(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 218 318 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
06.08.2008 Bulletin 2008/32

(21) Application number: **00970317.4**

(22) Date of filing: **29.09.2000**

(51) Int Cl.:
C06B 23/02 (2006.01) *C06B 23/04* (2006.01)
C06B 45/00 (2006.01) *C06D 5/06* (2006.01)

(86) International application number:
PCT/NL2000/000696

(87) International publication number:
WO 2001/023327 (05.04.2001 Gazette 2001/14)

(54) **GAS GENERATOR AND METHOD FOR THE GENERATION OF LOW-TEMPERATURE GAS**

GASGENERATOR UND VERFAHREN ZUR ERZEUGUNG VON GAS MIT NIEDRIGER TEMPERATUR

GENERATEUR DE GAZ ET PROCEDE DE PRODUCTION DE GAZ A FAIBLE TEMPERATURE

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **30.09.1999 RU 99120797**

(43) Date of publication of application:
03.07.2002 Bulletin 2002/27

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Description

[0001] The invention relates to applied chemistry, more specifically to a composition for the generation of gases of low temperature and a process for the obtaining of gases of low temperature.

[0002] Gas generating processes based on the decomposition or burning of chemical propellants and other compositions are frequently being used for a number of purposes such as the inflation of airbags from, for instance, cars, rafts, life boats and vests, fast installed partitions (which are used in well drifts to cut off the well in case of fire), drives and generators for different types of pneumatic systems and operations mechanisms etc.

[0003] Some technical methods for obtaining relative cold gases, in particular nitrogen, are known. These methods are based on the decomposition or the burning of solid materials in special units. These materials are generally shaped in the form of monolithic or porous products and come in all types of shapes and sizes.

[0004] The hot gases generated from the decomposition of these materials are in general cooled with the aid of special chemical cooling agents or by specific designed features such as heat exchangers.

[0005] The high temperature burning gases are passed through the layer of the cooling agent or the heat exchanger and the temperature of the gases decreases as a result of the endothermal decomposition process of, or heat absorption by the cooling agent. Such processes are described for instance in US-1362349, GB-1371506, FR-136897 and the Russian inventors certificate 801540. The use of heat exchangers is described in GB-1500137 and GB-1487944.

[0006] The degree of cooling of the generated gas depends on the nature of the cooling agent, the mass of the cooling agent, which can sometimes exceeds the mass of the gas-generating composition, and in case of the heat exchanger, the design features of exchanger.

[0007] One of the drawbacks of the prior art as cited above is the relatively complicated structure of these units. Another drawback is that the known gas generators do not allow or provide for the gases to be cooled below 150°C. Therefore the applicability of these gas generators is limited to systems that can withstand such high temperatures. These are disadvantages from cost-economic and application viewpoints.

[0008] Additionally, gases obtained by the use of the above described methods contain large and undesired amounts of components which may not only have a negative effect on the construction but also in case of airbags for cars, for the person (driver) who is supposed to be protected by the airbag.

[0009] Complicated design and complex products resulting in their increasing mass, size and complexity are negative features of these gas generating methods. This decreases reliability and efficiency of the complete system. Especially in the life saving airbags industry there is a continuous need for reliable, safe and economic methods for the generation of cold gases.

[0010] RF-patent 2108282 describes a method of generating cold gases, specifically nitrogen, but also hydrogen and oxygen, by using the endothermal decomposition of a product made of gas penetrable solid material. The gas penetratable solid material comprises a gas source and a heat absorbing mixture, whereby the gaseous reaction products are cooled by passing the hot gases through the porous body of the product in the moving direction of the reaction front. The hot gases heat the porous body to a temperature necessary to support the endothermic chemical reaction taking place. The heating of the porous body is necessary to enable the main reaction. The decomposition of the cooling agent is also an endothermic chemical reaction. The patent claims to obtain nitrogen gas from a solid propellant system with a purity better than 97% and a temperature below 150°C.

[0011] In the gas generator using this method (as well as in most other gas generators) azides, hydrides and chlorates are used as the gas source, which compounds are in general used in the form of alkali and earth-alkali compounds. On decomposition of these compound usually a highly reactive metallic slag remains behind in the gas generator.

[0012] As an example, for a nitrogen producing gas generator composition NaN_3 may be used. The decomposition reaction of NaN_3 results in Na and N_2. Likewise in other decomposition reactions of sodium compounds, also sodium is formed. The formed gas is blown off and the slag remains. This slag comprises of the remains of cementing agent and , the cooling agent and the metallic sodium. Under these conditions of gas generation the highly chemical reactive sodium is thus generated. This highly reactive material will accumulate in the condensed burning decomposition products and thus provides a potential hazard for persons involved. When moisture is present this can result in vigorous and dangerous reactions taking place in combination with the generation of the highly flammable and explosive hydrogen. The decomposition of which might be followed by explosions, other undesirable effects or even personal injuries, if persons are involved.

[0013] Methods for the neutralisation of sodium are itself known in the art and for instance described in "Sodium production, its properties and use", State Publishing House, Moscow, 1961 pp 142. One of the methods described for the removal of metallic sodium is destruction with water. To be able to apply this method in order to neutralise the used gas generator, the generator after use has to be hermetically sealed and transported to a suitable installation to adequately neutralise the reactive remains of the generator. This is dangerous, cost-ineffective, complex and thus undesirable.

[0014] In the case of sodium-compounds as the gas source, elemental sodium (Na) is formed upon decomposition of sodiumazide. Sodium is a highly reactive and aggressive chemical. As a result of this reactivity, sodium can react with a wide class of substances to a number of sufficiently stable compounds. One of these compounds is sulphur. Sodium reacts with sulphur to form sodium sulphide (Na_2S).

[0015] The neutralisation of sodium by reaction with sulphur or sulphur compounds in gas generating compositions is known for instance from US 3775199, US 5536340, EP 394103 and US 3741585. The sulphur is vaporised during the decomposition of the gas-generating composition and reacts with the formed sodium slag to the neutral sodiumsulphide.

[0016] In the gas generators of the prior art as described hereinabove, the sulphur is vaporised together with the gas generation. It is difficult to vaporise the sulphur at the same rate at which the sodium slag is formed and the rate at which it reacts with the sodium slag. As a result vaporised sulphur will exit the gas generator and/or not all metallic sodium is neutralised. This is a drawback of the use of mixtures of sulphur and gas-generating compositions as described in the prior art.

[0017] It is therefore a goal of the present invention to develop a product which will result in the effective generation of nitrogen gas of low temperature without the adverse effects as described above and without major concessions towards output and performance parameters of the gas generator.

[0018] It is another goal of the invention to provide for a process for the generation of nitrogen gas of low temperature and to provide for a gas generator which generates nitrogen gas of low temperature.

[0019] Inventors have now found a gas-generating configuration that can overcome the above-mentioned deficiencies of the prior art and results in the generation of low temperature gas with effective and sufficient neutralisation of the reactive slag.

[0020] The invention accordingly comprises a gas generator comprising at least one first body, comprising means for the generation of gas and one or more reaction products at a decomposition front by decomposition of a gas-penetrable porous solid material in said first body, and at least one spatially separated second body, comprising means for the generation of a neutralisation agent, wherein means are present for passing said gas through the said first body and means are present for passing said neutralisation agent through the said decomposed gas-penetrable solid material, whereby the neutralising agent does not come into contact with the decomposing solid material, during or prior to decomposition thereof, to neutralise one ore more reaction products - such as slag - from the generation of gas in the said first body, and wherein means are present for operating the generation of a neutralisation agent in the second body at a spatial interval and optionally a temporal interval from the generation of gas in the first body.

[0021] The principle of the invention encompasses the separation of gas generation material and neutralising material, thereby making it possible to improve the effectivity and reliability of the gas generation and neutralisation. According to an embodiment of the invention, two gas generating materials are present in one housing, spatially separated from each other. A first gas generator with the primary task of generating gas, preferably of low temperature, and a second gas generator with the primary task of generating neutralising compounds for the slag obtained from the first gas generator.

[0022] The first gas generator comprises a composition from which nitrogen, hydrogen and/or oxygen gas, preferably of low temperature can be obtained by the decomposition of a gas generating composition in the form of a gas penetrable solid material wherein the generated gaseous products are passed through the porous body in the direction of the moving decomposition front.

[0023] The second gas generator (the neutraliser) is another composition generating a neutralising gas, preferably comprising a gas generating composition together with an effective neutraliser compound, for instance sulphur, iron oxide, metal sulphide, metal oxides (from Fe, Cu, Mg, Ti, Sn, B etc.), SiO_2 and the like. With the neutraliser composition a neutralising gas is generated separately from the gas generated in the first generator. The neutralising gas is generated at a time and/or space interval with the first gas generator. It is an important aspect of the invention, that the neutralising agent does not come into contact with the decomposing solid porous material, during or prior to the decomposition thereof. The invention is based on the principle, that only after the material has been decomposed, the neutralising material is passed through the decomposed porous solid material, thereby neutralising the (usually hazardous) decomposition products (slag). The neutralising gas is generated at a rate and a manner that the effective neutralisation of slag is accomplished and the vaporous neutralising agent is not emitted. The neutralising agent, such as vaporous sulphur, reacts with the reaction products (slag) from the first gas generator such that the these products are effectively neutralised.

[0024] In an embodiment the invention thus relates to a first gas generator comprising a gas penetrable solid material comprising a nitrogen source, preferably an azide, more preferably sodiumazide, cementing agent and optionally a heat absorbing mixture, wherein the solid material has a porosity of 35-60 % and a second gas generator containing a neutraliser composition which contains sulphur and an additional nitrogen source.

[0025] The gases to be generated can be selected from the group of nitrogen, oxygen and hydrogen, or combinations thereof. Generally azides, hydrides and chlorates are used for that, preferably in the alkali metal form.

[0026] In a further embodiment of the invention the gas to be produced is nitrogen, the nitrogen sources in both the first and the second gas generator are selected from the group of alkalimetal azides or an earth-alkalimetal azides, preferably potassium azide or sodium azide, more preferably sodium azide.

[0027] The first and second gas generator do not have to be physically separated from each other. In embodiments of the invention they can be placed in any position relative to each other, as long as the vaporised neutraliser of the second generator can come into contact with the slag from the first generator.

[0028] In the invention, the neutralisation takes place behind the reaction front of the decomposition reaction of the first gas generator. The spatial interval between the said reaction front of the first gas generator and production of the neutralising agent in the second gas generator is such that the reaction products of high temperature from the first gas generator stay behind, while the nitrogen gas is blown off. The neutralisation front lags behind the decomposition front and neutralises the said reaction products remaining behind.

[0029] In another embodiment of the invention the rate at which the gas generating composition decomposes is different from the decomposition rate of the neutraliser charge. Thus, the decomposition of the gas generating composition and the neutraliser are started simultaneously. Metallic slag is formed, followed by the generation of vaporous neutraliser in the second generator, which neutralises the slag.

[0030] In another embodiment of the invention the moment at which the neutraliser is activated lies later than the moment of activation of the gas generator.

[0031] The activation, or ignition, of the two bodies can be done by any suitable means known in the art.

[0032] A typical embodiment of the invention is as follows.

[0033] A body consists essentially of two parts: the gas generator and the neutraliser. The gas generator will contain a porous solid material, containing a gas generating component such as sodiumazide, together with cementing agents (such as phenolic resins) and optionally cooling agents or other heat absorbing mixtures. The other part of the body is the neutraliser mass. The neutraliser contains the neutraliser (sulphur, iron, metal sulphides, metal oxide) and a gas generating component. The gas-generating component may be identical to the gas generating component in the first part, for instance sodiumazide. When the gas generator is activated, gas is generated and blown off, leaving behind highly reactive metallic sodium slag. The neutraliser is activated and the neutralising reagent is vaporised; in the case of solid neutralising agents it may be brought in aerosol form. The neutraliser will react with the slag, resulting in non-hazardous or less hazardous materials, in the case of neutralising sodium with sulphur, resulting in the neutral sodiumsulphide.

[0034] The amount of neutraliser is such that it is sufficient to effectively neutralise the slag formed in both the neutraliser and the gas generator and that only minimal or almost no vaporous neutraliser is blown off.

[0035] In the present invention, in order to facilitate the interaction between the sodium and the neutraliser compound (e.g. sulphur) it is preferred that the neutralisation product is in a form in which the reaction with the sodium slag is enhanced. To this extent the neutraliser can be mixed with the gas-generating compound in the form of powder, granules, etc.

[0036] In a gas generator according a preferred embodiment of the invention, said gas generator being based upon the use of sodium azide and sulpur, the combined amounts of the nitrogen sources in the first and second body comprises 50-80 wt.% drawn on the total weight of the gas generator and the amount of neutralisation agent in the second body 47-90 wt.% of neutralisation agent, drawn on the weight of the second body. The respective weight of the gas generator is measured in the absence of housing, external cooling aids, etc.

[0037] The second body (gas generator) comprises between 17 and 35 wt.% of the gas generator according to the invention, drawn on the total weight of the gas generator. The second body (gas generator) contains 10 to 53 wt.% of the nitrogen source and 47 to 90 wt.% of neutralising agent. In a preferred embodiment the second body (gas generator) contains 15 to 25 wt.%, more preferable 17 to 23 wt.% of nitrogen source and 75 to 85 wt. %, more preferable 77 to 83 wt.% of sulphur.

[0038] In a preferred embodiment the sulphur is in a particulate form, preferably in the form of small particles, more preferably in the form of sulphur powder.

[0039] The relative amounts of sodium azide and sulphur are contained between the lower limit of sulphur which that is the amount of sulphur necessary for the neutralisation of the elemental sodium formed. The upper limit of sulphur is determined by the amount at which almost no vaporised sulphur will be blown off or the amount that is considered acceptable with respect to output gas purity.

[0040] The rate at which the gas was generated was determined in order to provide for an optimal formulation together with the optional heat absorbing product and the neutraliser product. The ratio of the different components (nitrogen source, heat absorbing material and sulphur) was chosen such that the required maximum discharge of vaporised sulphur and the stable burning of the material was obtained. It was found that a stable ignition and burning of the material was not possible if the concentration of the sulphur in the material was more than 90 wt.% of the combined weight of additional nitrogen source and sulphur (neutraliser mass). If the concentration of sulphur was below 47 wt.% of said combined weight, the discharge of vaporised sulphur decreased below the desired level and the total (neutraliser mass)/(nitrogen source) ratio had to be increased in order to obtain the bonding of the elemental sodium in sufficiently high levels. The preferred mass ratio of the nitrogen source and the neutraliser is determined by the total neutralisation of sodium to sodium sulphide in the slag.

[0041] In a preferred embodiment of the invention the nitrogen source and the neutraliser, preferably sulphur, are homogeneously mixed as part of the second body.

[0042] In another preferred embodiment of the invention, the neutraliser product comprises sulphur and additional nitrogen source in an amount of 10-53 wt.% of the additional nitrogen source and 47-90 wt.% of sulphur, based on the combined weight thereof.

[0043] In this embodiment of the invention, the combined amount of the nitrogen source and sulphur, based on the total weight of the product is from 17 to 35 wt.%.

[0044] In case the combined amount of the additional nitrogen source and the sulphur is less than 17 wt.%, the total neutralisation of sodium is insufficient because of lack of sulphur. In case the amount is above 35 wt.%, the vaporised sulphur will be blown off with the generated gas and thus the purity of the generated nitrogen gas decreases.

[0045] It is to be noted that in some cases the generated gas may contain some entrained contaminants. If these are un-desirable in the intended use of the generator, it may be advantageous to include additional downstream filter means. This may be any kind of filter, such as sand, chemical filters, metal wire filters and the like. In some instances it may also be advantageous to include some additional neutralising agent in the filter, thereby providing an additional safeguard against contaminants being blown out with the gas.

[0046] In the case of generating a cold gas by passing the generated gas through the porous solid material, as described above, the situation may occur that when the material is almost completely decomposed, the cooling capacity of the remainder of the porous material is too small to maintain the temperature of the gas at a constant level. If in a specific application this is not acceptable, it can be advantageous to include downstream cooling means in the gas generator. It is possible to combine these cooling means with filter means discussed above, especially as both the cooling means and the filter means can easily be constructed from the same materials (sand, steel wire, steel wool, metal mesh and the like).

The invention also relates to a process for the generation of gases, preferably nitrogen, comprising the steps of:

- decomposition of a gas-penetrable porous solid material in a first body, whereby gas and other reaction products are generated at a decomposition front;
- passing the gas through said porous solid material;
- generating a neutralisation agent in a second body, wherein the second body is spatially separated from the first body;
- passing the neutralisation agent through said decomposed porous solid material;
- neutralising the said other reaction products in the first body by reaction with the neutralisation agent;
- maintaining a temporal and/or spatial interval between the decomposition front of the first body and a neutralisation front obtained by passing the neutralisation agent from the second body into the first body.

[0047] Upon ignition of the nitrogen source containing gas generating material and the neutralisation material, the materials start decomposing. The gaseous decomposition products of the nitrogen source pass through the ramified porous body in the moving direction of the reaction front and are cooled by transferring heat to the porous body. At the burning of the neutraliser, vaporised sulphur is generated and passed through the slag of the nitrogen source. In an embodiment of the invention a spatial and temporal interval between the reaction front of the nitrogen source and the reaction front of the neutraliser is provided. The reaction between the vaporised sulphur and the metallic sodium is exothermic. However, as there is a spatial and/or temporal interval between the gas generation and the neutralisation, this will not influence the temperature of the generated gas. This interval can be accomplished by a lower reaction rate of the neutraliser when compared to the reaction rate of the nitrogen source or by a suitable time delay. By this interval the vaporised sulphur is mainly generated after the sodium is formed, thus allowing for more optimal reaction conditions for both the generation of gas and the neutralisation of sodium.

[0048] The interval can also be controlled by design related features such as the adjustment of the flow rates by a different form of the burning surface or by the non-simultaneous ignition of the nitrogen source and the neutraliser. The invention accordingly comprises a generator for low temperature gas.

[0049] In a preferred embodiment the generated gases are cooled by passing the gases through a porous body in the moving direction of the reaction front.

[0050] In an preferred embodiment heat is absorbed which is formed in the exothermic reaction by a heat absorbing material included in the porous body.

[0051] In a preferred embodiment of the invention the amount of heat generated in relation to the amount absorbed heat is such that the generated gas is cooled to a temperature below 150°C, preferably below 100°C.

[0052] The invention is now elucidated on the basis of the attached figure. In the figure a gas generator is shown, having a housing 1, provided with an opening 2, for generated gas. In the housing 1, two gas generating bodies 3,4 are present. A first solid porous body 3, providing the major amount of gas, and a body 4, providing a neutralising gas. Further a body 5 of cooling and/or filter material is present, for example a sand filter, optionally containing a dispersed additional neutralising agent.

[0053] Once the body 3 has been ignited by igniting means (not shown), the decomposition starts, resulting in the production of a gas, which flows mainly in the direction of the arrows B, i.e. through the body 3, thereby heating the porous material, at the same time as being cooled to a relatively low temperature. Finally the cooled gases leave the housing 1, through opening 2 in the direction of arrows C.

[0054] The decomposition of the porous solid material proceeds with time and the decomposition front moves in the direction of arrow A.

[0055] From body 4, a neutralising gas is produced, after ignition of the body (by ignition means, not shown). The gas flows in the direction of arrows D and creates a neutralisation front (not shown) in body 3, which front stays behind the decomposition front, but moves in the same direction (arrow A).

Claims

1. Gas generator comprising at least one first body, comprising means for the generation of gas and one or more reaction products at a decomposition front by decomposition of a gas-penetrable porous solid material in said first body, and at least one spatially separated second body, comprising means for the generation of a neutralisation agent, wherein means are present for passing said gas through the said first body and means are present for passing said neutralisation agent through the said decomposed gas-penetrable solid material, whereby the neutralising agent does not come into contact with the decomposing solid material, during or prior to decomposition thereof, to neutralise one ore more reaction products - such as slag - from the generation of gas in the said first body, and wherein means are present for operating the generation of a neutralisation agent in the second body at a spatial interval and optionally a temporal interval from the generation of gas in the first body.

2. Gas generator according to claim 1, wherein the said means for generating a gas comprise components that generate nitrogen, oxygen, hydrogen or combinations thereof.

3. Gas generator according to claim 2, wherein the means in the first body comprise a gas-penetrable solid material comprising a gas source, cementing agent and optionally a heat absorbing mixture, wherein the solid material has a porosity of 35-60 wt.%.

4. Gas generator according to claim 1-3, wherein said first body comprises means for generating nitrogen, preferably an azide, more preferably sodium azide.

5. Gas generator according to claim 1-4, wherein the reaction products comprise slag containing sodium.

6. Gas generator according to any of the claims 1-5, wherein the second body contains a gas source and a neutralising agent.

7. Gas generator according to any of the claims 1-6, wherein the neutralisation agent is sulphur.

8. Gas generator according to any of the claims 1-7, wherein the combined amounts of the gas, preferably nitrogen sources in the first and second body comprises 50-80 wt.% drawn on the total weight of the gas generator and the amount of neutralisation agent in the second body 47-90 wt.% of neutralisation agent, drawn on the weight of the second body.

9. Gas generator according to any of the claims 1-8, wherein the second body is between 17 and 35 wt. %, drawn on the total weight of the gas generator.

10. Gas generator according to any of the claims 1-9, wherein the second body contains 10 to 53 wt.% of the nitrogen source and 47 to 90 wt.% of the neutralisation agent.

11. Gas generator according to any of the claims 1-10, wherein the generated gases are cooled by a heat absorbing material.

12. Gas generator according to any of the claims 1-11, whereby the heat absorbing material is included in the first body.

13. Gas generator according to claim 1-12, wherein downstream from the first body means are present for cooling and/or filtering the gases.

14. Gas generator according to claim 1-13, wherein said means also comprise neutralising agents for contaminants entrained in the gas.

15. Gas generator according to claim 1-14, wherein the said first and second bodies are contained within one container, said container having at least one outlet for generated gas.

16. Process for the generation of gases, preferably nitrogen, comprising the steps of:

- decomposition of a gas-penetrable porous solid material in a first body, whereby gas and other reaction products are generated at a decomposition front;
- passing the gas through said porous solid material;
- generating a neutralisation agent in a second body, wherein the second body is spatially separated from the first body;
- passing the neutralisation agent through said decomposed porous solid material;
- neutralising the said other reaction products in the first body by reaction with the neutralisation agent;
- maintaining a temporal and/or.spatial interval between the decomposition front of the first body and a neutralisation front obtained by passing the neutralisation agent from the second body into the first body.

17. Process according to claim 16, wherein the gener-

ated gases are cooled by passing the gases through the porous solid material in the same direction as the reaction front is moving.

18. Process according to claims 16 or 17, wherein heat is absorbed in the porous body, which heat is formed in the decomposition of the gas-penetrable porous solid material.

19. Process according to claims 11-13, wherein the amounts of heat formed and absorbed are such that the generated gas is cooled to a temperature below 150°C, preferably 100°C.

20. Process according to claim 17-19, wherein the heat absorbed in the porous solid material maintains the temperature necessary for decomposition of the gas-penetrable porous solid material.

21. Process according to claim 16-20, wherein the generated gases are passed through a filter and/or cooling means, downstream from the generation of the gases, said filter and/or cooling means optionally containing further neutralisation means.

Patentansprüche

1. Gasgenerator mit mindestens einem ersten Körper, der Mittel zur Erzeugung von Gas und einem oder mehreren Reaktionsprodukten an einer Zersetzungsfront durch Zersetzung eines gasdurchlässigen, porösen, festen Materials in dem ersten Körper aufweist, und mindestens einem räumlich getrennten zweiten Körper, der Mittel zur Erzeugung eines Neutralisationsmittels aufweist, wobei Mittel vorhanden sind, um das Gas durch den ersten Körper zu leiten, und Mittel vorhanden sind, um das Neutralisationsmittel durch das zersetzte gasdurchlässige, feste Material zu leiten, wobei das Neutralisationsmittel während oder vor der Zersetzung des festen Materials nicht mit dem sich zersetzenden festen Material in Kontakt kommt, um ein Reaktionsprodukt oder mehrere Reaktionsprodukte - wie etwa Schlacke - aus der Erzeugung von Gas in dem ersten Körper zu neutralisieren, und wobei Mittel vorhanden sind, um die Erzeugung eines Neutralisationsmittels in dem zweiten Körper in einem räumlichen Abstand und optional einem zeitlichen Abstand von der Erzeugung von Gas in dem ersten Körper zu bewirken.

2. Gasgenerator nach Anspruch 1, bei dem die Mittel zur Erzeugung eines Gases Komponenten aufweisen, die Stickstoff, Sauerstoff, Wasserstoff oder Kombinationen davon erzeugen.

3. Gasgenerator nach Anspruch 2, bei dem die Mittel in dem ersten Körper ein gasdurchlässiges festes Material aufweisen, das eine Gasquelle, Bindemittel und optional eine Wärme absorbierende Mischung aufweist, wobei das feste Material eine Porosität von 35 bis 60 Gewichtsprozent hat.

4. Gasgenerator nach Anspruch 1 bis 3, bei dem der erste Körper Mittel zur Erzeugung von Stickstoff, bevorzugt eines Azids, mehr bevorzugt Natriumazid aufweist.

5. Gasgenerator nach Anspruch 1 bis 4, bei dem die Reaktionsprodukte Schlacke aufweisen, die Natrium enthält.

6. Gasgenerator nach einem der Ansprüche 1 bis 5, bei dem der zweite Körper eine Gasquelle und ein Neutralisationsmittel enthält.

7. Gasgenerator nach einem der Ansprüche 1 bis 6, bei dem das Neutralisationsmittel Schwefel ist.

8. Gasgenerator nach einem der Ansprüche 1 bis 7, bei dem die kombinierten Mengen der Gasquellen, bevorzugt Stickstoffquellen, in dem ersten und dem zweiten Körper 50 bis 80 Gewichtsprozent bezogen auf das Gesamtgewicht des Gasgenerators aufweisen und die Menge von Neutralisationsmittel in dem zweiten Körper 47 bis 90 Gewichtsprozent Neutralisationsmittel bezogen auf das Gewicht des zweiten Körpers beträgt.

9. Gasgenerator nach einem der Ansprüche 1 bis 8, bei dem der zweite Körper zwischen 17 und 35 Gewichtsprozent bezogen auf das Gesamtgewicht des Gasgenerators aufweist.

10. Gasgenerator nach einem der Ansprüche 1 bis 9, bei dem der zweite Körper 10 bis 53 Gewichtsprozent von der Stickstoffquelle und 47 bis 90 Gewichtsprozent von dem Neutralisationsmittel enthält.

11. Gasgenerator nach einem der Ansprüche 1 bis 10, bei dem die erzeugten Gase durch ein Wärme absorbierendes Material gekühlt werden.

12. Gasgenerator nach einem der Ansprüche 1 bis 11, bei dem das Wärme absorbierende Material in dem ersten Körper enthalten ist.

13. Gasgenerator nach Anspruch 1 bis 12, bei dem stromabwärts von dem ersten Körper Mittel zum Kühlen und/oder Filtern der Gase vorhanden sind.

14. Gasgenerator nach Anspruch 1 bis 13, bei dem die Mittel auch Neutralisationsmittel für in dem Gas mitgenommene Verunreinigungen aufweist.

15. Gasgenerator nach Anspruch 1 bis 14, bei dem der erste und der zweite Körper in einem Behälter enthalten sind, der mindestens einen Auslass für erzeugte Gase aufweist.

16. Verfahren zur Erzeugung von Gasen, bevorzugt Stickstoff, mit den Schritten:

- Zersetzung eines gasdurchlässigen, porösen, festen Materials in einem ersten Körper, wodurch Gas und andere Reaktionsprodukte an einer Zersetzungsfront erzeugt werden,
- Leiten des Gases durch das poröse, feste Material,
- Erzeugen eines Neutralisationsmittels in einem zweiten Körper, wobei der zweite Körper räumlich von dem ersten Körper getrennt ist,
- Leiten des Neutralisationsmittels durch das zersetzte poröse, feste Material,
- Neutralisieren der anderen Reaktionsprodukte in dem ersten Körper durch Reaktion mit dem Neutralisationsmittel,
- Aufrechterhalten eines zeitlichen und/oder räumlichen Abstands zwischen der Zersetzungsfront des ersten Körpers und einer Neutralisationsfront, die erhalten wird, indem das Neutralisationsmittel von dem zweiten Körper in den ersten Körper geleitet wird.

17. Verfahren nach Anspruch 16, bei dem die erzeugten Gase gekühlt werden, indem die Gase in derselben Richtung, in der sich die Reaktionsfront bewegt, durch das poröse, feste Material geleitet werden.

18. Verfahren nach Anspruch 16 oder 17, bei dem in dem porösen Körper Wärme absorbiert wird, die bei der Zersetzung des gasdurchlässigen, porösen, festen Materials gebildet wird.

19. Verfahren nach den Ansprüchen 11 bis 13, bei dem die Mengen gebildeter und absorbierter Wärme so sind, dass das erzeugte Gas auf eine Temperatur unter 150 °C, bevorzugt 100 °C, gekühlt wird.

20. Verfahren nach Anspruch 17 bis 19, bei dem die Wärme, die in dem porösen, festen Material absorbiert wird, die Temperatur aufrecht erhält, die zur Zersetzung des gasdurchlässigen, porösen, festen Materials notwendig ist.

21. Verfahren nach Anspruch 16 bis 20, bei dem die erzeugten Gase stromabwärts von der Erzeugung der Gase durch ein Filter- und/oder Kühlmittel geleitet werden, wobei das Filter- und/oder Kühlmittel optional weitere Neutralisationsmittel enthält.

Revendications

1. Générateur de gaz comprenant au moins un premier corps, comprenant des moyens de générer un gaz et un ou plusieurs produits de réaction au niveau d'un front de décomposition, par décomposition d'un matériau solide poreux perméable aux gaz, dans ledit premier corps, et au moins un second corps séparé spatialement et comprenant des moyens de générer un agent neutralisant, **caractérisé en ce que** des moyens sont prévus pour faire passer ledit gaz à travers ledit premier corps et **en ce que** des moyens sont prévus pour faire passer ledit agent neutralisant à travers ledit matériau solide décomposé perméable aux gaz, l'agent neutralisant n'entrant pas en contact avec le matériau solide en décomposition durant ou avant la décomposition de celui-ci, pour neutraliser un ou plusieurs produits de réaction — tels que des résidus — à partir de la génération de gaz dans ledit premier corps, et des moyens étant prévus pour activer la génération d'un agent neutralisant dans le second corps avec un décalage spatial et éventuellement temporel à partir de la génération de gaz dans le premier corps.

2. Générateur de gaz selon la revendication 1, **caractérisé en ce que** lesdits moyens de générer un gaz comprennent des composants générant de l'azote, de l'oxygène, de l'hydrogène ou des combinaisons de ceux-ci.

3. Générateur de gaz selon la revendication 2, **caractérisé en ce que** les moyens présents dans le premier corps comprennent un matériau solide perméable aux gaz comprenant une source de gaz, un agent liant et éventuellement un mélange absorbant la chaleur et **en ce que** le matériau solide présente une porosité de 35 à 60 %.

4. Générateur de gaz selon les revendications 1 à 3, **caractérisé en ce que** ledit premier corps comprend des moyens de générer de l'azote, de préférence un azoture, de préférence encore de l'azoture de sodium.

5. Générateur de gaz selon les revendications 1 à 4, **caractérisé en ce que** les produits de réaction comprennent des résidus contenant du sodium.

6. Générateur de gaz selon l'une quelconque des revendications 1 à 5, **caractérisé en ce que** le second corps contient une source de gaz et un agent neutralisant.

7. Générateur de gaz selon l'une quelconque des revendications 1 à 6, **caractérisé en ce que** l'agent neutralisant est le soufre.

8. Générateur de gaz selon l'une quelconque des revendications 1 à 7, **caractérisé en ce que** les quantités cumulées de sources de gaz, de préférence d'azote, dans le premier et dans le second corps représentent 50 à 80 % du poids total du générateur de gaz et **en ce que** la quantité d'agent neutralisant dans le second corps représente 47 à 90 % du poids du second corps.

9. Générateur de gaz selon l'une quelconque des revendications 1 à 8, **caractérisé en ce que** le second corps représente entre 17 et 35 % du poids total du générateur de gaz.

10. Générateur de gaz selon l'une quelconque des revendications 1 à 9, **caractérisé en ce que** le second corps contient 10 à 53 % en poids de la source d'azote et 47 à 90 % en poids de l'agent neutralisant.

11. Générateur de gaz selon l'une quelconque des revendications 1 à 10, **caractérisé en ce que** les gaz générés sont refroidis par un matériau absorbant la chaleur.

12. Générateur de gaz selon l'une quelconque des revendications 1 à 11, **caractérisé en ce que** le matériau absorbant la chaleur est inclus dans le premiers corps.

13. Générateur de gaz selon les revendications 1 à 12, **caractérisé en ce que** des moyens sont prévus en aval du premier corps pour refroidir et/ou filtrer les gaz.

14. Générateur de gaz selon les revendications 1 à 13, **caractérisé en ce que** lesdits moyens comprennent également des agents neutralisants pour les contaminants entraînés par le gaz.

15. Générateur de gaz selon les revendications 1 à 14, **caractérisé en ce que** lesdits premier et second corps sont logés à l'intérieur d'un même carter, ledit carter présentant au moins une sortie pour le gaz généré.

16. Procédé de production de gaz, de préférence d'azote, comprenant les étapes consistant à :

- décomposer un matériau solide poreux perméable aux gaz dans un premier corps, le gaz et d'autres produits de réaction étant générés au niveau d'un front de décomposition ;
- faire passer le gaz à travers ledit matériau solide poreux ;
- générer un agent neutralisant dans un second corps, ledit second corps étant séparé spatialement du premier corps ;
- faire passer l'agent neutralisant à travers ledit matériau solide poreux décomposé ;
- neutraliser lesdits autres produits de réaction présents dans le premier corps en les faisant réagir avec l'agent neutralisant ;
- maintenir un décalage temporel et/ou spatial entre le front de décomposition du premier corps et un front de neutralisation obtenu en faisant passer l'agent neutralisant du second corps dans le premier corps.

17. Procédé selon la revendication 16, **caractérisé en ce que** les gaz générés sont refroidis en passant à travers le matériau solide poreux dans le sens de déplacement du front de réaction.

18. Procédé selon la revendication 16 ou la revendication 17, **caractérisé en ce que** la chaleur dégagée par la décomposition du matériau solide poreux perméable aux gaz est absorbée par le corps poreux.

19. Procédé selon les revendications 11 à 18, **caractérisé en ce que** les quantités de chaleur dégagées et absorbées sont telles que le gaz généré est refroidi à une température inférieure à 150°C, de préférence inférieure à 100 °C.

20. Procédé selon les revendications 17 à 19, **caractérisé en ce que** la chaleur absorbée par le matériau solide poreux maintient la température nécessaire à la décomposition du matériau solide poreux perméable aux gaz.

21. Procédé selon les revendications 16 à 20, **caractérisé en ce que** l'on fait passer les gaz générés à travers un filtre et/ou des moyens de refroidissement en aval de la génération des gaz, ledit filtre et/ou lesdits moyens de refroidissement contenant éventuellement d'autres moyens de neutralisation.

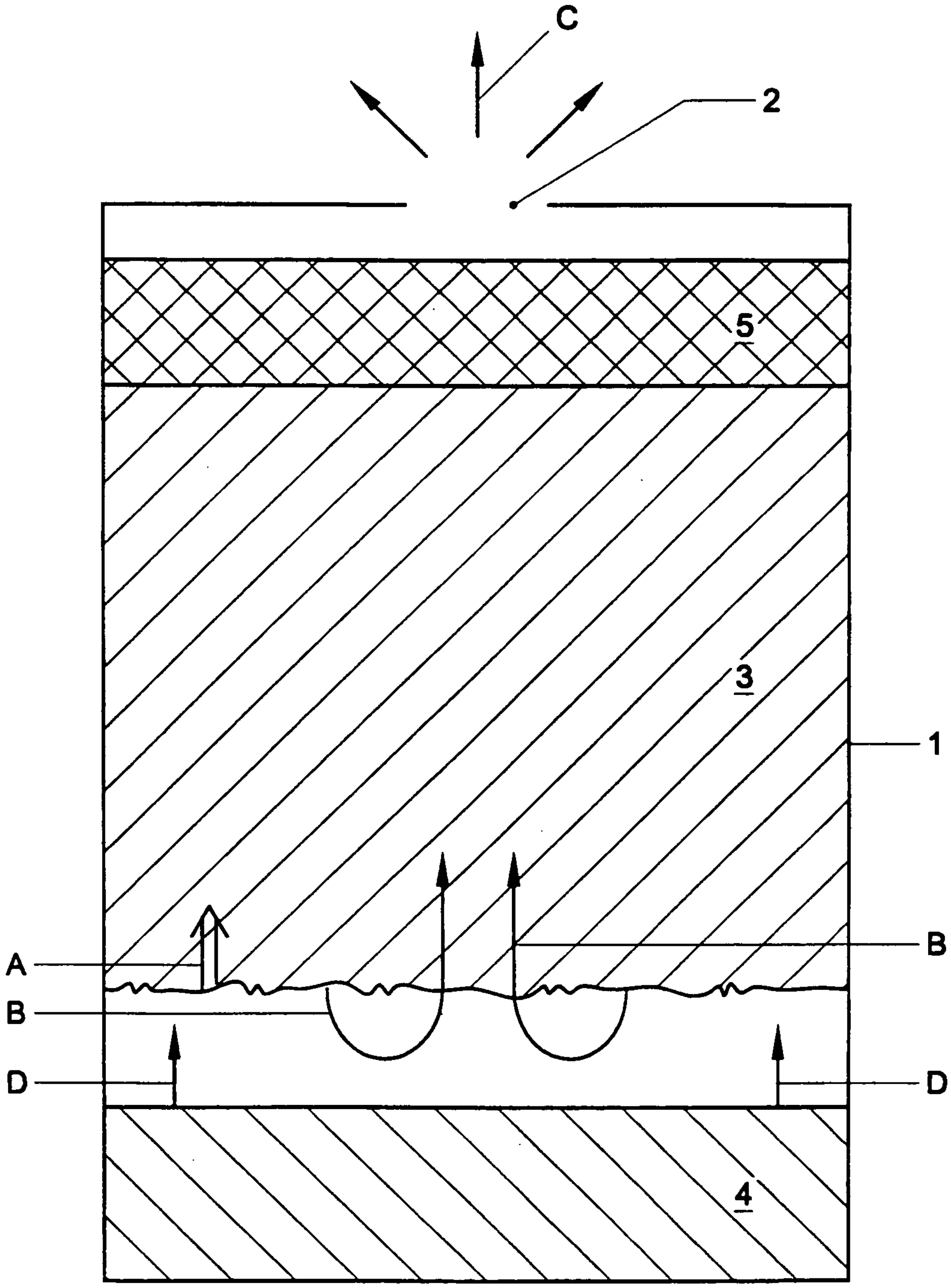

Fig. 1

REFERENCES CITED IN THE DESCRIPTION

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