the oxygen concentration sensor is lower

than a specified value, or the output value of the temperature sensor is out of a specific temperature range, wherein:

the oxygen concentration of the oxygen-enriched gas just before a control for changing the length of a purge step is started is used as a reference concentration,

a control for decreasing the length of a purge step by a specific length and detection of the oxygen concentration after the control are performed,

the reference concentration is replaced by the oxygen concentration after the change of the length of a purge step if the oxygen concentration is increased, and

controls for decreasing the length of a purge step and detection of the oxygen concentration are repeated until the oxygen concentration is decreased compared to the reference concentration (this point is referred as P^2 point below);

the oxygen concentration at P^2 point is used as a reference concentration,

a control for increasing the length of a purge step by a specific length and detection of the oxygen concentration after the control are performed,

the reference concentration is replaced by the oxygen concentration after the change of the length of a purge step if the oxygen concentration is increased, and

controls for increasing the length of a purge step and detection of the oxygen concentration are repeated until the oxygen concentration is decreased compared to the reference concentration (this point is referred as Q^2 point below);

the oxygen concentration at the Q^2 point is used as a reference concentration,

the control for decreasing the length of a purge step by a specific length and detection of the oxygen concentration after the control are performed,

the reference concentration is replaced by the oxygen concentration after the change of the length of a purge step if the oxygen concentration is increased, and

controls for decreasing the length of a purge step and detection of the oxygen

concentration are repeated until the oxygen concentration is decreased compared to the reference concentration (this point is referred as R^2 point below); and

the midpoint between points Q^2 and R^2 is determined as an optimal length of a purge step.

3. The oxygen enrichment device according to claim 1 or 2, wherein the midpoint between points Q^1 and R^1 or the midpoint between points Q^2 and R^2 is determined by the mean value of each of the lengths of purge steps.

4. The oxygen enrichment device according to any of claims 1 to 3, wherein the purge step control means registers an output value of the temperature sensor at the startup or at the change of a set flow rate of the device as a reference temperature, and performs the control by setting the length of a purge step defined by the reference temperature as a default value.

5. The oxygen enrichment device according to claim 4, wherein the purge step control means registers an output value of the temperature sensor at the startup or at the change of a set flow rate of the device as a reference temperature, and reset the length of a purge step to a value defined by an output value of the temperature sensor in advance.

6. The oxygen enrichment device according to any of claims 1 to 3, having the purge step control means provided with a preset range in which the length of a purge step is variable, wherein:

if the length of a purge step reaches a limit of the range in which the length of a purge step is variable without detecting a P point at which the oxygen concentration is decreased compared to the reference concentration, or

if the length of a purge step reaches a limit of the range in which the length of a purge step is variable without detecting a Q point at which the oxygen concentration is

decreased compared to the reference concentration after detecting the P point,

the attained limit of the range in which the length of a purge step is variable is determined as an optimal length of a purge step.

7. The oxygen enrichment device according to any of claims 1 to 6 having an oxygen flow rate sensor for detecting a flow rate of the oxygen-enriched gas produced by the oxygen enrichment device, wherein

the purge step control means performs control for stopping or suspending of executing the change of the length of a purge step when the flow rate of the oxygen-enriched gas is out of a specific range or when the detected value of the temperature sensor is out of a specific range of variation.

8. The oxygen enrichment device according to any of claims 1 to 6, wherein the purge step control performs control for stopping or suspending of executing the change of the length of a purge step when a value detected by the temperature sensor is out of a specific range of change.

9. The oxygen enrichment device according to claim 1, wherein a compressor control means is provided to increase/decrease a supply flow rate based on a detected value of an oxygen concentration of the oxygen enriched gas and to control the oxygen concentration to be maintained at a specified concentration.

10. The oxygen enrichment device according to claim 9, wherein the purge step control means is a control means with which the control by means of the purge step control and the control by means of the compressor control are not performed simultaneously.

1. A pressure swing adsorption-type oxygen enrichment device comprising:

a plurality of adsorption cylinders filled with an adsorbent which selectively adsorbs nitrogen relative to oxygen;

a compressor for supplying raw material air to the adsorption cylinders;

means for performing an adsorption step for supplying compressed air to each of the adsorption cylinders and extracting an oxygen-enriched gas by sequentially switching flow channels between the compressor and each of the adsorption cylinders;

means for performing a desorption step for depressurizing each of the adsorption cylinders and regenerating the adsorbent;

means for performing a pressure equalizing step for communicating each of the adsorption cylinders;

a flow-channel switching means for repeating a purge step in a specific timing, in which highly concentrated oxygen from the adsorption cylinder in the adsorption step is introduced into the adsorption cylinder in the desorption step;

a flow setting means for supplying the oxygen-enriched gas to a user at a specific flow rate;

an oxygen concentration sensor for detecting an oxygen concentration of the oxygen-enriched gas produced by the oxygen enrichment device;

a temperature sensor for measuring a temperature of the device; and

a purge step control means which controls a length of a purge step so as to maximize the oxygen concentration by changing opening/closing timing of the flow-channel switching means, when an output value of the oxygen concentration sensor is lower than a specified value, or the output value of the temperature sensor is out of a specific temperature range.

2. The oxygen enrichment device according to claim 1, wherein:

an oxygen concentration of the oxygen-enriched gas just before a control for changing the length of a purge step is started is used as a reference concentration,

a control for increasing the length of a purge step by a specific length and detection of the oxygen concentration after the control are performed,

the reference concentration is replaced by the oxygen concentration after the change of the length of a purge step if the oxygen concentration is increased, and

controls for increasing the length of a purge step and detection of the oxygen concentration are repeated until the oxygen concentration is decreased compared to the reference concentration (this point is referred to as P^1 point below);

the oxygen concentration at P^1 point is used as a reference concentration,

a control for decreasing the length of a purge step by a specific length and detection of the oxygen concentration after the control are performed,

the reference concentration is replaced by the oxygen concentration after the change of the length of a purge step if the oxygen concentration is increased, and

controls for decreasing the length of a purge step and detection of the oxygen concentration are repeated until the oxygen concentration is decreased compared to the reference concentration (this point is referred to as Q^1 point below);

the oxygen concentration at Q^1 point is used as a reference concentration,

a control for increasing the length of a purge step by a specific length and detection of the oxygen concentration after the control are performed,

the reference concentration is replaced by the oxygen concentration after the change of the length of a purge step if the oxygen concentration is increased, and

controls for increasing the length of a purge step and detection of the oxygen

concentration are repeated until the oxygen concentration is decreased compared to the reference concentration (this point is referred as R^1 point below); and

the midpoint between points Q^1 and R^1 is determined as an optimal length of a purge step.

3. The oxygen enrichment device according to claim 1, wherein:

an oxygen concentration of the oxygen-enriched gas just before a control for changing the length of a purge step is started is used as a reference concentration,

a control for decreasing the length of a purge step by a specific length and detection of the oxygen concentration after the control are performed,

the reference concentration is replaced by the oxygen concentration after the change of the length of a purge step if the oxygen concentration is increased, and

controls for decreasing the length of a purge step and detection of the oxygen concentration are repeated until the oxygen concentration is decreased compared to the reference concentration (this point is referred as P^2 point below);

the oxygen concentration at P^2 point is used as a reference concentration,

a control for increasing the length of a purge step by a specific length and detection of the oxygen concentration after the control are performed,

the reference concentration is replaced by the oxygen concentration after the change of the length of a purge step if the oxygen concentration is increased, and

controls for increasing the length of a purge step and detection of the oxygen concentration are repeated until the oxygen concentration is decreased compared to the reference concentration (this point is referred as Q^2 point below);

the oxygen concentration at the Q^2 point is used as a reference concentration,

a control for decreasing the length of a purge step by a specific length and detection of

the oxygen concentration after the control are performed,

the reference concentration is replaced by the oxygen concentration after the change of the length of a purge step if the oxygen concentration is increased, and

controls for decreasing the length of a purge step and detection of the oxygen concentration are repeated until the oxygen concentration is decreased compared to the reference concentration (this point is referred as R^2 point below); and

the midpoint between points Q^2 and R^2 is determined as an optimal length of a purge step.

4. The oxygen enrichment device according to claim 2 or 3, wherein the midpoint between points Q^1 and R^1 or the midpoint between points Q^2 and R^2 is determined by the mean value of each of the lengths of purge steps.

5. The oxygen enrichment device according to any of claims 1 to 4, wherein the purge step control means registers an output value of the temperature sensor at the startup or at the change of a set flow rate of the device as a reference temperature, and performs the control by setting the length of a purge step defined by the reference temperature as a default value.

6. The oxygen enrichment device according to claim 5, wherein the purge step control means registers an output value of the temperature sensor at the startup or at the change of a set flow rate of the device as a reference temperature, and reset the length of a purge step to a value defined by an output value of the temperature sensor in advance.

7. The oxygen enrichment device according to any of claims 2 to 4, having the purge step control means provided with a preset range in which the length of a purge step is variable, wherein:

if the length of a purge step reaches a limit of the range in which the length of a purge step is variable without detecting a P point at which the oxygen concentration is decreased compared to the reference concentration, or

if the length of a purge step reaches a limit of the range in which the length of a purge step is variable without detecting a Q point at which the oxygen concentration is decreased compared to the reference concentration after detecting the P point,

the attained limit of the range in which the length of a purge step is variable is determined as an optimal length of a purge step.

8. The oxygen enrichment device according to any of claims 1 to 7 having an oxygen flow rate sensor for detecting a flow rate of the oxygen-enriched gas produced by the oxygen enrichment device, wherein

the purge step control means performs control for stopping or suspending of executing the change of the length of a purge step when the flow rate of the oxygen-enriched gas is out of a specific range or when the detected value of the temperature sensor is out of a specific range of variation.

9. The oxygen enrichment device according to any of claims 1 to 7, wherein the purge step control performs control for stopping or suspending of executing the change of the length of a purge step when a value detected by the temperature sensor is out of a specific range of change.

10. The oxygen enrichment device according to claim 1, wherein a compressor control means is provided to increase/decrease a supply flow rate based on a detected value of an oxygen concentration of the oxygen enriched gas and to control the oxygen concentration to be maintained at a specified concentration.

11. The oxygen enrichment device according to claim 10, wherein the purge step

control means is a control means with which the control by means of the purge step control and the control by means of the compressor control are not performed simultaneously.