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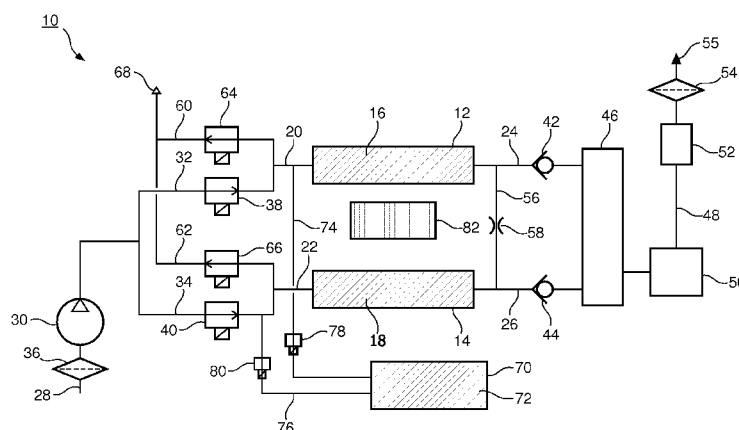
(54) **Title:** ARRANGEMENT AND METHOD FOR GENERATING OXYGEN

FIG. 1

(57) **Abstract:** The invention relates to oxygen separator (10), comprising an oxygen separation device (12, 14) being capable of separating oxygen from an oxygen comprising gas and being at least partly contaminatable by a contaminant and having a primary side and a secondary side, a gas inlet (20, 22) for guiding a flow of oxygen comprising gas to the primary side of the oxygen separation device (12, 14), and a decontamination container (70) comprising a decontamination material (72) for decontaminating the oxygen separation device (12, 14) from the contaminant, wherein the decontamination container (70) is located aside the main flowing path of the oxygen comprising gas. Such an oxygen separator (10) is less sensitive against impurities and provides an improved maintenance behavior. The invention further relates to a method of separating oxygen from an oxygen comprising gas by use of an oxygen separator (10).



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Arrangement and method for generating oxygen

FIELD OF THE INVENTION

The invention relates to the field of oxygen separation. More specifically, the invention relates to oxygen separation for therapeutic applications, particularly in the field of home care.

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BACKGROUND OF THE INVENTION

Oxygen therapy is the administration of oxygen as a therapeutic modality. It is widely used for a variety of purposes in both chronic and acute patient care as it is essential for cell metabolism, and in turn, tissue oxygenation is essential for all physiological functions. Oxygen therapy should be used to benefit the patient by increasing the supply of oxygen to the lungs and thereby increasing the availability of oxygen to the body tissues, especially when the patient is suffering from hypoxia and/or hypoxemia. Oxygen therapy may be used both in applications in hospital or in home care. The main home care application of oxygen therapy is for patients with severe chronic obstructive pulmonary disease (COPD).

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Oxygen may be administered in a number of ways. A preferable way of oxygen administration is by using a so called on demand generation of oxygen. Referring to this, commercial solutions, so-called oxygen concentrators or separators, respectively, are widely known. These oxygen concentrators mostly separate oxygen from an oxygen comprising gas, so that the oxygen is provided on demand, i.e. directly before use.

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A drawback of the oxygen concentrators, or oxygen separators, respectively, known in the art is the fact that next to desired adsorbed constituents of the oxygen comprising gas, such as nitrogen, undesired contaminants of the oxygen comprising gas, such as water or carbon dioxide, are adsorbed on an oxygen separation device thereby contaminating the latter. This contamination of the oxygen separation device often causes the requirement of additional measures next to a swing process in order to prevent contamination or to desorb the contaminants again.

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Known from US 7,550,036, B2, for example, is a gas concentrator which produces concentrated gas by applying a pressure difference to an adsorbent having a selective adsorption property to a specific gas and by separating the specific gas. The gas

concentrator comprises a plurality of adsorption beds containing the adsorbent for separating the specific gas from the mixed gas supplied via a filter for filtering out impurities. In case one adsorption bed is in adsorption mode, the other adsorption bed is in a recycling process. Additionally, in order to prevent that the moisture in the air may be adsorbed when the operation of the gas concentrator is stopped, additional devices for completely isolating the adsorption beds from the external air are required.

There is thus still the need for improving the contamination behavior of oxygen separation devices.

10 SUMMARY OF THE INVENTION

It is an object of the present invention to provide an arrangement and a method for separating oxygen from an oxygen comprising gas which is cost-saving to build, easy to perform, and/or which is advantageous with respect to maintenance.

This object is achieved by an oxygen separator according to claim 1. This object is furthermore achieved by a method of separating oxygen from an oxygen comprising gas according to claim 9. Preferred embodiments are defined in the dependent claims.

An oxygen separator comprises an oxygen separation device being capable of separating oxygen from an oxygen comprising gas and being at least partly contaminatable by a contaminant and having a primary side and a secondary side, a gas inlet for guiding a flow of oxygen comprising gas to the primary side of the oxygen separation device, and a decontamination container comprising a decontamination material for decontaminating the oxygen separation device from the contaminant, wherein the decontamination container is located aside the main flowing path of the oxygen comprising gas.

The term oxygen separator as used herein may particularly refer to a device which is capable of separating oxygen from an oxygen comprising gas. Consequently, by means of an oxygen separator, starting from an oxygen comprising gas, pure or essentially pure oxygen may be generated.

The term oxygen separation device may particularly refer to the active part of the oxygen separator. It may for example comprise an oxygen separation material which may interact with an oxygen comprising gas, or with defined constituents of the latter, and may thus separate the oxygen from the oxygen comprising gas by means of interaction with at least a part of the oxygen comprising gas, for example. Consequently, the oxygen separation device as such, or its oxygen separation material, respectively, is capable of separating oxygen from an oxygen comprising gas.

The expression of the oxygen separation device being at least partly contaminatable by a contaminant may particularly refer to a contamination or pollution process of the oxygen separation device because of which the oxygen separation capacity and/or the selectivity of the oxygen separation device towards oxygen is decreased. A
5 contaminant may thereby be any compound which may bind or adsorb to the oxygen separation device and may thus contaminate it, for example water or carbon dioxide. Furthermore, a contamination may take place at least partly and thus especially in a spatially limited expansion.

10 Additionally, the term oxygen comprising gas, as used herein, may refer to any gas which at least partly comprises oxygen, or which consists of oxygen.

Furthermore, the term primary side of the oxygen separation device, as used herein, may refer to the side or the part of the oxygen separation device being directed towards the direction, at which the oxygen comprising gas is guided to the oxygen separation device, whereas the term secondary side of the oxygen separation device, as used herein, may
15 refer to the side or the part of the oxygen separation device being directed towards the opposite side, i.e. to the side at which the generated pure oxygen is present. The primary side and the secondary side may thereby be separated by means of definition in the middle part of the oxygen separation device.

The term gas inlet may particularly refer to a channel or a conduct being
20 usable for guiding an oxygen comprising gas from a source of oxygen comprising gas to the oxygen separation device, or its primary side, respectively. Correspondingly, the term gas outlet may particularly refer to a channel or a conduct being usable for guiding generated oxygen from the oxygen separation device, or its secondary side, respectively, particularly out of the oxygen separator, i.e. to a storage device or to the point of use.

25 Additionally, the term decontamination material may refer to a material which is capable of releasing, or desorbing, at least one contaminant from the contaminated oxygen separation device and for immobilizing the contaminant, for example by adsorption, absorption or the like. Correspondingly, the term decontamination container may thus refer to a device being usable for storing the decontamination material at least for a limited amount of
30 time. Thus, the decontamination material preferably has a great affinity, for example adhesive strength, which may be same or greater compared to the oxygen separation device or its oxygen separation material, to the contaminant of choice.

An oxygen separator like defined above comprises an oxygen separation device, which is designed for separating oxygen from an oxygen comprising gas.

Consequently, by bringing in contact an oxygen comprising gas to the oxygen separation device a stream of pure oxygen may be provided at the secondary side of the oxygen separation device by means of interaction of the oxygen separation device, or its oxygen separation material, and the oxygen comprising gas. This may be realized, for example, by providing a pressure adjusting device for creating a pressure difference between the primary side and the secondary side of the oxygen separation device. The term pressure adjusting device may refer to any device which is capable of generating a pressure difference between the primary side and the secondary side of the oxygen separation device. It may for example be a gas compression device being connected to the primary side of the oxygen separation device, or a vacuum pump being connected to the secondary side of the oxygen separation device.

However, due to the fact that the oxygen comprising gas not only comprises oxygen but as well other constituents, the latter may as well interact with the oxygen separation device and may pollute, or contaminate the oxygen separation device, or the oxygen separation material, respectively. These interactions may negatively effect the selectivity of the oxygen separation device and/or the capability of oxygen separation. For example, in case air is used as oxygen comprising gas, an object of the oxygen separation device may be to interact with nitrogen, being the greatest constituent of air, and letting oxygen pass. However, in case other constituents of air, such as water or moisture respectively or carbon dioxide also interact with the oxygen separation device or the active material thereof, the selectivity as well as the activity may be deteriorated.

By providing a decontamination container comprising a decontamination material for decontaminating the oxygen separation device from the contaminant the contaminant or a plurality of contaminants may be released from the oxygen separation device, or its oxygen separation material, respectively, and may be adsorbed, for example, by the decontamination material. Consequently, a further regeneration step of the oxygen separation device may be realized, which may for example be performed next to and independently from a purging step. This allows performing the purging step in a much shorter period of time, thereby improving the performance of the oxygen separator.

Additionally, the oxygen separation material is much less sensitive for impurities due to the fact that contaminants may be removed from the latter in an easy manner. Apart from that, even if air, for example, would access to the oxygen separation device, for example by means of a damage, the contaminants may be removed easily and the

oxygen separator may work, at least for a limited amount of time, without essential limitations.

It may thereby be sufficient to just provide, for example, a fluidic connection between the decontamination material and the oxygen separation device, or its primary side, respectively, or a part of the oxygen separator being in fluidic communication with the oxygen separation device, or its primary side, respectively. This already allows a gas exchange to be achieved, a physical contact between the decontamination container or the decontamination material and the oxygen separation material is not required. As the affinity, or strength of interaction, respectively, of the decontamination material to the contaminant of choice is at least equal or greater compared to the oxygen separation material, a desorption of the respective contaminant or of the respective contaminants from the oxygen separation device, or the oxygen separation material, respectively, and an adsorption step, for example, at the decontamination material will appear.

Due to the fact that a connection is preferably formed between the decontamination material and the primary side of the oxygen separation device, desorption is especially effective as the contaminants mainly are adsorbed to the feed side and thus the primary side of the oxygen separation device.

Additionally, the decontamination container is located aside the main flowing path of the oxygen comprising gas. In other words, the oxygen comprising gas does not flow through the decontamination container in order to be guided from the source of oxygen comprising gas to the oxygen separation device, or its primary side, respectively. In contrast thereto, the flow of oxygen comprising gas may flow completely independent and locally isolated from the decontamination container. This allows the decontamination material not or not strongly to interact with the regular flow of oxygen comprising gas and furthermore reduces the contamination of the decontamination material itself. This in turn allows forming the decontamination container with reduced space and limited decontamination material.

It is thereby possible not only to provide one single decontamination material in the decontamination container, but to provide a plurality of different decontamination materials in the decontamination container forming a kind of mixture being selective for different contaminants.

Furthermore, especially portable oxygen concentrators are sensitive against impurities because of their limited space of the oxygen separation device, or the limited amount of oxygen separation material, respectively. For example, with respect to portable oxygen concentrators, impurities such as a water uptake of the oxygen separation material

may under circumstances lead quickly to decreased oxygen selectivity. Consequently, the arrangement according to the invention is especially advantageous for portable devices or for devices comprising a small oxygen separation device and/or a limited amount of oxygen separation material.

5 An arrangement like described above thus provides an oxygen separator which may particularly be used for medical home care applications and which provides essentially improved maintenance behavior compared to comparable oxygen separators known in the art and which furthermore provides a reduced sensitivity to impurities.

10 According to an embodiment the decontamination material is selectively and temporarily disconnectable and/or connectable via a fluid connection to the primary side of the oxygen separation device. According to this embodiment the decontamination material is not connected to the oxygen separation device permanently but may selectively and temporarily be connected to the latter only in case it is required, the contamination of the decontamination material as such may be reduced to an amount being as limited as possible.

15 This may further decrease the maintenance of a respective arrangement. Apart from that, the decontamination container may be designed in especially limited dimensions only which allows to produce the arrangement especially cost-saving and with limited required space. This may be especially advantageous for portable oxygen separators. In detail, especially in case the oxygen separator is a portable separator, saving space and saving weight is

20 advantageous with respect to convenience for the user and for a broad application range.

 A fluidic connection may furthermore be any connection through which an exchange of a fluid, such as a gas exchange, may be realized.

 The measure of separating or connecting the oxygen separation material with the decontamination material may thereby easily be performed by valves such as pneumatic

25 valves. In fact, a pressure adjusting system is provided anyhow so that pneumatic valves may easily be incorporated into such an arrangement. Pneumatic valves thereby provide reduced maintenance only, leading to a further improved maintenance behavior.

 According to a further embodiment a control unit is provided being capable of selectively connecting the decontamination material to the oxygen separation device in case

30 the oxygen separation device is in an off-mode and of selectively disconnecting the decontamination material to the oxygen separation device in case the oxygen separation device is in a regular working mode.

 This embodiment takes into consideration that during regular operation, i.e. in case the oxygen separation device generates oxygen from an oxygen comprising gas, the

oxygen separation material may come into a kind of equilibrium with the contaminants, such as moisture, especially close to the primary side, or the feed side, respectively, of the oxygen separation device after a certain amount of working time. Continuous operation of the oxygen separation device may thus come up with a kind of steady state situation with a defined small zone with significant contaminant load, which may be poisoned with respect to oxygen separation. The remaining portion of the oxygen separation device stays essentially clean and thus fully functioning for oxygen separation.

Consequently, with respect to the oxygen separation device, or the oxygen separation material, respectively, the uptake of contaminants lies in a comparable amount with respect to the release of the contaminants during a regular working mode and during a purging step. If, however, the oxygen separator is turned off and is thus in an off-mode, i.e. does not generate oxygen from an oxygen comprising gas, no oxygen separation process and particularly no purging process is performed. During an off-mode, a contaminant may move through the oxygen separation device, or its separation material, respectively and thus in a direction towards the secondary side. This step may take place, for example, by gas phase diffusion. As a consequence, that portion of the oxygen separation device will be polluted, which is not deteriorated during a regular working mode comprising an equilibrium. This effect is even amplified by the fact that in a subsequent working mode further contaminants will bind to the oxygen separation device. Consequently, inventors have found that especially during off-times of the oxygen separation device, a contamination may be increased and expanded to a greater volume, and thus maintenance is especially deteriorated by means of long off-times. If however, the primary side of the oxygen separation device is connected to the decontamination container, or the decontamination material, respectively, during off-times, the decontamination material will force contaminants to be transported into the decontamination container instead of to the clean oxygen separation material. Consequently, deterioration of the clean oxygen separation material during off-phase may be securely prevented and thus the contaminant content in the oxygen separation device may be reduced and the maintenance may significantly be improved.

By disconnecting or separating, respectively, the decontamination container and thus the decontamination material from the oxygen separation device and thus from a flow of oxygen comprising gas in a regular working mode of the oxygen separation device, however, it may be prevented that an excessive amount of contaminants comes into contact with the decontamination material and thus pollutes the latter in case it is not required. In detail, in case the decontamination material would come into contact with the flow of oxygen

comprising gas during the regular working mode of the oxygen separation device, due to its great affinity to the contaminants, the decontamination material itself would be contaminated and has to be renewed after a short period of time. According to this embodiment, however, only the contaminants being bound to the oxygen separation device at the equilibrium during the regular working mode have to be bound to the decontamination material. This further reduces the required amount of decontamination material and consequently improves the maintenance of the arrangement.

Apart from that, due to the fact that the decontamination container is connected to the oxygen separation device only in case the latter is in an off-mode, no deterioration of a working performance will appear. In detail, the flow of oxygen comprising gas has not to flow through the decontamination material due to the fact that the decontamination container is located aside the main flowing path of the oxygen comprising gas. Consequently, the performance of the oxygen separation device is not influenced in an undesired manner.

According to a further embodiment the decontamination material comprises a drying agent. Especially water is a contaminant which forms a kind of equilibrium, for example with a sieve bed, and does thus not deteriorate the oxygen separation behavior of the oxygen separator during normal working mode in an essential manner when being in a steady state. If however the oxygen separation device is turned off, for example, and leaves the conditions of the equilibrium, water may easily move through the oxygen separation material, for example, in the direction of the uncontaminated material. Consequently, especially in case the contaminant comprises water, a connection of the oxygen separation material and the decontamination container comprising a drying agent is advantageous and improves the maintenance behavior as well as the selectivity for oxygen separation.

With respect to the drying agent basically any drying agent may be used which comprises the same or a greater drying capacity compared to the oxygen separation material. For example, phosphorous pentoxide, such as the one being purchasable under its name sicapent from the company Merck may be used. This has the advantage of a high drying capacity together with a limited weight. With respect to the drying capacity, the latter may be determined by the partial pressure above the respective material, or its residual water content in air, at given conditions, such as temperature, load, etc. In detail, the partial pressure, for example of water, above the material being used as decontamination material should be the same or lower compared to the partial pressure above the oxygen separation device, or the oxygen separation material, respectively.

According to a further embodiment the oxygen separation device comprises a sieve bed with a nitrogen adsorbing material. In detail, a sieve bed may be used for adsorbing nitrogen when guiding a flow of oxygen comprising gas through the latter. The sieve bed may thus comprise a material which is capable of adsorbing nitrogen but does less interact with oxygen in order to let the oxygen pass through and to generate a flow of pure or essentially pure oxygen. The sieve bed may thus comprise a zeolite material, for example a lithium zeolite, such as the sieve material being purchasable under its name SXSDM from the firm CECA. Especially by using a sieve bed, contaminants may stay at the feed side, or at the region of the primary side of the latter, until they are removed by a purging process. If however, the oxygen separator is in an off-mode, the contaminants may move through the whole bed and thus contaminating regions not being contaminated in a regular working mode. Apart from that, by using a sieve bed it is especially effective to remove or desorb the contaminants and to immobilize them at the decontamination material. Consequently, especially by using a sieve bed the arrangement according to this embodiment is especially advantageous.

According to a further embodiment a heating device for heating the oxygen separation device may be provided. According to this embodiment, the desorption step of contaminants being present at the oxygen separation material may be improved. This may in an exemplary manner especially be the case if the oxygen separation material comprises water as contaminant. The amount of heating and thus the temperature and time applied may thereby be dependent from the oxygen separation device used and the contaminants which are to be desorbed.

According to a still further embodiment two oxygen separation devices are provided being arranged in parallel and each having a primary side and a secondary side, wherein the decontamination material is selectively and temporarily disconnectable and/or connectable via a fluidic connection to the primary side of each of the oxygen separation devices independently from each other. According to this embodiment, the oxygen separator may be designed as pressure swing adsorption system or as vacuum swing adsorption system. Especially by thinking about these adsorption systems, the present application is advantageous. In detail, in case one separation device is in a regular working mode, the further oxygen separation device may be in a purging mode. However, in case the purging procedure is shorter compared to the time at which the one oxygen separation device may work properly and thus before a purging step is required for the one oxygen separation device, the further oxygen separation device may be in an off-mode. During that off-mode,

for example, the decontamination material may be connected to the further oxygen separation device, allowing to significantly improve the maintenance behavior.

According to a further embodiment the decontamination container is designed as a disposable article. This embodiment allows removing the contaminated decontamination container after a certain working time and to exchange it by a new one in an especially easy manner. This embodiment further improves the maintenance behavior especially in case the oxygen concentrator is formed as a home care device, such as a portable home care device. A disposable article may be characterized in that it is easily to be fixed and to be removed from the arrangement. Additionally, the decontamination container may comprise an indicator for displaying the degree of contaminant load of the decontamination material or for displaying if the decontamination material or the decontamination container has to be exchanged.

The present invention further relates to a method of separating oxygen from an oxygen comprising gas by use of an oxygen separator according to the invention, the method comprising the steps of: guiding an oxygen comprising gas to the primary side of an oxygen separation device, generating a flow of oxygen through the oxygen separation device, wherein the oxygen separation device is at least partly contaminated by a contaminant, and connecting the primary side of the oxygen separation device to a decontamination material in a decontamination container, the decontamination container being located aside the main flowing path of the oxygen comprising gas.

Such a method provides an oxygen separation procedure which provides improved maintenance behavior and a reduced sensitivity with respect to impurities. In detail, due to the fact that the decontamination material is connected to the oxygen separation device or its primary side, respectively, contaminants which may pollute the oxygen separation device may be released, or desorbed, respectively, from the latter and may be guided to the decontamination material and may be immobilized there.

With respect to further advantages it is referred to the above description of the oxygen separator according to the invention.

According to an embodiment the decontamination material is selectively and temporarily disconnected and/or connected via a fluidic connection to the primary side of the oxygen separation device. According to this embodiment the amount of decontamination material may be kept low, which may particularly advantageous for home care devices and/or for portable devices.

According to a further embodiment the method comprises the steps of: performing a first cycle of oxygen generation, the first cycle comprising the steps of guiding

an oxygen comprising gas to the primary side of an oxygen separation device, and generating a flow of oxygen through the oxygen separation device by creating a pressure difference between the primary side and the secondary side of the oxygen separation device, and performing a second cycle of oxygen generation, the second cycle comprising the steps of
5 guiding an oxygen comprising gas to the primary side of an oxygen separation device, and generating a flow of oxygen through the oxygen separation device by creating a pressure difference between the primary side and the secondary side of the oxygen separation device, wherein the oxygen separation device is turned in an off-mode between the first cycle and the second cycle, and wherein the oxygen separation device is connected selectively and
10 temporarily to the decontamination material solely during the off-mode of the oxygen separation device.

According to this embodiment the oxygen separation device is connected to the decontamination container only in case the oxygen decontamination container is in an off-mode. This enables the decontamination material not to come into contact with the flow
15 of oxygen comprising gas during the regular working mode and thus avoids an excessive contamination of the decontamination material as such. Apart from that, it is prevented that that part of the oxygen separation device, or its oxygen separation material, respectively, which is close to the secondary side of the latter and is thus potentially not contaminated, is deteriorated during the off-phase of the oxygen separation device. It is obvious for one
20 skilled in the art that during that off-mode, a purging step may be realized. Depending from the contamination and the time available, the decontamination container may be connected to the decontamination material separated from a purging step, or during a purging step, wherein a connection separated from a purging step may be preferred. The purging step may comprise the steps of guiding oxygen to the secondary side of the oxygen separation device,
25 and generating a flow of oxygen from the secondary side to the primary side of the oxygen separation device by creating a pressure difference between the primary side and a secondary side of the oxygen separation device.

BRIEF DESCRIPTION OF THE DRAWINGS

30 These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 shows a schematic view of an embodiment of an arrangement according to the invention.

DETAILED DESCRIPTION OF EMBODIMENTS

In figure 1, an oxygen separator 10 for generating oxygen is schematically shown. The oxygen separator 10 may be used for generating oxygen with respect to therapeutic applications, for example in the field of COPD treatment. The oxygen separator 10 may be designed as a stationary arrangement, for example for using it in a hospital, or it may be a portable device, for example for using it in the field of homecare applications. However, the oxygen separator 10 may furthermore be used for any application at which pure or essentially pure oxygen has to be provided, for example in air planes or for welding purposes.

The oxygen separator 10 comprises at least one oxygen separation device 12 which is capable of separating oxygen from an oxygen comprising gas and which is contaminatable by a contaminant, for example by water or carbon dioxide. However, it is preferred that the oxygen separator 10 comprises at least two oxygen separation devices 12, 14 being arranged in parallel. In the following, the invention is described with respect to two oxygen separation devices 12, 14. However, it is clear for one skilled in the art that every feature may be provided correspondingly by using just one oxygen separation device 12 or more than two oxygen separation devices 12, 14. Each oxygen separation device 12, 14 may be formed as a sieve bed and may be equipped with an oxygen separation material 16, 18. The oxygen separation material 16, 18 is particularly configured for letting oxygen pass but for interacting with, or adsorbing, respectively other components being present in an oxygen comprising gas. In case air is used as oxygen comprising gas, it is thus preferred that the oxygen separation material 16, 18 is configured for adsorbing nitrogen. Suitable oxygen separation materials 16, 18 may comprises a zeolite material such as a lithium zeolites material. However it may be possible to use every suitable oxygen separation material 16, 18 known in the art, for example for use in for swing processes, such as pressure swing adsorption ore vacuum swing adsorption processes.

An inlet 20 is provided for guiding a flow of oxygen comprising gas to the oxygen separation device 12, or its primary side. Correspondingly, an inlet 22 is provided for guiding a flow of oxygen comprising gas to the oxygen separation device 14, or its primary side, respectively. Furthermore, outlets 24, 26 for guiding enriched oxygen comprising gas, or pure oxygen, respectively, out of the oxygen separation devices 12, 14 are provided.

The inlets 20, 22 of the oxygen separation devices 12, 14 are connected to an inlet 28 of the oxygen separator 10. Connected to the inlet 28 may be a source of oxygen

comprising gas, such as a gas storing device or the air surrounding the oxygen separator 10. Additionally, a pressure adjusting device for creating a pressure difference between the primary side and the secondary side of the oxygen separation device 12, 14 may be provided. According to figure 1, a compressor 30 is provided for compressing the oxygen comprising gas and forcing it through the inlet conducts 32, 34 to the oxygen separation devices 12, 14. Downstream or upstream the compressor 30, an inlet filter 36 may be provided in order to provide a first cleaning step of the oxygen comprising gas. In detail, especially solid particles may be filtered out of the oxygen comprising gas.

In order to allow the oxygen comprising gas to be guided through the oxygen separation devices 12, 14 intermittently, inlet valves 38, 40 may be provided in the inlet conducts 32, 34. A valve according to the invention shall be any device which may allow a gas flow, inhibit a gas flow and/or regulate the amount of a gas flow. Consequently, by closing the valve 40 and by opening the valve 38, the oxygen comprising gas may be guided through the first oxygen separation device 12, whereas the oxygen comprising gas may be guided through the second oxygen separation device 14 by opening the valve 40 and by closing the valve 38. Correspondingly, a valve 42, such as a check valve, may be provided in the outlet 24 and a valve 44, such as a check valve, may be provided in the outlet 26. By guiding the oxygen comprising gas through the first oxygen separation device 12, the valve 42 may be opened whereas the valve 44 may be closed. Correspondingly, by guiding the oxygen comprising gas through the second oxygen separation device 14, the valve 44 should be opened whereas the valve 42 should be closed.

Downstream the valves 42, 44, the outlets 24, 26 are connected to an oxygen accumulator 46, or a gas tank, respectively, in order to store the generated oxygen. The oxygen accumulator 46 may be connected to an outlet line 48 in which a flow controller 50 may be provided in order to control a stream of pure oxygen. Apart from that, a purity sensor 52 may be provided in the outlet line 48 in order to monitor the purity of the generated oxygen. Furthermore, an additional filter 54 may be provided in the outlet line 48 before the generated oxygen is guided to an outlet 55.

The outlet 24 of the first oxygen separation device 12 and the outlet 26 of the second oxygen separation device 14 may be connected by a conduct 56 upstream the valves 42, 44, in which a flow regulator 58, such as an orifice or a flow controller, may be provided. This allows guiding a defined part of the generated oxygen, for example generated in the oxygen separation device 12, back through the further oxygen separation device 14, or vice versa, for purging purposes and thus for regenerating the oxygen separation devices 12, 14.

With this regard, purging lines 60, 62 are provided at the primary sides of the oxygen separation devices 12, 14, each comprising a valve 64, 66. If oxygen is guided through the oxygen separation devices 12, 14 for regeneration purposes, the outflow may then be guided selectively through the purging lines 60, 62 and through an exhaust 68.

5 The oxygen separator 10 further comprises a decontamination container 70, for example being designed as a disposable article, which comprises a decontamination material 72. In one embodiment, the decontamination material 72 may be the same as the oxygen separation material 16, 18. However, the decontamination material 72 may as well be a compound or a mixture of compounds having a greater affinity with respect to the
10 contaminants of choice. In a non-limiting example, the decontamination material 72 may be a drying agent. The decontamination material 72 serves for decontaminating the oxygen separation device 12, 14, i.e. the oxygen separation material 16, 18, from a contaminant. Therefore, the decontamination material 72 is located aside the main flowing path of the oxygen comprising gas and may be selectively and temporarily disconnectable and/or
15 connectable via a fluidic connection to the primary side of the oxygen separation device 12, 14. In order to realize the latter, the decontamination container 70 may be connected to the oxygen separation devices 12, 14 at their primary side or to the inlets 20, 22 via decontamination conduits 74, 76. Provided in the decontamination conduits 74, 76, for example, valves 78, 80, such as pressure valves or check valves, may be provided in order to
20 open or to close the respective connection. The decontamination conduits 74, 76 may be formed by having a rather big diameter but only a limited length. For example, the diameter may lie in a range of • 1mm to • 10mm and the length may be realized in a amount of • 1cm to • 10cm.

 In order to allow an automated procedure, a control unit, not shown as such,
25 may be provided being capable of selectively connecting the decontamination material 72 to the oxygen separation device 12, 14 in case the oxygen separation device 12, 14 is in a off-mode and of selectively disconnecting the decontamination material 72 to the oxygen separation device 12, 14 in case the oxygen separation device 12, 14 is in a regular working mode. This may be realized, for example, by piloting the valves 78, 80. In case two oxygen
30 separation devices 12, 14 are provided, it is preferred that the decontamination material 72 is selectively and temporarily disconnectable and/or connectable via a fluidic connection to the primary side of each of the oxygen separation devices 12, 14 independently from each other. This may be realized, like stated above, by providing independent decontamination conduits 74, 76.

Additionally, a heating device 82 may be provided for heating the oxygen separation device 12, 14. According to this, one single heating device 82 may be provided acting on both oxygen separation devices independently in a controllable manner, or one heating device 82 may be provided for each oxygen separation device 12, 14.

5 A method of separating oxygen from an oxygen comprising gas by use of the oxygen separator 10 may comprise the steps of: guiding an oxygen comprising gas to the primary side of an oxygen separation device 12, 14, generating a flow of oxygen through the oxygen separation device 12, 14, particularly by creating a pressure difference between the primary side and a secondary side of the oxygen separation device 12, 14, wherein the
10 oxygen separation device 72 is at least partly contaminated by a contaminant, and connecting the primary side of the oxygen separation device 12, 14 to a decontamination material 72. The decontamination material 72 may thereby be connected and/or disconnected to the primary side of the oxygen separation device 12, 14 via a fluidic connection selectively and temporarily.

15 In a preferred embodiment, said method comprising the steps of: performing a first cycle of oxygen generation, the first cycle comprising the steps of guiding an oxygen comprising gas to the primary side of an oxygen separation device 12, 14, and generating a flow of oxygen through the oxygen separation device 12, 14 by creating a pressure difference between the primary side and the secondary side of the oxygen separation device, and
20 performing a second cycle of oxygen generation, the second cycle comprising the steps of guiding an oxygen comprising gas to the primary side of an oxygen separation device 12, 14, and generating a flow of oxygen through the oxygen separation device 12, 14 by creating a pressure difference between the primary side and the secondary side of the oxygen separation device 12, 14, wherein the oxygen separation device 12, 14 is turned in an off-mode between
25 the first cycle and the second cycle, and wherein the oxygen separation device 12, 14 is connected selectively and temporarily to the decontamination material 72 solely during the off-mode of the oxygen separation device 12, 14.

While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or
30 exemplary and not restrictive; the invention is not limited to the disclosed embodiments. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The

mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope.

CLAIMS:

1. Oxygen separator, comprising
an oxygen separation device (12, 14) being capable of separating oxygen from
an oxygen comprising gas and being at least partly contaminatable by a contaminant and
having a primary side and a secondary side,

5 a gas inlet (20, 22) for guiding a flow of oxygen comprising gas to the primary
side of the oxygen separation device (12, 14), and

a decontamination container (70) comprising a decontamination material (72)
for decontaminating the oxygen separation device (12, 14) from the contaminant, wherein
the decontamination container (70) is located aside the main flowing path of

10 the oxygen comprising gas.

2. Oxygen separator according to claim 1, wherein
the decontamination material (72) is selectively and temporarily
disconnectable and/or connectable via a fluidic connection to the primary side of the oxygen
15 separation device (12, 14).

3. Oxygen separator according to claim 1, wherein a control unit is provided
being capable of selectively connecting the decontamination material to the oxygen
separation device (12, 14) in case the oxygen separation device (12, 14) is in a off-mode and
20 of selectively disconnecting the decontamination material (72) to the oxygen separation
device (12, 14) in case the oxygen separation device (12, 14) is in a regular working mode.

4. Oxygen separator according to claim 1, wherein the decontamination material
(72) comprises a drying agent.

25 5. Oxygen separator according to claim 1, wherein the oxygen separation device
(12, 14) comprises a sieve bed with a nitrogen adsorbing material.

6. Oxygen separator according to claim 1, wherein a heating device (82) for heating the oxygen separation device (12, 14) is provided.

7. Oxygen separator according to claim 1, wherein two oxygen separation devices (12, 14) are provided being arranged in parallel and each having a primary side and a secondary side, wherein the decontamination material (72) is selectively and temporarily disconnectable and/or connectable via a fluidic connection to the primary side of each of the oxygen separation devices (12, 14) independently from each other.

8. Oxygen separator according to claim 1, wherein the decontamination container (70) is designed as disposable article.

9. Method of separating oxygen from an oxygen comprising gas by use of an oxygen separator (10) according to claim 1, the method comprising the steps of:

guiding an oxygen comprising gas to the primary side of an oxygen separation device (12, 14),

generating a flow of oxygen through the oxygen separation device (12, 14), wherein the oxygen separation device (12, 14) is at least partly contaminated by a contaminant, and

connecting the primary side of the oxygen separation device (12, 14) to a decontamination material (72) in a decontamination container (70) being located aside the main flowing path of the oxygen comprising gas.

10. Method according to claim 9, wherein the decontamination material (72) is selectively and temporarily disconnected and/or connected via a fluidic connection to the primary side of the oxygen separation device (12, 14).

11. Method according to claim 9, said method comprising the steps of:

performing a first cycle of oxygen generation, the first cycle comprising the steps of guiding an oxygen comprising gas to the primary side of an oxygen separation device (12, 14), and generating a flow of oxygen through the oxygen separation device (12, 14) by creating a pressure difference between the primary side and the secondary side of the oxygen separation device (12, 14), and

performing a second cycle of oxygen generation, the second cycle comprising

the steps of guiding an oxygen comprising gas to the primary side of an oxygen separation device (12, 14), and generating a flow of oxygen through the oxygen separation device (12, 14) by creating a pressure difference between the primary side and the secondary side of the oxygen separation device (12, 14), wherein

5 the oxygen separation device (12, 14) is turned in an off-mode between the first cycle and the second cycle, and wherein

 the oxygen separation device (12, 14) is connected selectively and temporarily to the decontamination material (72) solely during the off-mode of the oxygen separation device (12, 14).

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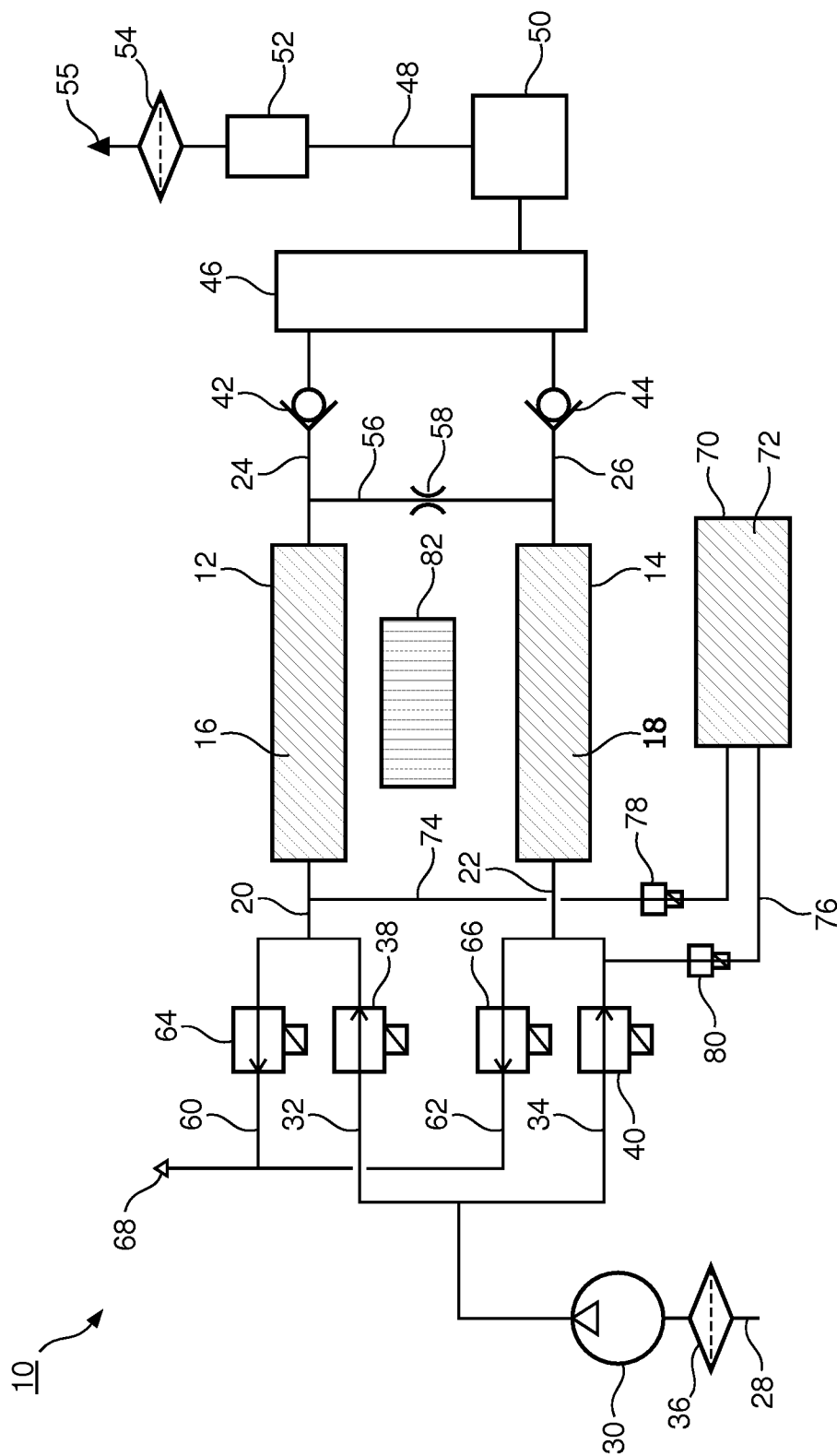


FIG. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2013/050344

A. CLASSIFICATION OF SUBJECT MATTER
INV. B01D53/04 C01B13/02
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B01D C01B A61M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EP0-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/134246 A1 (BABICKI MATTHEW L [CA] ET AL) 26 September 2002 (2002-09-26) paragraphs [0002], [0003], [0004], [0020], [0021], [0027], [0031], [0055], [0064], [0206] - [0208] -----	1-11
X	US 7 550 036 B2 (LEE JUNBAE [KR] ET AL) 23 June 2009 (2009-06-23) cited in the application column 1, line 18 - column 2, line 3; figures -----	1-3,5,7, 9-11
A	US 2008/202337 A1 (TAYLOR BRENTON [US] ET AL) 28 August 2008 (2008-08-28) paragraphs [0005], [0010], [0011], [0013]; figures -----	1-11



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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