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(54) **Process for the generation of a gas**

(57) The present invention is directed to a process for generating a gas having a temperature of between 50 and 500°C, by generating a hot gas using combustion of a combustible material, cooling at least part of the said hot gas using the endothermal decomposition of a product made of gas penetrable solid material, wherein

- the porosity of the said product made of gas penetrable solid material and thereby the heat exchange

with the undecomposed mass is controlled, or

- by adjusting the chemical composition of the said product made of gas penetrable solid material and/or the gas generating material, and/or
- by mixing part of the cooled gas and part of uncooled gas to provide a gas of the required temperature.

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Description

[0001] The invention relates to applied chemistry, more specifically to the generation of gases of low temperature for various purposes.

[0002] Under various circumstances there exist the need for providing a gas to a system, for example for blanketing purposes, passivation, medicinal, cooling, heating and the like. Usually these systems are either based on compressed gases stored in cylinders, or on compressors driven by external power, such as gasoline or electricity. The latter approach is not useful in case the power/energy has to be provided on locations where such facilities are not available. Examples thereof can be found in all kinds of emergency systems, rescue and salvage systems and the like. Also the use of compressed gas has disadvantages, as these systems require maintenance and cannot be relied on in situations where only occasionally need exists for its use. Further, the use of compressed gas may lead to temperature decrease due to adiabatic expansion.

[0003] The weight and size of the system for providing the gas for power generation is also an important consideration.

[0004] Gas generating processes based on the decomposition or burning of chemical propellants and other compositions are frequently being used for a number of purposes. It is known that gas for inflation can be generated by decomposition or burning of solid materials, such as azides. However, these materials have the disadvantage that they generate a very hot gas, which is often unwanted, because of the hazards thereof to the environment or the object to be used.

[0005] It is known that these gases can be cooled by using the endothermal decomposition of a product made of gas penetrable solid material.

[0006] The hot gas generated by the burning of a solid material passes through the porous material. The heat of decomposition needed is given off by the hot gas, which cools as a consequence thereof.

[0007] The decomposition can consist of an endothermal reaction, or of a phase transition of the solid porous material or making use of physical properties (e.g. heat capacity). Examples of phase transition are melting, evaporation and sublimation.

[0008] However, there is a need for generating a gas in that way, whereby the temperature of the gas is not fixed at the level determined by the system, but rather can be determined independently of the system. There is also a need for generating a gas having a temperature intermediate between the temperature of a cold gas generator (between 25 and 95°C) and of a hot gas generator (about 1000°C).

The invention is accordingly directed to a process and a system for generating a gas having a temperature of between 50 and 500°C, by generating a hot gas using combustion of a combustible material, cooling at least part of the said hot gas using the endothermal decom-

position of a product made of gas penetrable solid material, wherein

- the porosity of the said product made of gas penetrable solid material and thereby the heat exchange with the undecomposed mass is controlled, or
- by adjusting the chemical composition of the said product made of gas penetrable solid material and/or the gas generating material, and/or
- by mixing part of the cooled gas and part of uncooled gas to provide a gas of the required temperature.

[0009] The present invention is based on the surprising idea, that it is possible to produce a gas of an intermediate temperature by various means, namely either by controlling the porosity of the said product made of gas penetrable solid material and thereby the heat exchange with the undecomposed mass, by adjusting the chemical composition of the said product made of gas penetrable solid material and/or the gas generating material, or by providing a by-pass for part of the hot gas, which is then mixed with the cold gas.

[0010] Further, the first two embodiments may be combined with the last one to provide a variable temperature. By selecting the ratio of the two gas flows, the temperature of the final gas can be selected. It is quite surprising that it is possible to obtain two separate gas flows from the single source of combustion, without influencing the total combustion unduly.

[0011] In general, the process of the present invention is carried out by providing the combustion of a combustible material, whereby at least part of the generated gas is passed through the cooling material, and optionally part is by-passing the cooling material.

[0012] In the present invention gases, specifically nitrogen, oxygen, hydrogen, or a gas-mixture, are generated, based on the endothermal decomposition of a product made of gas penetrable solid material. The gas penetrable solid material comprises a nitrogen (or other 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.

[0013] The type of gas generating material can be freely selected among the suitable propellant or other gas generating materials. Generally the gas to be generated will be nitrogen, but it is also possible to generate oxygen, hydrogen or a suitable mixture of gases.

[0014] 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. The initial temperature of the gases depends on the chemical composition of the gas generating mass, and can be influenced by that.

[0015] The degree of cooling of the generated gas depends on the nature of the cooling agent, the porosity (grain size) of the cooling agent, the chemical composition of the cooling agent, and/or the mass of the cooling agent, which can sometimes exceeds the mass of the gas-generating composition. Generally the gas is cooled to a temperature below 100°C, but a value within the range of 25 to 75°C is preferred.

[0016] Further a by-pass of hot gas can be created, which hot gas is mixed with the cool gas in a variable amount. The relative amounts of the two gas flows determine the final temperature, which may be between about 50°C and about 500°C. The relative amounts of the two gas flows, hot and cold, can be obtained using suitably designed lines and valves.

[0017] When sodium compounds are used as the gas source for the temperature gas production, the decomposition reaction generally results in Na and the gas. The formed gas is blown off and the slag remains. This slag comprises of the remains of cementing agent and cooling agent and metallic sodium. Under these conditions of gas generation the highly chemically reactive sodium is thus generated. This highly reactive material will accumulate in the condensed burning 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.

[0018] According to a preferred embodiment this problem can easily be overcome by the use of a gas generator comprising a first body, comprising means for the generation of gas, and a second body, comprising means for the generation of a neutralisation agent, wherein means are present for contacting the neutralisation agent with the reaction products formed in the generation of gas in the first body, and wherein means are present for operating the means in the second body at a temporal and/or spatial interval with the means in the first body.

[0019] The principle encompasses two gas generators. A first gas generator with the primary task of generating gas of variable temperature, and a second gas generator with the primary task of generating neutralizing compounds for the slag obtained from the first gas generator.

[0020] The first gas generator contains a composition from which gas of variable 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 moving direction of the reaction front.

[0021] The second gas generator (the neutraliser) is another composition, comprising a gas generating com-

position together with an effective neutraliser compound, for instance sulphur. With the neutraliser composition gas and vaporised sulphur is generated at a time and space interval with the first gas generator. The gas and vaporised sulphur is generated at a rate and a manner that the effective neutralisation of slag is accomplished and the vaporised sulphur is not emitted. The vaporised sulphur reacts with the reaction products from the first gas generator such that the products are effectively neutralised.

[0022] The process of the present invention may be used for generating gas of a variable temperature, i.e. a temperature that is relatively independent of the type of gas generating material, and which temperature may further be dependent on the specifics of the location and the situation. Examples of suitable applications are especially in the rescue and salvage operations, generating of aerosols having multispectral properties (IR and visible), heat shields, and the like. The composition can also be employed for gas generation in areas where only permissible explosives are allowed.

[0023] The present invention can also suitably be applied in the melting, spraying and/or atomizing of insecticides, herbicides, fungicides, rodenticides, and the like, which materials are quite often applied in the form of a mist or aerosol, using airplanes or other suitable machinery for that purpose.

[0024] All these applications have in common that they require a relatively cold and harmless gas to be generated at short notice at locations where no external power is available. Important in these applications is also that the equipment is relatively compact and remains reliable even after long periods of storage, without maintenance or testing. Especially the use of compressed gas requires continuous maintenance activities. For example in remote locations this may be difficult to arrange.

Claims

1. Process for generating a gas having a temperature of between 50 and 500°C, by generating a hot gas using combustion of a combustible material, cooling at least part of the said hot gas using the endothermal decomposition of a product made of gas penetrable solid material, wherein
 - the porosity of the said product made of gas penetrable solid material and thereby the heat exchange with the undecomposed mass is controlled, or
 - by adjusting the chemical composition of the said product made of gas penetrable solid material and/or the gas generating material, and/or
 - by mixing part of the cooled gas and part of uncooled gas to provide a gas of the required tem-

perature.

2. Process according to claim 1, wherein a combustible gas generating material is combusted and the generated hot gas is passed through the gas penetrable solid material. 5
3. Process according to anyone of the claims 1 and 2, wherein the gas is selected from the group of nitrogen, oxygen, hydrogen and gasmixtures. 10
4. Process according to claim 1-3, wherein the gas is used in rescue and salvage operations.
5. Process according to claim 1-3, wherein the gas is used in generating of aerosols having multispectral properties (IR and visible), heat shields, and the like. 15
6. Process according to claim 1-3, wherein the gas is used for gas generation in areas where only permissible explosives are allowed. 20
7. Process according to claim 1-3, wherein the gas is used for melting and/or spraying and/or atomizing active substances, such as insecticides, herbicides, fungicides, rodicides and the like. 25

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Application Number
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Place of search THE HAGUE		Date of completion of the search 21 June 2000	Examiner Schut, R
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