Oxygen reduction system and method for operating an oxygen reduction system

Description

~~The present invention relates to a method for operating an oxygen reduction system in accordance with the preamble of independent claim 1.~~

Accordingly, an aspect of the invention ~~relates in particular to~~ provides a method for operating an oxygen reduction system comprising a source of inert gas for providing an oxygen-reduced gas mixture, or inert gas respectively, and a line system. The line system of the oxygen reduction system is fluidly connected or connectable to the inert gas source and to at least one enclosed area in order to supply at least a portion of the gas mixture or gas provided by the inert gas source to the at least one enclosed area as needed. ~~It is thereby provided~~ The method comprises supplying for at least a portion of the gas mixture or gas provided by the inert gas source to be fed through the line system to the at least one enclosed area during the normal operation of the oxygen reduction system such that the oxygen content in the atmosphere of the enclosed area assumes a predefined or definable value which is reduced compared to the oxygen content of the normal ambient air. The method further comprises the method step of conducting a leak test on at least one section of the line system by pressure-testing the line section to be checked for tightness using at least a portion of the gas mixture or gas provided by the inert gas source.

Embodiments of ~~T~~the invention further relate~~s~~ to an oxygen reduction system for the regulated reducing of the oxygen content in the atmosphere of an enclosed area, wherein the oxygen reduction system comprises an inert gas source for providing an oxygen-reduced gas mixture, or inert gas respectively, and a line system which is fluidly connected or connectable to the inert gas source and to the enclosed area in order to supply at least a portion of the gas mixture or gas provided by the inert gas source to the enclosed area as needed.

The method or system according to embodiments of the invention, ~~or the inventive system respectively,~~ serves for example in minimizing risk and in extinguishing fires in a protected room subject to monitoring, whereby the enclosed room ~~is~~ may be continuously rendered inert to different drawdown levels for the purpose of preventing or controlling fire.

A further application example for the inventive inerting method is providing hypoxic training conditions in an enclosed room in which the oxygen content has been reduced. Such a room enables training under artificially simulated high-altitude conditions, also referred to as "normobaric hypoxic training." Another

Claims

1. A method for operating an oxygen reduction system ~~(1)~~ comprising an inert gas source ~~(2, 3)~~ for providing an oxygen-reduced gas mixture, or inert gas respectively, and a line system ~~(7; 7.1, 7.2, 7.3, 7.4)~~ which is fluidly connected or connectable to the inert gas source ~~(2, 3)~~ and to at least one enclosed area ~~(20.1, 20.2)~~ in order to supply at least a portion of the gas mixture or gas provided by the inert gas source ~~(2, 3)~~ to the at least one enclosed area ~~(20.1, 20.2)~~ as needed, wherein the method comprises the following method step:

   - supplying at least a portion of the gas mixture or gas provided by the inert gas source ~~(2, 3)~~ to the at least one enclosed area ~~(20.1, 20.2)~~ through the line system ~~(7; 7.1, 7.2, 7.3, 7.4)~~ such that the oxygen content in the atmosphere of the enclosed area ~~(20.1, 20.2)~~ assumes a predefined or definable value which is reduced compared to the oxygen content of the normal ambient air,

   ~~characterized in that~~wherein

   the method further comprises the method step of conducting a leak test on at least one section of the line system ~~(7.1, 7.2, 7.3, 7.4)~~ by pressure-testing the line section to be checked for tightness using at least a portion of the gas mixture or gas provided by the inert gas source ~~(2, 3)~~.

2. The method according to claim 1,
   wherein the following method step is performed in the conducting of the leak test on the line section:

   i) blocking a flow of the gas mixture or gas provided by the inert gas source ~~(2, 3)~~ through the line system ~~(7; 7.1, 7.2, 7.3, 7.4)~~ such that the section of the line system ~~(7.1, 7.2, 7.3, 7.4)~~ to be tested for tightness remains fluidly connected to the inert gas source ~~(2, 3)~~ but not to the at least one enclosed area ~~(20.1, 20.2)~~;

   ii) filling the line section under testing with at least a portion of the gas mixture or gas provided by the inert gas source ~~(2, 3)~~ such that excess pressure builds up in the line section to be tested for tightness; and

iii) determining whether the excess pressure which developed in the line section under testing drops below a critical threshold value within a predefined or definable time period.

3. The method according to claim 2,
wherein the flow through the line system ~~(7; 7.1, 7.2, 7.3, 7.4)~~ is blocked in method step i) by means of closing at least one valve ~~(5.1, 5.2, 5.3, 5.4, 5.5, 5.6)~~, particularly a zone valve in the line system ~~(7; 7.1, 7.2, 7.3, 7.4)~~.

4. The method according to claim 2 or 3,
wherein method step iii) is initiated after the gas mixture or gas introduced into the section of the line system ~~(7.1, 7.2, 7.3, 7.4)~~ to be tested has settled.

5. The method according to one of claims 2 to 4,
wherein a chronological pressure curve is quantified in method step iii) and the decrease in pressure determined by analyzing the chronological pressure curve.

6. The method according to claim 5,
wherein the chronological pressure curve is determined by an absolute pressure or differential pressure measuring system ~~(8.1, 8.2, 8.3, 8.4)~~.

7. The method according to any one of claims 2 to 6,
wherein the following further method step is provided subsequent to method step iii):

iv) emitting a malfunction notification when the pressure which built up in the section of the line system ~~(7.1, 7.2, 7.3, 7.4)~~ under testing drops below the critical threshold value within the given time period in method step iii).

8. The method according to any one of claims 1 to 7,
wherein a plurality of directly adjacent sections of the line system ~~(7.1, 7.2, 7.3, 7.4)~~ separable by valves ~~(5.1, 5.2, 5.3, 5.4, 5.5, 5.6)~~ are successively tested for tightness.

9. The method according to any one of claims 1 to 8,

wherein the inert gas source ~~(2, 3)~~ comprises a compressor system ~~(2, 2.1, 2.2)~~ and a gas separation system ~~(3)~~ situated downstream of the compressor system ~~(2, 2.1, 2.2)~~ in terms of the flow, wherein an initial gas mixture compressed by the compressor system ~~(2, 2.1, 2.2)~~ is at least intermittently introduced into an inlet ~~(3a)~~ of the gas separation system ~~(3)~~ and wherein the compressed initial gas mixture is at least partly separated into different gas components in the gas separation system ~~(3)~~ such that an oxygen-reduced and nitrogen-enriched gas mixture is provided at an outlet ~~(3b)~~ of the gas separation system ~~(3)~~, wherein to conduct the leak test, either the compressed initial gas mixture provided by the compressor system ~~(2, 2.1, 2.2)~~ or the nitrogen-enriched gas mixture provided at the outlet ~~(3b)~~ of the gas separation system ~~(3)~~ is introduced into the section of the line system ~~(7.1, 7.2, 7.3, 7.4)~~ to be checked.

10. The method according to any one of claims 1 to 9,
wherein the method step of conducting a leak test is preferably performed automatically at predefinable times and/or upon predefinable events, and even more preferentially selectively automatically.

11. The method according to any one of claims 1 to 10,
wherein the method step of conducting a leak test is performed when the oxygen content in the atmosphere of the at least one enclosed area ~~(20.1, 20.2)~~ has been reduced to the predefined or definable value by the regulated feed of at least a portion of the gas mixture or gas provided by the inert gas source ~~(2, 3)~~, and wherein none of the gas mixture or gas provided by the inert gas source ~~(2, 3)~~ is fed to the at least one enclosed area ~~(20.1, 20.2)~~ through the line system ~~(7; 7.1, 7.2, 7.3, 7.4)~~ while the leak test is being conducted.

12. The method according to any one of claims 1 to 11,
wherein the method further comprises the following method step:

- determining the oxygen content in the atmosphere of the at least one enclosed area ~~(20.1, 20.2)~~,

wherein the oxygen content is preferably determined continuously or at predefined or predefinable times/events.

13. The method according to claim 12,
wherein the method step of supplying at least a portion of the gas mixture or gas provided by the inert gas source ~~(2, 3)~~ to the at least one enclosed area ~~(20.1, 20.2)~~ occurs as a function of the oxygen content detected in the atmosphere of the at least one enclosed area ~~(20.1, 20.2)~~ such that the oxygen content in the atmosphere of the at least one enclosed area ~~(20.1, 20.2)~~ can be maintained – with a control range as applicable – at the predefined or predefinable value.

14. An oxygen reduction system ~~(1)~~ for the regulated reducing of the oxygen content in the atmosphere of an enclosed area ~~(20.1, 20.2)~~, wherein the oxygen reduction system ~~(1)~~ comprises the following:

- an inert gas source ~~(2, 3)~~ for providing an oxygen-reduced gas mixture or inert gas respectively;
- a line system ~~(7; 7.1, 7.2, 7.3, 7.4)~~ which is fluidly connected or connectable to the inert gas source ~~(2, 3)~~ and to the enclosed area ~~(20.1, 20.2)~~ in order to supply at least a portion of the gas mixture or gas provided by the inert gas source ~~(2, 3)~~ to the enclosed area ~~(20.1, 20.2)~~ as needed;
- at least one device for blocking a flow of the gas mixture or gas provided by the inert gas source ~~(2, 3)~~ through the line system ~~(7; 7.1, 7.2, 7.3, 7.4)~~; and
- a control device ~~(100)~~ designed to control the inert gas source ~~(2, 3)~~ and the at least one blocking device so as to realize a method in accordance with any one of claims 1 to 13.

15. The oxygen reduction system ~~(1)~~ according to claim 14,
wherein the at least one device for blocking a flow of the gas mixture or gas provided by the inert gas source ~~(2, 3)~~ through the line system ~~(7; 7.1, 7.2, 7.3, 7.4)~~ comprises a valve ~~(5.1, 5.2, 5.3, 5.4, 5.5, 5.6)~~, particularly a zone valve, able to be controlled by the control device.